Re-Thinking Finance

How Poor Finance Theory and Practice Distorts Investments and Economic Policy

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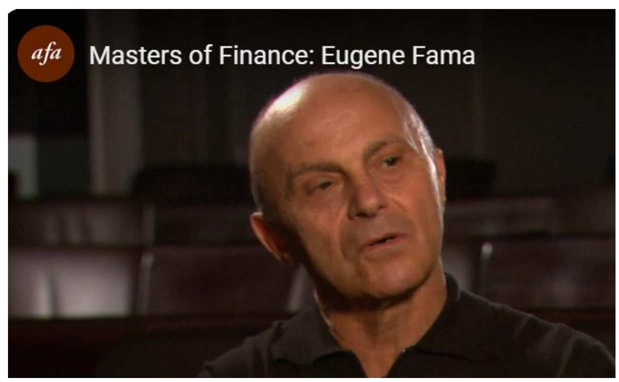
PART I – Introduction to Finance and Problems with Finance Theory and Practice

Chapter 1: Introduction – Flawed Financial Analysis Techniques

I have had stops and starts at writing this book for many years. When I began the book, I admired famous people in finance like Merton Miller, Harry Markowitz, Bob Hamada, William Sharpe, Fisher Black, Myron Scholes, and Eugene Fama. In the late 1970's and 1980's I was impressed by the seeming elegance of the capital asset pricing model ("CAPM") that I learned at the University of Chicago. At the same time, I was anxious to understand all the sophisticated techniques used in practice by investment bankers when I was a credit analyst at a bank. I wanted to know what fancy methods they used for things like creating a selection of comparable companies in merger and acquisition ("M&A") transactions and how project finance professionals used sophisticated techniques to derive target values for the debt service coverage ratio and the equity internal rate of return ("IRR"). My original idea in writing this book was to provide a few practical ideas about implementing finance theory that I have learned through working on many finance issues around the world and that I wanted to use as support for my financial modelling classes.

As I continued to work with different financial tools my opinions changed. After re-reading numerous articles and books about finance written by academics; providing expert testimony on cost of capital in many courtrooms; working as a banker on large financing transactions; building thousands of corporate and project finance models; living through financial crises; understanding the nuances of project finance; consulting on financing and M&A transactions; observing bull markets and low credit spreads; and, most of all meeting teaching courses where I meet smart people all around the world who are often frustrated with finance, I have come to conclude that very much (not all) of the finance theory taught in MBA courses and written in Finance Books is either useless or fundamentally incorrect.



Picture from Eugene Fama interview with Richard Roll. In the interview (which I discuss later) Fama brags about his sophisticated statistical analysis but notably skates around and does not answer a question about whether cost of capital can be measured.

For people who apply traditional finance in their daily work that includes things like computing value from discounted cash flow at the weighted average cost of capital ("WACC"); applying the CAPM in measuring cost of capital; applying simple or seemingly complicated terminal value formulas; using country risk premiums to adjust value in developing countries; un-levering and re-levering beta for computing impairment write-offs; using enterprise value to earnings ("EV/EBITDA") multiples in developing terminal value; assuming prospective EBTIDA changes without adjusting terminal capital expenditures; believing the formula for computing value from growth, return on invested capital ("ROIC") and WACC is accurate; downloading betas that include mean reversion from Bloomberg; evaluating the minimum acceptable equity internal rate of return ("IRR") from something like the adjusted net present value ("NPV") method; computing ROIC from financial statements to gauge performance without adjusting depreciation; presuming the cost of equity is always more than the cost of debt; not recognizing the difference between mean reverting and non-mean reverting risks; plopping the equity market risk premium from Damodaran's website, my suggestion that all of these techniques are wrong may seem to be radical. My hope is that these aggressive assertions which run counter to finance academics, teachers in prominent MBA programs, practical tools used by investment bankers and consultants and decision tools used by CFO's will prompt you to think differently.

Picture of Merton Miller from Trillion Dollar Bet film. I think Miller's fundamental idea of separating value operations from financing was remarkable. The idea of using project finance to measure risk seems to be counter to his ideas but I think he would agree with the idea.

Given my assertions, you may think that this book has no practical application as you will most probably have to use the classic tools in finance in practice no matter what I say. I beg you to not stop reading now as I do provide practical alternative analytical techniques rather than just complaining about current approaches when working through the flaws associated with finance theory and its application. These alternatives include a different way to compute IRR by measuring the earned risk premium (not the modified IRR or MIRR); a different way to construct financial statements that does not bias measured returns (using economic depreciation); different ways to evaluate risk through debt capacity and debt structure in project finance as an alternative to measuring risk with classic cost of capital; different ways to think about beta without mean reversion adjustments; alternative approaches for conceptualizing and computing terminal value and changes in risk over the life cycle of an investment; different ways to compute the cost of capital through evaluating the price to book ratio relative to the earned return. You may not be able to apply these alternative ways to think about finance, but if you can understand some and think differently, my hope is that you will be provoked into opening your mind about some of the issues.

Two Initial Propositions Behind Finance and Use of Financial Models in Demonstrating Problems in Finance Theory

The list of things that are wrong with finance includes a lot of criticism of the way risk is measured through trying to estimate the cost of capital. You could even think that this long book ultimately comes down to arguing that a lower cost of capital should be used in assessing investments and not much else. And to be sure, I do address many problems with attempting to measure the value of risk including bias in evaluating the cost of capital. I suggest that distortions that come from ideas developed by academics, consultants, bankers and the like affect essential investment decisions like infrastructure investments that should be made for a viable transaction to clean energy. This suggestion comes from a penchant for many institutions like universities, investment banks, consultants and others to favour the investor class who need justification in earning high returns, often derived from having monopolistic industry structures. But in addition to cost of capital issues, I address many subjects other than the minimum required return on investment (the definition of cost of capital) in subsequent chapters. These alternative ways to think about finance come from going back to the most fundamental propositions of finance which should be the at the start of any finance text but are not.

Proposition One: Finance Boils Down to Two Things – Making a Forecast and Incorporating Risk of the Forecast

The initial basic proposition of finance is that any valuation used in an investment decision comes down to only two things which boils down to performing a cost and benefit analysis. These two things are (1) forecasting the future and (2) placing some kind of risk analysis on the forecast. Investments involve incurring some kind of cost, not necessarily spending money, which can range from taking time to go running in the morning to making advertising expenditures, to spending money for building a toll road, to hiring a new employee with expertise in artificial intelligence. To assess these investments, you must make a forecast of the future benefits such as cash flow or health benefits from exercising or the pleasure I get from investing my time in writing this book (I am not expecting any revenues). I suggest later on that the study of finance boils down to cost and benefit analysis on making investments with uncertain returns. This cost and benefit analysis which you can call valuation is make complicated by the fact that the future is uncertain – you do not really know about the benefits you will receive in the future from making an investment. This means some kind of risk measurement must be applied to this forecast in arriving at the valuation.

The two parts of this value proposition – first, forecasting and, second, applying risk to forecasts may seem like no big deal. But they are two of the most difficult problems in economics. The two parts of cost and benefit analysis are the basis for valuation using discounted cash flow; assessment of the ability to pay back a loan; the evaluation of making an acquisition of a company. Forecasting is addressed throughout the book by evaluating reasonable rate of return expectations given competitive pressures. For example, if somebody projects earning a high rate of return on an investment with low risk that does not have some kind of unique and long-lasting competitive advantage or monopoly power, the forecast should be challenged.[1] Part of this return assessment is questioning the fundamental calculations of the return on invested capital ("ROIC"), return on equity ("ROE") and the internal rate of return ("IRR"). Throughout this book I emphasize that application of putting some kind of risk measurement on a cash flow forecast does not imply that the only way to measure risk is through applying premiums to the cost of capital. Other implicit or explicit risk measures addressed include use of multiples like P/E ratios in valuation, debt capacity in project finance, use of probability in assessing start-up investments, or assessing risk with time series characteristics of cash flows with direct assessment of the possibility of obsolescence, fashion changes and other factors.

Proposition Two: Value Comes from Earning a Return Above the Cost of Capital

A second and related fundamental proposition in finance that should be the starting point of thinking about valuation is the idea that value is created through earning a rate of return above the cost of capital and making investments where an excess return is being earned. This proposition connects finance to the strategy of a firm where the emphasis is on the evaluating the rate of return statistic and thinking about the reasonableness of earning high returns over a long period. If a company has some kind of lasting competitive advantage allowing it to earn a strong return (maybe from some kind of monopoly power), it should grow that business. When the benefits are greater than the costs from an investment, keep making the investment. If the company is earning less than its cost of capital in another segment of the business, it should stop investing and even exit that part of the business. This second proposition involving rate of return, growth and cost of capital is pretty obvious. If you do something good, you want to grow the activity and vice versa. The problem addressed in this book is that measurement of these three variables over time – rate of return, expected growth and cost of capital. Measurement of return and cost of capital are underneath chapters that cover project finance, financial statement analysis, valuation multiples, performance measurement and terminal value.

Who am I to Question All of These Underlying Ideas and Applications of Finance

It may seem arrogant for a person without a finance PHD (me), who has spent much of his life programming financial models to suggest that there are so many things wrong with finance theory and practice. I admit I do have psychological hangups about academia as much of my family has doctorate degrees in hard sciences and are associated with prominent academic institutions. But I have no doubt that my experience in learning details from professionals all over the world and seeing how investments are made in practice has given me

[1] The same can be applied to earning a high return from a government contract – eventually the government will probably figure things out and put pressure or get out of the contract.

a much better background to comment on finance theory and practice than by teaching aspiring private equity professionals in New York or Chicago. By getting my hands dirty working with real valuation issues and data through writing financial models you one can see the problems with trying to apply accepted finance theory to valuation methods, interpretation of accounting equations (for return on investment), approaches used to estimate the required return on different investments, metrics used in finance equations and even risk philosophy.

When I began teaching classes in financial analysis to practitioners around the world more than three decades ago, I was insecure, and I thought the most important thing I could impart to participants in my classes was the mechanics of financial modelling. This is something quite concrete and I thought I could at least leave students with some practical excel tricks. I even wrote a long and very boring book about modelling.[2] Later, I gained a little more confidence and began to emphasize the use of modelling in evaluating contracts and investment case studies with project financing structuring. In this book I move further away from the modelling mechanics and deal with fundamental issues of theory, practice and philosophical questions at the heart of finance. I demonstrate that the way finance theory and practice have developed is biased at a basic level and it distorts essential decision making and public policy related to key environmental and developmental issues facing the world. In financing essential investments that depend on achieving a low cost of capital, we can do much better than measuring risks and associated required returns than clicking on Damodaran's website; than reading irrelevant articles by Dean Pietro Veronesi; than by studying statistical methods of stock prices developed by Eugene Fama; or than by applying formulas written in the McKinsey book which suggests that companies earning monopoly profits is good for the economy.

While this book is about financial theory, using financial models to prove that many fundamental concepts are wrong is an essential element of the book. I argue that a problem with people who teach and develop financial theory is that they do not construct enough nuanced real-world financial models as contrasted to statistical models with irrelevant t-statistics (I understand why, as it can certainly be painful and boring). In this book, instead of focusing on excel tricks and modelling mechanics, I use financial models to demonstrate the problems with the way finance is taught and practiced. For example, I demonstrate that analysis of the price to book ratio together with earned returns on equity tells you a lot more about the cost of capital than statistical analysis using the CAPM. All that said, I hope not to detract from the ideas of the book with discussion of modelling mechanics. Instead, I have put documentation of the mechanics for the various models in accompanying webpages. There is a video explaining the financial modelling mechanics for each chapter.[3]

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[2] Corporate and Project Finance Modelling, Wiley.

[3] The descriptions of financial modelling techniques can be found at www.edbodmer.com. In discussing the various issues, I will point to places on the website where you can prove the concepts for yourself.

Organisation of the Remainder of This Book

I have separated this book into six different parts. I have arranged the separate parts so that some sections can be into standalone books on project finance, corporate finance and cost of capital. Part I includes this chapter and the next few chapters. These chapters address problems with the way finance is taught in top MBA programs; how finance academics do not address essential valuation issues; which constitute Part I begin by presenting some of my opinions on what is wrong with finance.

Part II moves to issues associated with the fundamental statistic in finance, the rate of return, which measures expected or actual benefits in the numerator and the investment cost in the denominator. As the rate of return is fundamentally a measure of growth, Part II begins with some philosophical notions of growth, return and cost of capital supported by mathematical analysis. Alternative approaches to measure return (using earned risk premium rather than IRR) and assess financial performance (using economic depreciation) are introduced. Questions of compounding risk and assessing minimum required return are addressed differently than typical What does it mean to society if investors earn higher growth rates than the overall rate of growth in the economy; does earning a return above the cost of capital imply that a society is productive and performing better than societies where firms earn the cost of capital. What are fundamental issues related to waiting for consumption imply with respect to the real cost of capital.

Part III works through comprehensive financial analysis to value different energy investments to demonstrate problems with finance including the four sins in corporate finance – imagining terminal value can be computed; overestimating cost of capital, wrongly interpreting multiples (P/E, EV/EBITDA, Price to Book) and distorting measures of return to evaluate performance. The discussion uses the case of investing in clean energy to demonstrate the ideas. By providing an overview of analysis methods starting with interpretation of the IRR and moving to project finance versus corporate finance, this part of the book demonstrates how different analysis techniques fit together. The remaining parts of the book describe in more detailed analysis of the way return is measured, how project finance concepts can address problems in evaluating terminal value and cost of capital, and how economic depreciation, better cost of capital management and terminal value assessment can be used in assessing valuation multiples.

Part IV addresses project financing of single investment. Project finance rather than corporate finance should be the foundation of cash flow assessment, risk analysis and cost of capital analysis that is driven by the financing structure. The section explains why traditional definitions and teaching of project finance generally miss the essence of project finance can provide methods to value long-term investments and raise funds for the investments in a rigorous and structured manner.

Part V switches from project finance to corporate finance. Once the cash flow, risk and value of one project is established, the value of a portfolio of current and future assets can be assessed which make up a corporation. Once the value of a corporation is understood to be a portfolio of assets that can be assessed using risk and return evaluation of separate projects, alternative methods of evaluating cash flow projections, terminal value and multiples can be developed.

Part VI addresses technical issues with associated with measuring cost of capital. The many problems with applying the CAPM are described ranging from coming up with the risk-free rate and the market risk premium to the remarkable convention of using an arbitrary using a simplistic mean reversion factor for beta. The notion of adding country risk premiums from government bond assessment is also discussed. Alternatives to the CAPM are presented using the fundamental notion that when an investment is earning its cost of capital, the market value of that investment is equivalent to the amount of money invested.

The idea is that I try to explain ideas in a non-technical way and then later work through technical details including modelling issues. To organise the book using this approach I have divided the chapters into five parts. Part II provides an overview of the valuation and risk analysis issues so that you can gain a comprehensive picture of problems and possible resolutions (I suspect many will stop reading after Part I). Part II describes more detailed issues with measuring IRR, NPV, rate of return and performance measurement. Part III moves to project finance which present unique ways to derive the cost of capital. Maybe should be separate books.

If DCF mechanics are wrong; typical techniques for measuring IRR to assess and investment are wrong; use of comparative multiples is wrong; standard techniques for measuring the cost of capital are wrong; the WACC formula is wrong; measuring the return on invested capital from financial statement analysis is wrong; terminal valuation techniques are wrong; the assumption that stock prices follow a random walk is wrong and the general proposition that debt has a lower cost than equity is wrong, this would certainly be enough material for a book. When I initially wrote this chapter, I began compiling a list of specific propositions in finance that are very irritating to me. So that you can see this book is not about general blah blah blah discussions but addresses specific problems, I have included a list of particular items that academics, consultants, investment bankers and others get wrong about finance (my son calls me der wütender alter throttle). But so that you can get to more important things than my complaints, I have relegated my list to an appendix.

Chapter 1 Appendix

Selected Irritating Illustrations of Bad Finance Theory and Practice

1. Loudmouth stock analysts on television who imply that P/E and EV/EBITDA ratios have some kind of inherent meaning without ever having made the effort to study all of the nuanced factors such as the age of assets, changes in short-term returns, impairment and other write-offs, movements in the cost of capital and other factors that can cause seemingly very similar companies to have very different valuation metrics.

2. The manner by which the financial professionals assume that growth in stock indices implicitly represent underlying earnings power of corporations when computing the equity market risk premium ("EMRP") without considering the effect on stock indices from capital gains that come about because of changes in the cost of capital (the stock market goes up when real interest rates decline, and this has nothing to do with corporations earning a higher return).

3. Valuation analysts and teachers who believe the McKinsey value driver formula: Value = Income x (1-Return/Growth)/(Cost of Capital – Growth) can be applied in practice without understanding that the formula falls apart as soon as changing returns, changing growth rates and more careful definitions of return are assumed (if returns are constant, valuation is really easy and you don't need the formula).

4. The way people in finance look at a website (Damodaran) and plop out either a country risk premium and/or the overall equity market risk premium without understanding the implicit assumptions inherent in the formulas and without working through details of the calculation.

5. Suggestions made by McKinsey and others that it is appropriate to compute the Modified IRR ("MIRR") which does nothing more than give you back the discount rate that you input or to present the multiple of invested capital which is just another way of computing an old fashion payback period.

6. Doctrines of finance experts that cash flow to the firm – cash flow from both debt and equity investors should always be used in financial analysis without recognizing that financers who structure debt implicitly provide the best information about the risk of investments (meaning that equity IRR rather than project IRR and ROIC should be the basis of valuation for many assets).

7. Harvard case studies and analysts who apply or recommend terminal value calculations that miss essential points about required capital investments to replace equipment and maintain returns, and do not evaluate gradual changes in returns, gradual changes in growth and trends in the cost of capital in the long-term.

8. Investment bankers in M&A presentations performing the senseless exercise of un-gearing and re-gearing betas without considering the risk of debt or assuming the debt beta can be computed in a reasonable manner.

9. The proposition in CFA materials that that the cost of equity is always higher than the cost of debt without considering the basic idea that debt has downside and no upside other than earning the credit spread while equity has an unlimited upside.

10. Finance academics who acknowledge that the CAPM does not work and who suggest the Arbitrage Pricing Model as an alternative without recognizing the arbitrage pricing model makes most sense in the context of an investment that can be hedged with forward prices so as to eliminate risk premiums from the valuation analysis.

11. All sorts of financial analysts who compute the WACC through multiplying the interest rate by one minus the tax rate and not recognizing that the value of the tax shield is analogous to a government grant which suggests that the amount of the debt rather than the interest rate should be adjusted.

12. Standard and Poor's and Moody's crazy to evaluate risk without starting with the fundamental notion that some risks related to weather, commodity prices or economic cycles are mean reverting and other risks related to fashion, obsolescence and political events are permanent.

13. Finance professors who show off by creating a Monte Carlo simulation without making attempts to measure mean reversion and without properly testing for the presence of mean reversion.

14. Finance textbooks (e.g., Damodaran, McKinsey and other) that apply the same valuation model for an investment in the start-up or development stage as in the mature stage and that do not recognize that valuation models must explicitly consider probability of failure in the early stage of an investment.

15. Finance programs (e.g., the Amsterdam Institute of Finance) that assert a finance expert can find innovative ways to interpret financial statements without understanding that it is virtually impossible to construct useful information for the central statistic required of valuation analysis which is the economic rate of return on invested capital and the economic return on equity capital.

16. Finance academics who discuss the CAPM but have never worked through real world problems with different betas being computed if daily, weekly or monthly prices are used; if different historic EMRP if different databases are used; and if different risk-free rates are used with different implicit inflation forecasts.

17. Valuation analysts who cannot take a step back and realise that the long run value of a corporation above the historic investment comes from two pots, the first being a forecast of the ability to earn economic profit from existing investments and the second is the philosophic question of the ability of management to continue to make investments that earn monopoly profit.

18. Value line and MarketWatch who publish beta statistics that are artificially pushed towards 1.0 in an arbitrary manner using a paper published in 1975 even though it is easy to demonstrate that for mature companies no such movement towards 1.0 exists.

19. Financial economists who do not understand the politics behind cost of capital and returns and who assert that societies with companies that are earning high returns (i.e., monopoly profits) and generating high growth (with negative environmental impacts) are good for society.

20. Bankers and consultants who waste time on putting together comparative samples of valuation ratios such as EV/EBITDA, P/E and market to book without carefully studying the age, prospective return, capital expenditure levels and other factors for individual companies that explain why the ratios are different.

Chapter 2: Problem Source: Academics, MBA Programs, Consultants and Practitioners

After introducing problems with finance in Chapter 1, we now move to thinking about what has given rise to the problems in finance theory and practice. There is a lot of vitriol on social networks these days that includes personal attacks and a lot of name-calling and I try to avoid this when addressing who is responsible for getting so many key things wrong in finance. But as I am commenting on so many theories and practices that I am convinced are so seriously flawed, I may ruffle a few feathers, especially of business schools, academia and consulting firms. But rather than making empty complaints about people and institutions, I hope to demonstrate specific problems with research, teaching and practicing finance that are addressed in more technical detail in later chapters.

Picture of Jack Welch president of GE who was worshiped in MBA courses and who used ROIC to evaluate employees (and fire people who obtained low ROICs). We demonstrate problems of the ROIC statistic and problems in not evaluating cash flow over the lifetime of projects.

When watching videos or listening to podcasts you may come across Warren Buffet's complaints about MBAs and business schools which are pretty general and do not hit at specific issues such as the techniques to gauge risk and return. Similarly, you may listen to discussions about problems with Boeing deriving from too many MBA's whose ideas originate from Jack Welch (known as Neutron Jack for the way he demanded people to be fired).[4] I use the example of GE and Jack Welch to demonstrate how I hope to be commenting on specific thinking about financial issues are addressed rather than simple complaints.

When I was studying business a long time ago, Jack Welch's ideas were worshiped, and GE was the most valuable company in the world. In the past decades GE's value has plummeted dramatically, and Welch's ideas are less used as a model in MBA programs. In thinking about what went wrong, I remember a case study where we had a long discussion about strategy and ultimately the case boiled down to a manager at GE who increased price so that he could achieve the return on invested capital ("ROIC") target that was used to measure short-term performance. The emphasis on current year ROIC limited investments that had a long development lead time (perhaps with zero income for many years). You can contrast the GE

[4] The ideas of Welch have been suggested as the underlying problem for Boeing when making decisions about investing new planes that have a very long development period. Jack Welch's ideas that arguably caused the demise of General Electric also led to the fall in the reputation of Boeing.

model with the investment made by NVDIA (discussed in the next chapter) where the company developed its chip and software along with buying multiple companies in 2006 in order to be a leader in AI that did not payoff for many years. The focus on ROIC also dissuaded investment strategies that had relatively low long-term returns but also had mitigated risks. Use of return on invested capital rather than equity returns also neglected key information coming from funding sources (i.e. lenders) that contain a lot of information about risk.

Finance is Where Medicine was Before Louis Pasture and where Electricity was before Michael Faraday

I am convinced that professors of finance in prominent universities, investment bankers, consultants and others blindly follow approaches to measuring return and risk that are mysterious and can best be best described as magic potion. This magic potion includes using the CAPM to measure cost of capital, compounding risk premia, applying simplistic terminal value formulas, developing financial statement analysis that does not produce useful return information, implementing meaningless country risk premiums, making vague statements about growth stocks and value stocks, using P/E and EV/EBITDA valuation multiples that compare seemingly similar companies with but have different trends in returns, valuing start-up ventures and/or development expenditures with some kind of target return rather than probability and making a host of other calculations that have not been demonstrated to improve investment analysis. These ideas in finance are not the only subject that is founded on mysterious forces and magicians.

I have come to believe that the subject of finance is something like the understanding of electricity early in the 19th century before the discoveries of Michael Faraday or maybe finance is like the understanding of medicine before Louis Pasture. Faraday invented electromagnetic devices, the electric dynamo and wrote principles underlying electromagnetic induction, diamagnetism, and electrolysis. He used the principles to construct the electric dynamo (the ancestor of modern power generators) and the electric motor. It was largely due to his efforts that electricity became practical for use in technology rather than some kind mysterious force that was interesting but could not be used. In the case of medicine, before the work of Louis Pasture, many foundations of medicine were not understood well, and a lot of treatment was analogous to magic potion. Pasture, who was not a physician, dramatically changed the world by removing many aspects of medicine that were previously treated with what today could be considered magic potions. the mystery through his work to understand the

Michael Faraday who took the mystery out of electricity to make a useful electric motor.

causes and preventions of diseases, sterilisation, germ theory and vaccines provided much more solid foundations for much of medicine.

In the remainder of this book I demonstrate with careful financial modelling and data analysis that much of finance theory is tantamount to different kind of magic potion. I suggest that finance concepts taught in business schools without rigorous analytical thinking about cost of capital, appropriate return measurement, careful cash flow forecasts, evaluation of affordable prices have led to social problems, aggravated difficulties faced by companies attempting to construct new investments in developing countries and affected the overall quality of life (for example, with focus on traffic and strip malls rather than railways). The financial principles taught in MBA programs and supported by academics arguably aggravate environmental problems because of inflated cost of capital assigned to capital intensive renewable energy and other investments necessary for any chance of either combating or adapting to climate change. I do not assert my ideas in this book can fix any problem and I do not claim that my suggestions can change anything. I certainly do not suggest my ideas are revolutionary. My goal is to point out fundamental problems in finance and give you some alternative ideas to think about.

Initial Source of Finance Problems – How Finance is Taught in Business School

I am now brave enough to assert my beliefs that the very foundations of finance are often flawed (I don't work for a big bank anymore and I don't have to worry about being careful about what I say). One of the starting points that gives rise to problems with finance is ideas that have been taught to private equity professionals, investment bankers, commercial bankers, consultants, financial analysts and others as a part of financial education, in particular MBA programs. I am certainly one of those people who have been taught the financial ideas – I came out with knowledge of some fancy ideas; but no philosophy; no discussion of the social implications of investment decisions; no use of nuanced financial models to question the IRR statistic, valuation multiples, return as a performance measure or formulas to quantify terminal value. As you go into the real world after your financial studies, you may not use the CAPM as much as it was discussed in business school and you will not apply fancy statistical analysis that proves markets are efficient. But you may well apply other ideas from the MBA program that are supposedly sacrosanct and were never really questioned: you will evaluate IRR's in ranking investments; you will create DCF models using WACC; you may well use EV/EBITDA multiples in valuation; you will sometimes adjust the cost of capital with un-geared and re-geared beta; you will gauge the performance of a company or a division of a company with ROIC or ROE.

I am virtually sure that understanding some very basic ideas that finance is about the cost and benefit analysis of alternative investment decisions (through making a forecast and assessing risk of that forecast relative to the investment) are not the starting point of finance education. I have a tough time imagining people graduating from business school acknowledging social and political issues associated with high cost of capital estimates. Nor do I think that finance alumnae would admit that what they are doing in valuation is estimating how long monopoly profits can last from earning higher returns than cost of capital and how long can those monopoly profits last from management skills. You will probably not think of any corporation as a portfolio of projects that will eventually cease to exist that have different risk profiles over time. Some of your MBA courses may address accounting and interpretation of financial statements, but they will not deal with the fact that return on investment which is the basis for valuation and performance measurement is distorted. I cannot imagine serious questioning the implications and analysis of mean reversion of beta, estimation of country risk premiums, questions of whether the equity market risk premium can be greater than the growth rate in the economy, derivation of risk from debt sizing, biases in the IRR and other related issues. These subjects will be addressed in later chapters by doing the hard work of gathering data and constructing structured financial models to prove the distortion created by popular financial techniques.

When reading the previous paragraph, you may think I have some kind of political agenda in this book. It is true that some issues such as the fact that if companies earn returns higher than cost of capital there will be greater dispersion in income, do have political implications. But my real goal is more modest. I want you to think differently about issues such as what the IRR really measures; how accounting for depreciation distorts return on investment (negating financial statement analysis); use of project finance as a way to value investments rather than as a different kind of debt; interpretation of multiples and understanding the key difference between interpretation of P/E and the price to book ratio; alternative ways to estimate cost of capital; evaluation of country risk premiums using the implied probability of default; considering terminal value formulas from philosophical ideas about how long the ability to earn monopoly profits can last; distortion in beta calculations by computing the statistics yourself; bias in un-leveraging and re-leveraging betas when lenders are implicitly measuring risk; and understanding the importance of mean reversion in risk assessment. Of course, there are brilliant people in finance and the way that finance is taught is not all the same with these problems. My objective in this and the many remaining chapters of this text is to give you an alternative way to think about finance and demonstrate that you should question both academic and practical financial analysis.

Business School Case Studies that Worship Aggressive Expectations of Return on Capital

In teaching courses to professionals around the world over the past three and a half decades, I have gone to a website and paid for case studies used in MBA programs. Studying real cases can certainly be an effective way to think about issues in making effective investments. Sometimes you can find teaching notes on the web that explain what students are supposed to learn from the courses. In complaining about how finance is taught and applied, reviewing a few selected case studies published by HBS and other MBA programs illustrates specific problems with finance education. The case studies often seem to be written by graduates who are proud of the companies where they have landed a job. I imagine students discussing the cases in large auditoriums and attempting to make seemingly insightful and complimentary comments about financial strategy of the company in question, after all their objective is to find a job at one of these companies. But many of the cases that were touted to be effective ran into failure that I once even considered writing this entire book around them (I chose not to). It has been interesting to discuss some of the cases with people who were actually involved in the cases to get a very different perspective from the glowing perspective suggested in the cases. In discussing these cases I note the very high desired return. I do not mean to suggest that the idea of earning a return above the cost of capital is bad. But I do question the notion that a very high return can be earned on over a long period of time without doing something very special. A few examples of cases that I have purchased and reviewed include:

- A case study called "AES in Africa" about a barge with an electricity plant in Lagos Nigeria. The case was introduced by discussing social responsibility and that "the company has acted on its belief that AES has a responsibility to be involved in projects that provide social benefits, such as lower cots to customers, a high degree of safety and reliability increased employment and a cleaner environment." When travelling to Lagos I was given the contract for the AES investment, gives a very different story. The high price in the contract implied a payback period of 2-3.5 years (depending on the assumption about the true cost of the plant) for a plant that had a lifetime of about 20 years.[5] Other provisions of the contract dramatically favoured AES and people familiar with the case the contract as an example of what not to do.
- An HBS case study named "Petrozuata" that was followed up by and article "Petrozuata, A Case Study of the Effective Use of Project Finance." The teaching note for the case suggested that students evaluate the lender project finance terms and discover how wonderful the financial structure was. But in the case write-up and the teaching note, there was no discussion of whether the investment resulted in a reasonable balancing of interests between the country and private investor, ConocoPhillips. After using the case I met people from Venezuela who were familiar with the actual project. They described the financing and contract structure as analogous to Christopher Columbus trading with indigenous people who gave up their gold for virtually nothing. Using numbers from the case provided, this "Case Study of Effective Use of Project Finance" produced a return for

[5] AES In Nigeria, Lawal Dosunmu, John McMillan, 2002 | Case No. IB29

ConocoPhillips of 25% over thirty years with conservative oil price assumptions that did not exceed 19 USD per barrel in nominal terms.[6] Worse, the case applied a 7% equity market risk premium and other arbitrary factors in developing an equity cost of capital of 20%. In the end, the case was not an effective use of project finance as the government nationalised the project. The nuanced question of whether you can earn high returns from taking resources out of the country was not addressed.

- A case on First Solar Corporation, written by a professor at Stanford Business School that was so complementary of management of the company that it included CVs of the principals. The case made an argument for using thin solar film panels rather than the silicon panels that turned out to be completely wrong as silicon panels made in China have dominated the market. To limit the dramatic First Solar's stock the company began to put together solar panels as a construction contractor, and it moved production to Malaysia. The company did stay in business in part through high U.S. tariffs on solar panels which can maybe called a success. Rather than touting management, the best lesson in the case is illustration of financial markets giving credit to a company is earning a high return without any sustainable competitive advantage and pushing the stock price to levels that made no sense.[7]
- A case named Norfolk Southern and Canadian Pacific about a merger where part of the assignment was to make a discounted cash flow valuation and part was to evaluate synergies from cost savings. The case touted the management of the acquiring company as being able to increase efficiency in an aggressive manner driven by a hedge-fund billionaire and activist investor named William "Bill" Ackman. The case does not question whether the merger motivation was to increase prices. In valuing the target, Norfolk and Southern, the case did not consider details of how capital expenditures in the long-term vary with expected growth; how stable working capital can be assessed; what are reasonable projections of the rate of return. The merger failed.[8]
- A case study named Burton Sensors about a hypothetical company with supposed financial difficulties. The case included comparative company data that include statistics such as operating margin and profit margin but nothing about the return on investment or return on equity that ultimately drive value. The case also stated that "The equity-risk premium was 5.8%" as if the key statistic is a published number that can be verified. The case also included a badly written financial model that did not recognize the increase in equity capital from not paying dividends and did not address the IRR on a new investment.[9]

Although the above case studies highlight issues in finance theory and practice, my favourite example is the first of three cases on the Dabhol plant in India, which involved major

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[6] "A Case Study of the Effective Use of Project Finance", Benjamin Esty, Bank of America Journal of Applied Finance, Fall 1999.

[7] "First Solar, Inc. In 2010", Stanford Graduate School of Business, Morgan Jerome Hallmon, Robert Siegel and Professor Robert A. Burgelman.

[8] "Norfolk and Southern", Harvard Business School, William E. Fruhan and Wei Wang, case 9-216-057 September 15 , 2017.

[9] "Burton Sensors, Inc.", Harvard Business School, William E. Fruhan and Wei Wang, Case 9-918-539 June 27, 2018.

energy and construction firms. The companies that invested in the project were Bechtel, General Electric and Enron, which at the time were three of the most prominent companies in the U.S. The second paragraph in the case, the quote from Rebecca Mark copied below tells you more about business education than a lot of the technical discussion in this book.[10] Rebecca (you can look up where she received her MBA on LinkedIn) proudly asserts that Enron will "spread the privatization gospel", have "missionary zeal" and bring "market mentality" in countries that "desperately need this kind of thinking."

> As they inched along the traffic jam of Bombay taxi cabs on Marine Drive, Rebecca Mark and Joe Sutton reflected upon the intense negotiation efforts of the past year and what had been accomplished. Their company, Enron Development Corporation, EDC, the development arm of the Enron Corporation, had been attempting entry into the potentially huge Indian market. EDC was headed by **Rebecca Mark, its youthful, energetic president and CEO**. She summed up her philosophy and mission:
>
> We are a very eclectic bunch with some ex-military people and some ex-entrepreneurs. We are brought together with a certain amount of **missionary zeal** which I think you have to have in this business. It demands so much of you all the time that you really have to believe in what you are doing. I think for us that **missionary zeal** has three parts – first, that these projects are **good for the country**. They get the economy moving by bringing in power and they bring in investment. Second, these plants are environmentally safe and without equal when you consider other options of coal or nuclear power. Third, **we are bringing a market mentality and spreading the privatization gospel in countries that desperately need this kind of thinking.** We are in the business of doing deals. This deal mentality is central to what we do. It's never a question of finding deals but of finding the kind of deals we like to do. We like to be pioneers.

This quote is not just a laughing matter. It raises issues about the attitude of company executives and if students can read the quote without commenting on the company's arrogance, something is wrong.

The good news about the Dabhol case study is that you can easily compute two key statistics from information in the case. An exhibit to the case provides the price of power and the operation and maintenance expense that was used in the price contract negotiated with the State-owned company that was to buy the power. With the revenues defined by the price and the operation and maintenance expense along with the capital expenditure for the project provided in the case (in the first paragraph), you can compute the pre-tax IRR on the project and the price of power. Assuming a three-year construction

Picture of Rebbeca Mark from LinkedIn

[10] Enron Development Corporation: The Dabhol Power Project in Maharashtra, India (A). Harvard Business School 9-596-099. Rev. July 6, 1998

period, this rate of return is about 17%. This rate of return does not include the amount margin earned by Enron, General Electric and Bechtel on the various contracts, which dramatically increase the return. I suspect that Harvard students discussing the case were not instructed to compute the rate of return and then assess whether it produced reasonable prices to consumers in India. They probably did not discuss the price of power contract relative to exiting power and what would happen to electricity that is stolen, and the financial condition of the company buying power if the price increased dramatically. I have met some former Enron employees who were familiar with the case over the years and their stories about how the contract was secured were a lot spicier than being a missionary for the privatization gospel. Despite a highly structured contract structure, the project ceased operations because of unaffordability. It was ultimately rescued when the former president of Bechtel, Dick Cheney, became Vice President of the U.S.

Academics Admit that the Issue of Cost of Capital Has Not Been Resolved

There are a lot of very smart finance professors, and a natural question is why the fundamental problems in finance are not routinely addressed in the literature. I do not read much finance literature written by academics which means that my comments here may neglect some good and relevant work on some of the subjects of this book. But when I do read some of the papers, I get the impression that professors try to prove ideas (that are generally not very relevant to anything) using elegant statistical analysis (when a couple of simple graphs of particular cases may be more useful). I agree with Nicholas Taleb who, in critiquing academic papers, wrote: “[t]he discussions are jargon-laden and heavily mathematical to give the illusion of science.”[11] Without an extensive review of the literature, it is fair to say that there is not much in analysis addressing fundamental issues of forecasting of cash flow, considering alternative measurements of risk, quantifying terminal value, assessing calculations of rate of return.

Reviewing a whole lot of academic research that do not address the fundamental problems with finance is outside the central idea of this book. But maybe a couple of examples can help to illustrate the problem. After Dean Pietro Veronesi from the University of Chicago decided against including a project finance or energy course in his curriculum, I reviewed a couple of papers for which he won awards. One paper studied whether “richer households’ wealth display a higher CAPM beta” presumably suggesting that richer people are less risk averse (not that beta is computed differently).[12] The paper contains page after page of formulas like those shown below to derive a not very surprising (or interesting) conclusion. This kind of writing is typical in finance research. What you cannot finding is writing is discussion of things like the philosophy of estimating terminal value; use of debt financing criteria to estimate the cost of capital; overcoming distortions in measuring rate of return; measuring value of a

[11] Fooled by Randomness, page 175.

[12] “Heterogeneous Households under Uncertainty”, Pietro Veronesi, University of Chicago, NBER, and CEPR, October 2019

corporation as a portfolio of investments at different stages of their life from venture capital type investments to stable bond-like cash flow; evaluating how mean reversion and volatility affect cost of capital for a project. These and other subjects would require creating little financial models and making simulations do demonstrate why the ideas are flawed – you can create the theoretical correct value assuming the forecast and the risk analysis is correct. Then you can evaluate multiples, terminal value formulas, accounting statements and other real world parameters that are painful to compute for academics.

In preparing for giving testimony on the cost of capital, I watched some interviews given by Eugene Fama. I came across a video that better describes problems with finance theory and academics better than a review of many papers. In this video, a famous finance professor name Richard Roll interviewed the noble prize winner Eugene Fama as one in a series of videos named “The Masters of Finance.” I initially watched this video to gather information for my testimony in a case involving estimates of the cost of capital when testifying on the Capital Asset Pricing Model. I watched the video a few times. The first time I watched the video I thought the Fama seemed relatively pleasant, and the recounting of his work seemed impressive. After watching it again more carefully I was less impressed. The most shocking question and the most telling question from Richard Roll was: “Do you agree that the cost of capital has not been determined”. Fama does not provide a response.[13] Every investment decision and valuation analysis depends on risk which is typically measured with cost of capital. Without being able to measure the cost of capital there is very little in finance.

$$\max_{\{C_{it}\}_{t=0}^{T}} E_0\left[\int_0^T e^{-\phi t}\frac{C_{it}^{1-\frac{1}{\rho_i}}}{1-\frac{1}{\rho_i}}dt\right] \quad \text{subject to} \quad E_0\left[\int_0^T M_t C_{it}dt\right] = s_i P_0 \tag{3}$$

where M_t is the equilibrium state price density (normalized to $M_0 = 1$). The Lagrangean of the static optimization is

$$L_i = E_0\left[\int_0^T e^{-\phi t}\frac{C_{it}^{1-\frac{1}{\rho_i}}}{1-\frac{1}{\rho_i}}dt\right] - \xi_i\left(E_0\left[\int_0^T M_t C_{it}dt\right] - s_i P_0\right) \tag{4}$$

where ξ_i is the Lagrange multiplier determined by the static budget constraint. The maximization is taken state by state and time by time obtaining the first-order condition

$$e^{-\phi t}C_{it}^{-\frac{1}{\rho_i}} = \xi_i M_t \quad \Longrightarrow \quad C_{it} = e^{-\rho_i \log(\xi_i)+\rho_i g_t} \tag{5}$$

where

$$g_t = -\phi t - \log(M_t) \tag{6}$$

Aggregate now across agents and impose the market clearing condition $D_t = \int C_{it}di$ to obtain the equilibrium condition:

$$D_t = \int e^{-\rho_i \log(\xi_i)+\rho_i g_t}di = E^{CS}\left[e^{-\rho_i \log(\xi_i)+\rho_i g_t}\right] \tag{7}$$

where the last step exploits the law of large numbers and $E^{CS}[.]$ denotes the cross-sectional average across agents i.[3] The quantity g_t, and hence the equilibrium state price density M_t, is the solution to equation (7), which I denote by $g_t = g(\delta_t)$. The state price density is then

$$M_t = e^{-\phi t - g(\delta_t)} \tag{8}$$

Given the equilibrium $g(\delta_t)$, the constants ξ_i are determined by the budget constraints (3). After substitution of M_t and using $P_0 = E_0\left[\int_0^T M_\tau D_\tau d\tau\right] = E_0\left[\int_0^T e^{-\phi\tau+\delta_\tau-g(\delta_\tau)}d\tau\right]$, the budget constraint (3) can be written as follows:

$$e^{-\rho_i \log(\xi_i)} = s_i\lambda(\rho_i) \quad \text{where} \quad \lambda(\rho_i) = \frac{E_0\left[\int_0^T e^{-\phi\tau+\delta_\tau-g(\delta_\tau)}d\tau\right]}{E_0\left[\int_0^T e^{-\phi\tau+(\rho_i-1)g(\delta_\tau)}d\tau\right]} \tag{9}$$

I finally substitute this expression back in equilibrium condition (7) to obtain:

$$e^{\delta_t} = E^{CS}\left[s_i\lambda(\rho_i)\, e^{\rho_i g(\delta_t)}\right] \tag{10}$$

[3] I assume throughout conditions are such that the law of large number can be applied. See Feldman and Gilles (1985), Judd (1985).

More Problems in Financial Analysis from McKinsey and Other Consultants

[13] You can watch his video at https://www.youtube.com/watch?v=tRSaz5TIyno.

Besides the teaching of business education and articles written by academics, another source of the problems with the current state of finance comes from consultants and the idea of that value can be quantified with a formula. Unlike the academic papers, the consultants seem to provide practical guides for use in financial analysis. In later chapters, I will often refer to a book written by McKinsey consultants named "Valuation Measuring and Managing the Value Companies." I heard people call this book the bible of finance and the book explains ideas used by Jack Welch introduced earlier. Problems with the McKinsey formulas and more importantly, the more general ideas on how to measure the costs and benefits of an investment are discussed in the many subsequent chapters. At its core, the McKinsey book touts the benefits of monopoly profits and suggests an economy works well when companies can earn high rates of return (by charging high prices). Authors of this book use the return on invested capital (ROIC) as a primary metric to evaluate an investment, but they do not question all of the nuances and biases in the ROIC formula.

The fact that the objective of a firm should try to earn returns above the cost of capital and then grow is summarized by a formula that I label the value driver formula. This formula is easy to prove (but is not proven in the McKinsey book) is:

Value = (1-growth/ROIC)/(WACC-growth)

This formula is touted to have the three value drivers of value and can be used to guide corporate strategy, management performance evaluation, terminal valuation, value multiples and other issues. Understanding why this formula does not work in different situations (through working through financial models with different assumptions) we can see a lot of what is wrong with financial analysis.

The danger of applying ideas that value can be boiled down to mathematical formulas like those suggested by McKinsey rather than considering a corporation as a portfolio of current and prospective project investments leads to many problems in financial analysis (this is why I argue that project finance should be the foundation of valuation). An example what McKinsey tries to do is when addressing the question of terminal value. Authors of the McKinsey book suggest that the formula shown below this paragraph should be used. Terminal value (labelled as continuing value) is supposed to be computed using the equation with all sorts of different returns and growth rates along with presuming that monopoly profits from current activities can be extended forever (the initial term, Economic Profit/WACC). My suggestion is that the problem of what will be the value of a company when all products are obsolete; all existing investments are finished

$$CV = \frac{\text{Economic Profit}_{t+1}}{\text{WACC}} + \left[\frac{\text{NOPLAT}_{t+1}\left(\frac{g_A}{\text{RONIC}_A}\right)(\text{RONIC}_A - \text{WACC})}{\text{WACC}(\text{WACC} - g_A)}\right]\left[1 - \left(\frac{1+g_A}{1+\text{WACC}}\right)^N\right] + \frac{\text{NOPLAT}(1+g_A)^N\left(\frac{g_B}{\text{RONIC}_B}\right)(\text{RONIC}_B - \text{WACC})}{\text{WACC}(\text{WACC} - g_B)(1+\text{WACC})^N}$$

producing income; all management is retired is something that cannot be boiled down to an equation.[14] Instead of trying to put valuation into a formula, I want you to step back and understand why things like terminal value cannot be resolved without thinking hard about what would make a company's ability to earn economic profits over a very long period of time.

Result: Resorting to Confusing Language to Confuse Things (Liquidity Springing Reserve Accounts)

Many years ago, when I worked for a bank, we would require a project company (called a special purpose vehicle or SPV) to put some money into something called a debt service reserve account so that in case something unpredictable happens such as a sudden breakdown of equipment, the SPV can make cash payments without having get a loan or raise equity capital. Nowadays companies can use something like a credit card, called a letter of credit, to have assurances that unpredictable payments can be made. I recently met someone in a workshop who asked me about something called a liquidity springing reserve. It seemed to be something very sophisticated and at one time I would be intimidated by things like this. When finding details of the liquidated springing reserve, it turns out is the same as a debt service reserve account that is created with a letter of credit. This fancy term – liquidity springing reserve -- demonstrates what much of finance seems to be about these days, which is trying to impress people with complicated terms. When explaining finance to engineers and others who what to understand how finance works, I tell them that the trick to being a finance expert is to: (1) talk really fast; (2) use big words and, (3) if you sense that people are still understanding you, make up new words.

After thinking about the lack of rigour in finance including statistics (IRR, P/E etc.) that mean little and are badly interpreted; financial education with case studies that prompt you to believe you can earn high returns with fancy financial structures; academic articles that don't answer real questions and are not understandable; and consultant formulas that cannot be used, the idea of attempting to confuse is natural. I have no doubt that you will find many examples of creating confusion when you are beginning to work in finance. My friend Conrad (a lawyer) gave me the following explanation description of finance expertise:

A medical doctor, an engineer, and a finance professor are at a cocktail party.

- ✓ The medical doctor pompously asserts that the medical profession is the oldest profession. He cites a passage from the Bible, in Genesis where God creates man and woman. "Surely," he says, "this was the first medical act."
- ✓ The engineer jumps in and says, "I remember a passage prior to that, which says, out of the chaos and confusion, God created the earth. Surely, this was the first act of engineering and predates the first medical act."

[14] McKinsey Book Version 6, page 278.

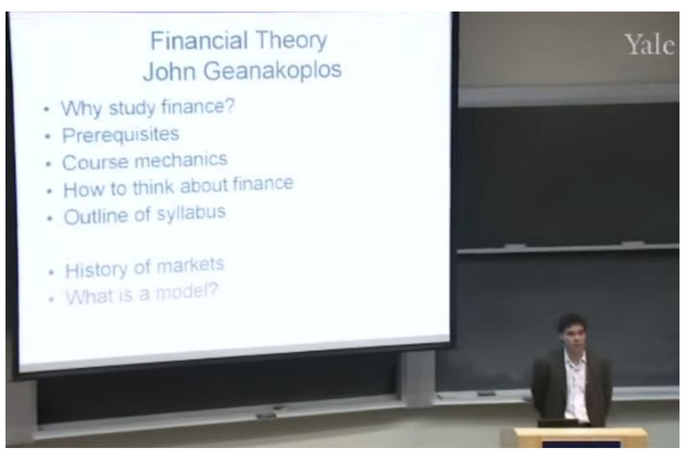
- ✓ “Aha!” says the finance professor, “who created the confusion?!”

Chapter 3 - Philosophical Issues: Cost of Delaying Gratification, Assessing and Compounding Risk

Why is the Study of Finance and Valuation Important in the World and What is the Definition of an Investment

After introducing general problems with finance, this chapter moves to underlying issues involving measuring return on investment and the associated risks. The idea is to prompt you to think about questions of how to evaluate investment decisions, the time value of money and required returns for taking risk. Using fundamental definitions of finance, investments and return along with a very simple economy you can think about what ultimately drives risk-free interest rates, methods for making forecasts and measurement of the risk premium for an investment. By structuring a crazy example of an island without money, stock markets, reserve banks, balance of payments or statistical analysis my hope is that you will ponder questions like whether a real risk free rate much above zero makes sense; whether compensation for taking risk should increase a lot over time and the magnitude of a risk premium that should be added because benefits from an investment are uncertain. In the next chapter we move to evaluating these questions with data from the stock market and economic statistics.

If you have taken a course in corporate finance, investments, banking, financial management, options or something else, it is likely that you will not begin with the question of what is at the heart of any question in finance or what defines the subject of finance. If you ask a high paid investment banker what the definition of finance is, you will probably hear some fast-talking technical jargon like that discussed at the end of the last chapter. When I ask the question to young students, and I get vague answers that finance is about making a lot of money. I watched a video by a Yale professor named John Geanakoplos[15] give his first lecture in finance to undergraduate students. He spent the session essentially bragging about how his hedge funds earned a lot of money and did not discuss any foundational issues of



[15] Part of American Finance Association. Video is at https://youtu.be/vTs2IQ8OefQ

forecasting and cash flow. Before delving into details of the many different subjects in this book, taking a step backwards and thinking about what is really at the heart of finance will be helpful in thinking more deeply about why finance techniques make sense.

To answer the question about what finance is, I began by wondering how other people define it and how the subject of finance compares to other subjects. I did a little search on the internet to see what others suggest being the definition of finance. I also compared the definition of finance to the definition of some other more traditional subjects. Definitions of physics, chemistry, and economics you find pretty clear definitions (even for economics):

Physics: "the branch of science concerned with the nature and properties of matter and energy. The subject matter of physics includes mechanics, heat, light and other radiation, sound, electricity, magnetism, and the structure of atoms."

Chemistry: "the branch of science that studies the composition, structure, properties, and behaviour of matter. It explores how substances (elements and compounds) are formed, interact, and undergo transformations during chemical reactions, including the energy changes involved."

Economics: "Economics is the social science that studies how individuals, businesses, governments, and societies allocate scarce resources. It focuses on the production, distribution, and consumption of goods and services, analysing how choices are made under conditions of scarcity. The field is divided into microeconomics (individual/firm behaviour) and macroeconomics (economy-wide trends)."

Moving to the definition of finance, the first definition of finance that comes up from a google search suggests that finance is both and art and a science:

Finance: "Finance is the art and science of managing money, encompassing the processes of raising, investing, borrowing, budgeting, and forecasting funds for individuals, businesses, and governments. It involves allocating financial resources to achieve specific goals while managing risk and studying financial assets, liabilities, and, importantly, the time value of money."[16]

The suggestion that finance is either an art or science should make you either laugh, cry or vomit. But if you think about all of the activities mentioned in the art and science definition of finance above – raising money, investing, borrowing, budgeting -- they involve making some kind of cost and benefit analysis. The cost and benefit analysis in turn requires some kind of forecasting while also accounting for risk that the forecasts can be wrong and the time value of money. When cost of capital is computed from CAPM; when a project financed investment is assessed with IRR and the debt service coverage ratio ("DSCR"); when a stock price is assessed with a P/E ratio; when the value of debt is assessed with a credit spread and just about any

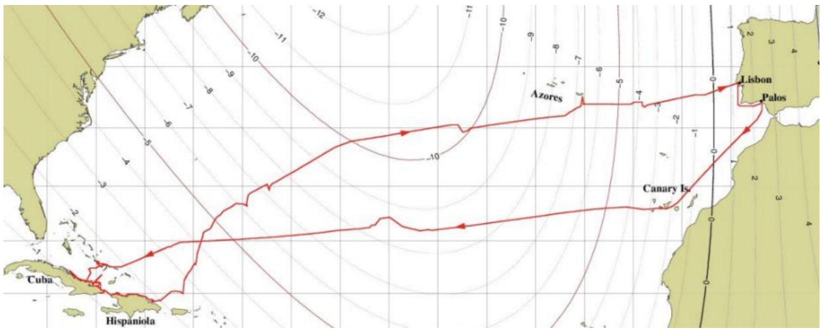
[16] This is an AI summary of finance that comes from the Corporate Finance Institute. https://corporatefinanceinstitute.com/resources/wealth-management/what-is-finance-definition

other issue related to money, finance boils down to assessing the value of an investment relative to its cost. The problem with any of the cost and benefit analysis is that the benefit is uncertain and must be evaluated with some kind of risk assessment. For purposes of thinking about the subjects in this book, finance involves evaluating risk, making forecasts and assessing the results of investment decision forecasting. The subjects in finance boil down to assessing the cost and benefits of making an investment and assessing the performance of the investment, where an investment involves some kind of initial cost with uncertain future benefits. If the benefits exceed the cost, value is created. If the benefits are less than the costs, value is destroyed.

An alternative definition of finance that I use can be boiled down to measurement of the rate of return as a metric to measure the cost and benefit of making an investment. Rate of return can be measured in different ways depending on whether you are making an investment, assessing the performance of an existing investment, considering effects of an investment on society or comparing different investments. At this point do not worry about the return is measured with return on invested capital ("ROIC"), return on equity ("ROE"), internal rate of return ("IRR"), price to book ratio ("P/B") or an NPV cost and benefit ratio. Each of the return measures include some kind of periodic or accumulated income or cash inflow relative to the outflow for an investment. In the case of IRR, the measure of the rate of return includes an estimate of future cash flow over a future period compared to cash flow made for investing in the project. For valuing an investment and assessing the performance of an investment, the return is gauged against some kind of benchmark return.

What is an Investment, Christopher Columbus, NVIDIA and Going to the Dentist

I doubt that many finance classes start with the question of assessing Christopher Columbus' effort to secure financing the investment in his first attempted trip to Asia as one of the most important investment decisions in history. But thinking about the risks associated with Columbus' investment risks - the forecast of the distance to Asia being wrong, shipwrecks, mutiny of staff, never finding anything, not being able to return if he did find something. These risks were accepted by a financing structure that has analogies to modern project finance. Columbus had incentives to seek gold and spices to pay back the private investors (his percentage of profit was 10% analogous to bonuses paid to managers in private equity.) Financing of the investment was a public/private partnership with private entities (from a consortium of Genoese and Florentine bankers in Seville) and public parties (Queen Isabela and King Ferdinand of Spain).[17] As in modern transactions there were incentives provided to sailors – the Spanish Crown promised a lifetime pension to the first person to spot land (which Columbus unfairly attributed to himself).



The financing structure was developed after a road show that failed with other investors. Columbus had earlier approached King John II of Portugal, but the investment proposal was rejected in part because a committee (you can call this an investment committee) concluded that Columbus's calculations of the diameter of the earth were incorrect leading to a forecast of the voyage length that was absurdly optimistic. The estimated distance from Portugal to Asia was the primary forecast model associated with the investment in Columbus' voyage. Using the well-known idea at the time that the earth was round, Columbus projected a distance of about 5,000 km to get from Palos in southwest Spain to India via the Atlantic Ocean. His forecast was way off as the true distance to India from Palos is actually about 20,000 km which would have rendered the voyage impossible without a land mass between. From the perspective of Columbus and his private investors, the risks of the forecast being wrong and the cost of the investment probably far outweighed potential benefits.

Ultimately, the return on investment to Columbus and the private investors was tiny compared to the external costs and benefits of the voyage. For Queen Isabela and King Ferdinand, the risk and return profile was different than for Columbus and the private investors. From the perspective of the king and the queen, the possibility of finding a new route to Asia, that would allow trading to secure spices and other goods, outweighed the probability

[17] Andrew Mach Contributor, "Christopher Columbus: Five things you thought you knew about the explorer." Oct. 10, 2011, 2:10 p.m. ET. Christian Science Monitor.

of finding nothing even if there was a big probability of failure. This makes you think about the effects on society of an investment and how investment policy with societal impacts can be much more than the effects on the investors themselves. The total investment in the voyage is estimated to by roughly $1 million to $3 million in current USD which is miniscule compared to the real impacts of the voyage.[18]

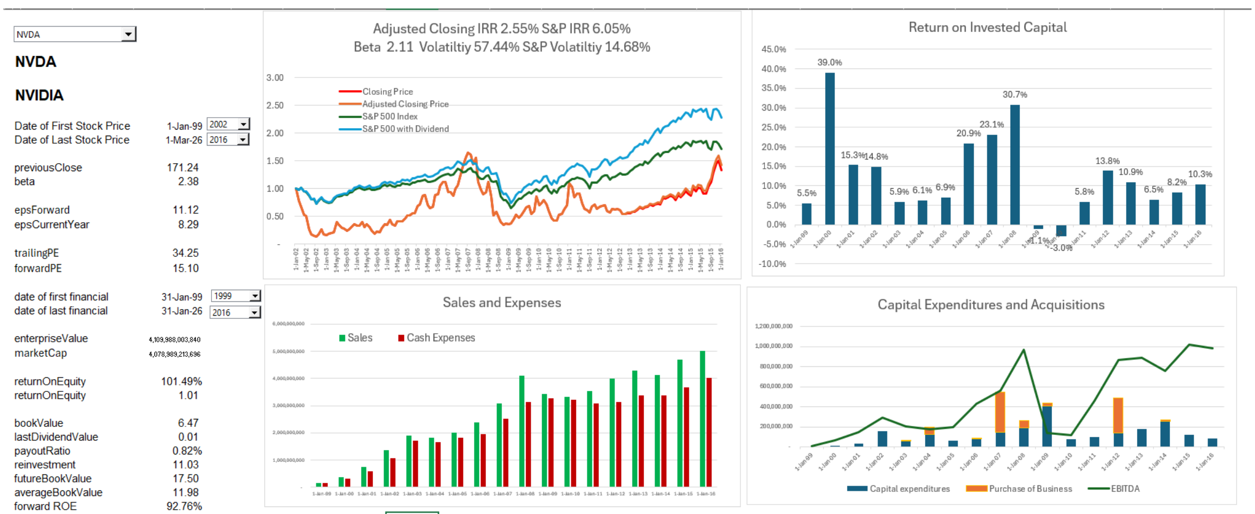
In project finance (the subject of Part IV), analysts try to measure the effects on the overall society of an investment as well as the rate of return to private investors. The return to private investors is measured with the internal rate of return ("IRR") which vaguely measures the growth rate in cash flow (this is discussed in detail in later chapters). An alternative IRR measured from cash flow to investors can be computed that incorporates the societal costs and benefits as well as the private cash flow. This is cost and benefit statistic is called the economic IRR. You could think about computing the economic IRR of Columbus' voyage, but I think it would be almost impossible to get your head around the societal costs and benefits and even make a vague estimate. Benefits could include starting the "Age of Discovery," providing massive wealth and new commodities for Europe; introducing crops like the potato and maize to the old world; allowing Spain to become a global superpower. On the other hand, the societal costs were devastating – genocide of indigenous peoples killing many millions; initiation of the transatlantic slave trade; the brutality and extreme violence of the conquistadors; the ecological impact of invasive species and livestock that permanently altered the American ecosystem.

Maybe we should think about an investment that is a bit more modern than the Santa María, the Pinta, and the Niña (the Santa María did not make it back). Before moving to discussion of fundamental forecast methods and evaluation of the costs and benefits of investment decisions, I consider another investment -- the series of development investments made by NVIDIA in powerful computer chips and software that eventual allowed the development of artificial intelligence.[19] The reason I choose the NVIDA story as a second investment case, is the way the company continued pushing ahead with an idea to massively increase computation speed that took a more than a decade to produce large benefits.

NVIDIA was formed from the three people shown in the adjacent picture in 1993 (before iPhones (2007); WIFI was used extensively (2000); the cloud (2006); and YouTube(2005)). Jensen Huang who was born in Taiwan left his job at Sun Microsystems with his two partners to develop a company that would make computer chips. The company began to focus on chips that increased the speed of calculations for early computer gaming. While NVIDIA famously

[18] Bayard Johnson, "Who Could Possibly Be in Favor of Columbus Day?", ICT is IndiJ Public Media, October 12, 2015
[19] Nvidia's Explosive Rise from Zero to Trillions (Documentary), https://www.youtube.com/watch?v=1QC9X_QW52k&t=1192s

almost failed after manufacturing a flawed chip – the company had 30 days of remaining cash -- it became successful in chips for the computer gaming sphere and became public in 1999. In 2006 NVDIA began to develop something called Compute Unified Device Architecture ("CUDA").[20] This combination of hardware and software improved the calculation speed of computer chips by 50 times and arguably eventually enabled the development of AI.[21] If we measure when NVIDIA's investment in CUDA began really paying off as when GPT began at the end of 2022, the investment took sixteen years to develop. During the time NVIDIA's investments to increase calculation processing speed began development in 2006, the company did not perform very well from a financial perspective. The accounting rate of return was not very good – the ROIC's were either negative or around 10% during the eight years from 2009 to 2016 (see the accompanying charts that are part of a program that is free to use and that I developed for this book)[22]. It is difficult to imagine many large corporations worried about earnings guidance and presenting return statistics to investors accepting this kind of very long gestation for an investment. It is more likely that companies would want to focus on their core business and ask managers to focus products that could increase current EPS and ROIC per the ideas of Jack Welch.



Once the value of NVIDIA's chips was finally recognized, the returns and value took off as shown in a second excerpt below (again from the program that retrieves financial data.) The two excerpts demonstrate that short-term ROE or ROIC do not predict the ultimate value of investments and it may be better to develop ideas with a long payout. The excerpt below shows that the ultimate compound annual return you would have earned if you invested at the date of

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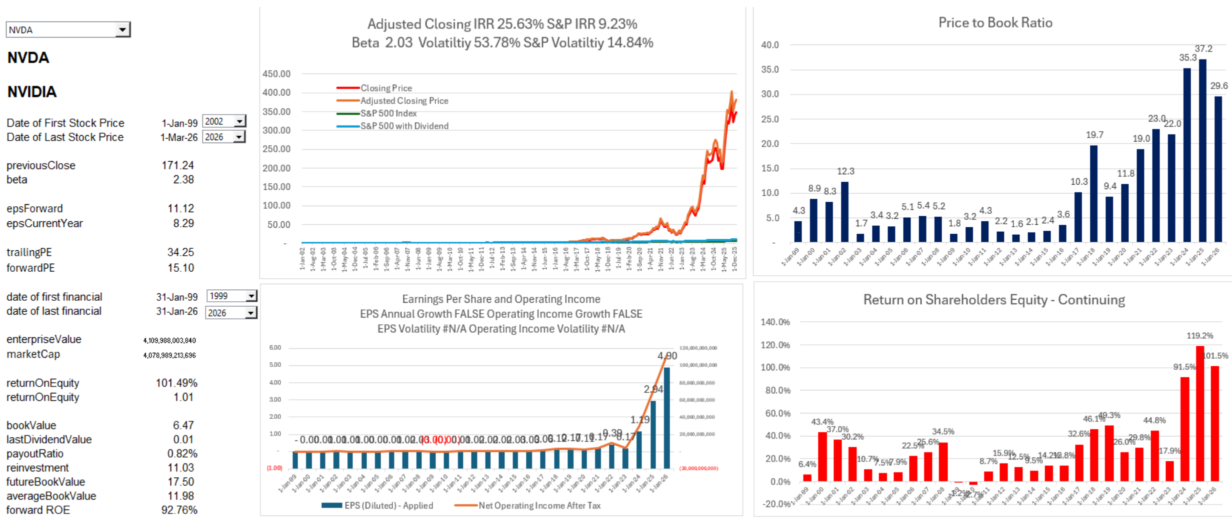
[20] According to Google Gemini: "NVIDIA's CUDA is a parallel computing platform and programming model allows the use Graphic Processing Units ("GPU's") to be used for general-purpose computing. This software ecosystem enables harnessing GPU power to build AI models.

[21] According to Gemini, "AI systems, particularly large language models like ChatGPT, require enormous computing power. NVIDIA GPUs are designed for parallel processing, making them uniquely suited to handle these complex computations far faster than traditional CPUs.

[22] You can find information on how to scrape data using Python and VBA to make these kind of charts for any public company at www.edbodmer.com.

the IPO in 1999, re-invested any dividends you received back in NVIDA stock and then sold the stock in 2026 would have been 26%, which doesn't seem spectacular. I hope the case makes you think about evaluating risks and returns back in 2006 when the development of the process to increase calculation speed began.



Perhaps the most interesting analogy between Columbus' voyage and the development of CUDA by NVIDIA is the subject of external costs and benefits related to the investment. Personally, I have no idea whether AI is an overly hyped marketing phenomena or whether it will dramatically help the well-being of humans. Some assert that tech industry leaders aren't asking enough about the ultimate effects of AI. Suggestions have been made that (1) AI itself poses risk to the future of humanity if it gets out of control, and (2) the AI can be dangerous when manipulated by people with bad intent.[23] It is very far outside the scope of this book to suggest some kind of AI regulation; but considering external effects of investment that are not directly measured by financial IRR can be an important issue in assessing the cost and benefits of an investment.

You can think about the costs and benefits of many other investment decisions which are not as dramatic as Columbus' first voyage or NIVIDA's investment in CUDA. These could include going to the dentist, taking a jog in the morning, buying a stock, gambling or taking time to read this book. Other investment decisions include the incursions by Hitler and Napoleon into Russia, the Manhattan project or the decision by U.S. cities to remove street cars at the behest of GM and Ford. Each of these decisions involves a cost (whether measured directly in monetary terms or in time or in territory) and each decision has an uncertain benefit in the

[23] "'Godfather of AI' says tech companies aren't concerned with the AI endgame. They're focused on short-term profits instead", Sasha Rogelberg, Fortune Magazine, March 21, 2026.

future. For any of these decisions you can compute a private or societal rate of return that is measured by the benefits relative to the cost.

The fundamental definition of any investment decision which is at the heart of finance involves deciding whether to spend something now when you do not know exactly what you will receive in the future. You can think of a company as making a continual series of small and large investment decisions ranging from purchasing inventory to building a factory. Each investment decision whether for advertising, investing in new employees or making a major acquisition is supported by some sort of implicit or explicit forecast of the future and affects the value of the company. Turning to investment decisions made in your personal life, I once thought that the stress, costs and difficulties of having a child was a horrible investment. That changed when I had grandchildren and I realized that sometimes you have to wait a long time for an investment to pay off. Later-on in this chapter and more in subsequent chapters I demonstrate how long-term investments are penalised using many of the conventional financial analysis techniques. In the meantime, we can turn to more specific issues in measuring returns and different ways to think about incorporating risks of investments in the analysis.

Robinson Crusoe and Finance – Measuring Costs and Benefits of an Investment Decision in a Simple Economy

To think about finance issues and in particular the acceptable returns to compensate for risks, I have made some ridiculous simplifications. In the paragraphs below I contemplate

financial analysis of an investment decision in a very simple economy with no money, no financial markets and no corporations. The idea is to think about how you would evaluate risk and the time value when assessing future benefits of an investment; to think about whether risk premiums should be compounded over time; and to think about the level of risk premium given a probability distribution of outcomes. These fundamental questions underlie major questions in finance including measuring the cost of capital and evaluating risks of investments decisions.

Pretend that you are stranded on an island like Robinson Crusoe. But unlike Robinson, assume that you are with your family on an island near Malaysia. Your family likes to spend time together and to relax while looking at the nice scenery on the island (i.e., you want leisure time). But every day you have to look for food and to find wood to make a fire. To get more leisure time in the future and spend more time relaxing with your family, you can make various different investments. These investments can be measured in forgone leisure time in the near future in order to get more leisure time in the future. Maybe you could construct a bath from a barrel you found on the beach or a make a little farm that can make strawberries and other fruits and vegetables.

I have wasted too much time imagining the potential details of how investments could work and even thought about how you could make a contraption to hold warm water so you wouldn't have to collect so much wood (using solar power as an alternative of fossil fuel). Instead of thinking about specific investments, the I have created hypothetical investments where you spend current leisure time in the near term which can potentially save time later on. The benefits and costs of the investment are measured in the amount of time is saved and the entire economy of the island is measured in time (there is no inflation). The island is a bit like the country of Bhutan that I had the honour of visiting to teach a course, where the king measures happiness instead of classic GDP (I understand that there was an election to decide if people wanted a democracy that lost by 99%). On our island, there is no division into producers and consumers, the inventive is simply to make more leisure time for the family. I urge you to not start thinking about whether the economic structure of the island is socialistic or capitalistic; the idea is to focus on measuring costs and benefits of an investment decision.

The Time Value of Deferred Benefits and Risk-Free Rate

The first issue related to an investment in our little example is what is the value of delaying gratification which is the starting point of measuring the cost of capital and the real risk-free rate. In modern economies, when we compare future money with current money, we have to adjust the future money by how much purchasing power we will lose because the future money buys less stuff. This is inflation, and to compare the future money with current money we need to take inflation out of the calculation. For our island economy, inflation adjustments are not necessary as everything is measured in working time and leisure time. Assume that you make an investment of 175 hours in the next few weeks (5 hours per day times 7 days per week times 5 weeks), and you expect to save the same amount of time in the future . Further, assume that there is no risk at all associated with making this investment, meaning you are completely sure about the future savings, and you are sure the investment will take exactly 175 hours. The question of whether you need more expected future leisure time savings than the time it takes to make the investment is the same is the question of whether the real risk-free rate is more than, less than or equal to zero.

I have wasted time considering this investment with a simple model shown in the adjacent table.[24] If the investment pays off in one year and the risk-free rate is zero, then the future savings are the same as the amount of your investment. The risk-free rate of zero implies that there is no cost to you of delaying gratification from having more leisure hours in the future and less today. I don't know if delaying gratification has a cost as most economists would assume, and it is not difficult for me to imagine that there is no difference between having the leisure hours today or in one year. I did see the effects of delayed gratification when having a discussion with my grandson and his mother. When telling my grandson that if he can wait until tomorrow to get ice cream, he can have two ice creams instead of one, he strongly protested suggesting a preference for current consumption (he may also have been gauging whether the promise of ice cream tomorrow really was risk free). I hope I am not insulting anybody by suggesting the having a big preference for current consumption is essentially a childish idea and it is reasonable for adults to have little preference. This implies a real risk-free preference of something close to zero. If you explain to your family that you will have about the same increased leisure time in the future than the lost leisure time in the near term once you make your investment, and your family agrees, you could argue that the risk-free rate with no inflation is close to zero.

Timing				
Period			0	1
Investment Period	0		TRUE	FALSE
Return Period	1		FALSE	TRUE
Operations				
Hours for Investment	175.00		175.00	-
Hours Saved	175.00	175.00	-	175.00
Net Hours			(175.00)	175.00
Net Present Value at Rf	0.00%	$0.00		
Return on Hours	0.00%			

The closest way to evaluate the risk-free rate in markets without inflation is using Treasury Inflation-Protected Securities ("TIPS"). For these U.S. government bonds, the principal adjusts based on the Consumer Price Index ("CPI"). When inflation rises, the principal increases; if deflation occurs, the principal decreases. The yield on TIPSs is shown on the adjacent chart. TIPS yield is the "real" yield meaning for example, if a 5-year TIPS has a 1.2% yield and inflation averages 3% over that period, the nominal return is roughly 4.2% annually. If the yield is zero, then investors are willing to accept a return equal to the inflation rate and, consistent with the proposition that future delayed consumption is equal to current consumption. (The yield shown in the graph

[24] This model is documented at https://edbodmer.com/step-by-step-process-to-complete-exams/

depends on actions of the federal reserve bank and interest rates on other bonds that do not adjust with the inflation rate).

General Philosophical Ideas About a Risk Premium in the Simple Economy

Perhaps the risk-free rate is very low, reflecting non-childish thinking about deferring gratification, but what if the investment has a probability of failure and is not risk free. To address this question, assume that our investment has a 50% chance of failure. Given this probability of failure, the amount of hours if you can successfully develop the investment should be at least double the amount of hours in the risk-free scenario if the investment is to make sense. With the 50% probability of success, you can compute the expected value of the saved leisure hours. Without a risk-free rate, the saved leisure hours in the success case must be double the 175 hours spent, or 350 hours. With a positive risk-free rate and preference for current hours, savings in a successful scenario should increase. The increased hours to meet the risk-free hurdle with a 1% IRR and with the NPV being equal to zero when a 1% discount used is shown in the adjacent table.

The difficult question about our investment is how to measure the effect of anxiety on our investment decision that has a 50% chance of failure, and which means that your family may require more saved hours than those implied by a 50-50 weighting for incurring this anxiety.[25] Finance implies that a risk premium to the received benefits (more required future leisure time) should be added to compensate for the uncertainty. This means the benefits must be more than twice as much as the expenditure for your family to be willing to accept being nervous about spending the time to construct your investment. I suggest that the idea of trying to put a number on risk is mysterious and cannot be boiled down to a formula. But when studying questions like this in finance, you are taught that you can put an objective number on the risk premium. You may learn about the standard deviation of returns as measuring risk, a capital markets line that represents an efficient frontier, and the notion that you can develop different portfolios or risky and risk-free

Timing	[Driver]	[Sum]			
Period			0	1	
Investment Period	0		TRUE	FALSE	F
Return Period	1		FALSE	TRUE	F
Operations					
Hours for Investment	175.00		175.00	-	
Hours Saved	176.75	176.75	-	176.75	
Net Hours			(175.00)	176.75	
Net Present Value at Rf	1.00%	$0.00			
Return on Hours (IRR)	1.00%				
Expected Value - No Risk Premium - 50% Chance of Success					
Hours for Investment	175.00		175.00	-	
Hours Saved - Successful Case	353.50	353.50	-	353.50	
Hours Saved - Failure Case	-		-	-	
Expected Hours Saved			(175.00)	176.75	
Net Present Value at Rf	1.00%	$0.00			
Return on Hours (IRR)	1.00%				
Expected Value - Risk Premium --	7.00%				
Hours for Investment	175.00		175.00	-	
Hours Saved - Good Case	378.00	378.00	-	378.00	
Hours Saved - Bad Case	-		-	-	
Expected Hours Saved			(175.00)	189.00	
Net Present Value at Rf	8.00%	$0.00			
Return on Hours (IRR)	8.00%				
Risk Premium in Hours/Year	6.93%				

[25] When people gamble, they gain pleasure from taking risk that has a negative expected return.

investments. This all leads to quantification of the risk premium as the increased growth rate you need to earn on investments.

The idea of the risk premium is that stock markets have more variability than investing in a short-term government bond, and investors require compensation for being nervous about the possibility of losing money. It is difficult to make analogy between measuring the risk premium in the actual economy using these concepts and the way risk premium could be measured on our little island. Maybe there could be some kind of risk placed on each percentage of failure in an investment (more anxiety with a higher percentage of failure), and a general premium could be placed on risky investments with a benchmark of 50% chance of failure. This would be something like measuring an overall risk premium for stocks compared to risk-free bonds, the equity market risk premium ("EMRP") and then applying a beta statistic that measures risks of individual risks relative to the market.

Maybe the risk premium for a project with a 50% chance of failure is 7% which is the overall equity premium used in the Petrozuata case introduced in Chapter 2 (this is completely arbitrary, but so is the 7% and other premia plopped out of somewhere by the writers of the HBS case to ultimately arrive at a risk premium of about 14%). To see how a risk premium works, begin with the risk-free case where a cost of delayed gratification is assumed. Because of the assumed risk-free rate driven by delayed gratification of 1%, the future savings to justify the investment must be 1% higher than the 175 hours spent or 176.75 hours of leisure time for a one-year investment. This is shown in the section of the table titled "Expected Value – No Risk Premium." Because of the cost of the anxiety, the amount of hours generated from our investment must be higher than the 176.5 hours in the risk-free case. Now you need to have the amount of expected saved hours be 8% (7% plus 1%) above the invested hours, which is 189 hours (you can divide 189 by 175 and assure the growth rate in hours is 8% - this growth rate is the same as the IRR). The net present value ("NPV") of the hours at discount rate of 8% -- 189/(1.08) -- is equal to the investment demonstrating that the IRR and the NPV measure essentially the same thing. You can say that the definition of the IRR is the discount rate that makes the NPV equal zero which is a very dangerous thing to think about as explained in Chapter 7).

We Compound Everything in Finance – Does That Mean Risk Premium Should be Compounded

If we assume that a 7% risk premium we just discussed is somehow applied as in the last example, the next question is whether this risk premium should be increased for investors if the investment has a longer-term horizon than one year. As I cannot recall this issue of compounding risk premium being raised in discussion of finance, I was initially afraid to even raise this question as the idea of compounding risk premia is ingrained in finance. Later in the book I will raise a number of questions related to changing risk and whether an increasing risk premium makes sense. I label WACC as what absolute complete crap in part because of the way it assumes that risks of investment projects do not change over time. I also protest the idea of not gauging whether cash flows follow a process where volatility increases over time (which could justify compounding risk premiums), or alternative whether the cash flows exhibit mean reversion.

In financial analysis, when the risk-free rate and risk premium are computed, both of the items are implicitly or explicitly assumed to compound. If the risk premium is 7% and the risk-free rate is 1% to make 8%, as in our one-year case, then in the case with a longer time frame, the 8% compounds over time, the 7% compounds and the 1% compounds. This happens whether the investment is evaluated with IRR or NPV and is illustrated for a 5-year case in the shown in the adjacent table. The effect of the compounding returns is dramatic and conforms to the quote that is probably not from Einstien that where he supposedly called compound interest “the most powerful force in the universe”.[26]

In our simple example, the total amount of hours saved to achieve the 8% return in the one-year case was 378 hours. If the saved hours are measured over five-years as illustrated on the adjacent table, the required saved hours to justify the risk premium on our investment increases to 438 hours, an increase of 16%. If you increase the investment period to 20 years, the amount of saved hours must be 849 hours. Think about this, the probability of success has not changed and there is no change in the assumption about the technical efficacy of the investment. But just because the investment has a longer life, you need have a much more efficient investment.

Timing	[Driver]	[Sum]						
Period			0	1	2	3	4	5
Investment Period	0		TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
Return Period	5		FALSE	TRUE	TRUE	TRUE	TRUE	TRUE
Operations								
Hours for Investment	175.00		175.00	-	-	-	-	-
Hours Saved	36.06	180.28	-	36.06	36.06	36.06	36.06	36.06
Net Hours			(175.00)	36.06	36.06	36.06	36.06	36.06
Net Present Value at Rf	1.00%	$0.00						
Return on Hours (IRR)	1.00%							
Expected Value - No Risk Premium - 50% Chance of Success								
Hours for Investment	175.00		175.00	-	-	-	-	-
Hours Saved - Successful Case	72.11	360.57	-	72.11	72.11	72.11	72.11	72.11
Hours Saved - Failure Case	-		-	-	-	-	-	-
Expected Hours Saved			(175.00)	36.06	36.06	36.06	36.06	36.06
Net Present Value at Rf	1.00%	$0.00						
Return on Hours (IRR)	1.00%							
Expected Value - Risk Premium --	7.00%							
Hours for Investment	175.00		175.00	-	-	-	-	-
Hours Saved - Good Case	87.66	438.30	-	87.66	87.66	87.66	87.66	87.66
Hours Saved - Bad Case	-		-	-	-	-	-	-
Expected Hours Saved			(175.00)	43.83	43.83	43.83	43.83	43.83
Net Present Value at Rf	8.00%	$0.00						
Return on Hours (IRR)	8.00%							
Risk Premium in Hours/Year	21.56%							

Later in the book, when critiquing finance theory, I will argue that many problems come from the implicit assumption that the risk required by investors compounds over time at a high growth rate. Perhaps the primary example is in applying the CAPM, the equity market risk premium is assumed to compound over time. By implication, this suggests that risks also increase at a compound rate over time rather than being defined at the time the investment is made. Similarly, when evaluating credit spreads on loans (and especially loans to developing countries), the margin compounds over the term that the loan is being repaid.

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[26] According to Barbara Wolff, former archivist at the Albert Einstein Archives, “To the best of my knowledge - and I have searched for a reliable source of that and similar statements a number of times over more than 20 years - Albert Einstein neither said that “compounded interest is more complicated than relativity theory”, nor did he call it the most powerful force in the universe”.

The question I hope you ponder is whether this risk premium is really necessary to compensate for risk and if the hoped-for risk premium is not present, the investment will not be made. If the compounded risk premium is not rally necessary, as in our island example where we just want more leisure time and we are not worried about delayed gratification, then a long-lived investment is inappropriately penalized. The force that Einstien supposedly discussed but probability did not, may not seem like a big deal. But later I discuss very long-lived projects such as hydro power plants in Africa.

To demonstrate evaluation of risk premium, consider in a situation in which cash flows fully mean revert. Assume that you need a premium for taking the risk of rolling a dice, compared to receiving a fixed payment. Maybe you can receive 3.5 today, the average of the rolls (1+2+3+4+5+6)/6 or you can receive the value of the roll of the dice (1 or 2 or 3 or 4 or 5 or 6). When you receive the specific value of the roll of the dice instead of always receiving the average, you may need a risk premium because of your anxiety. Let's assume that the risk premium required is 10% to accept the uncertainty. Now your expected value in the case where you take the risk is 3.5 x 1.1 = 3.85.

	Safe Option		Risky Option
Roll Die Today	3,500		
		1	1,100
		2	2,200
		3	3,300
		4	4,400
		5	5,500
		6	6,600
		Expected	3,850
		Risk Premium	10.00%

Now change the example and assume that you can receive the same proceeds for the risky case and the risk-free case in 5 years. Assume the risk-free rate is 3.5%. Consider first the risk-free alternative. As the risk-free rate measures the value of purchasing power you have in five years, instead of receiving the fixed amount of 3.5 you would be just as happy to accept (1.035)^5 x 3.5 or 4.16 in five years. This can be considered receiving the amount in a different currency. You could convert the risky alternative to the different currency and measure the risky alternative as (1.035)^5 x 3.85 or 4.57. But if you applied the risk premium to the investment, and you included the loss in the time value of money, you would require (1.135)^5 x 3.5 = 6.59. As the risk has not increased over time, there is no reason to require much higher amount. You can now ponder whether the probability of a country defaulting is more like the rolling of a die or a time series where the volatility increases over time. If the probability of default of a country is stable (even if it is high), do you really need to earn a much higher risk premium on long-term debt relative to short-term debt.

Chapter 4: Financial Markets and Economic Activity: Implications for Finance

After introducing concepts rate of return, the time value of money, risk measurement and the IRR in Chapter 3, we turn to analysis of historic and expected returns. The return data provides background for considering many finance issues covered in the rest of the text. The reason for including this chapter in the initial part of the book is to prompt you to think further about fundamental investment questions related to reasonable expected returns, measurement of IRR, growth in future cash flow, risk premiums for equity versus government bonds, and the minimum required return that is acceptable given the risk of cash flow. This data review involves gathering and interpreting data for economic variables as well as stock and bond markets. The data in this chapter is evaluated on a macro level for the U.S. because of the availability of data. The next chapter addresses returns and economic growth for other counties and for selected individual companies.

When I review case studies used in universities, return and cost of capital numbers which have big effects on valuation come directly or indirectly from the equity market risk premium ("EMRP") which is plopped out of somewhere, often without any explanation. This EMRP is the number for measuring the relationship between the expected growth in overall equity markets and the risk-free rate and is the starting point for measuring the cost of capital. At some point I remember reading that this number, the difference between the expected market return and the risk-free rate, is the most studied number in finance and maybe all of economics. The analysis in this chapter attempts to address the theory behind this EMRP number in terms of what it should be in theory as well as what the number has been in the past. Studying the number includes the relationship between returns on stocks versus different time series such as corporate profit and overall economic growth and different interest rates. A number of adjustments and ambiguities in the data including adjustments for inflation rates and other factors are addressed in each. There are paradoxes with the data relative to economic and financial theory which ultimately affects crucial investments.

The ability to find data and do analysis by yourself has changed dramatically over the years. Decades ago, we had to rely on the work of others and a database developed by Ibbitson and Sinfield[27] to study the history of financial markets and evaluate reasonable suppositions about what kind of returns are expected by investors (a number that you cannot directly find). You can now get immense amounts of data yourself, transpose the data into real terms adjusted for inflation and analyse stock prices for companies listed on just about any exchange around the world. In addition to studying the history of financial markets over the last century

[27] The data through 1987 is presented in the book 1989 Roger G. Ibbotson and Rex A. Sinquefield Dow Jones-Irwin is a trademark of Dow Jones & Company, Inc. Data from this book combined with information from yahoo.finance allows you to develop long series for return variables.

to, the chapter explains how to extract and interpret the data so that you can perform analysis yourself.

Before proceeding, I think a little caveat is necessary. Reviewing historic data on markets and economies can lead to economic polity arguments related to distribution of income, performance of national economic policy, the fairness of capitalism, the decline in empires, the efficiency of markets and other big issues. You are welcome to draw conclusions from the data, but the objective here is purely related to my themes in this book, namely the study of investment value from measurement of risk and expected cash flow.

Stock Returns and Economic Growth

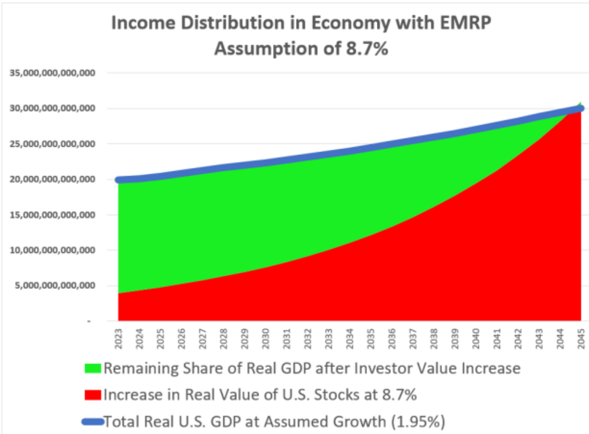
To give context to the data in this chapter and evaluate historic returns, cost of capital and growth, the following quote in a book about the equity market risk premium provides a starting point.

> ***The key insight, which draws on earlier work by a number of authors, was that aggregate corporate profits cannot grow indefinitely much faster—or much slower—than GDP. (And as Herbert Stein was fond of reminding us, any economic trend that cannot continue forever will not.) If profits grow faster than GDP, they eventually take over the economy, leaving nothing for labour, government, natural resource owners, or other claimants. If profits grow more slowly than GDP, they eventually disappear, and businesses will have no profit motive to continue operating. Thus, in the very long run, the ratio of profits to GDP is roughly constant.[28]***

This quote implies that you could make a powerful case that the sensible and logical expected growth in earnings should be around 2-3% which has been the economic growth over many decades, and many economists have suggested this to be the basis of future expected returns. But it is very common to use numbers that are much higher such as the data published by a professor named Aswath Damodaran who in 2023 suggested the number is almost 6%. Achieving the real growth rate of about 6% presented by Mr. Damodaran would be surprising. It would either mean that (1) real growth in GDP could be far above 2% which is not consistent with history or expectations of any economist; and/or (2) corporate profits which already reflect high rates of return can continue to grow faster than the overall economy; and/or (3) multiples of earnings (the P/E ratio) will continue to expand.

[28] Rethinking the Equity Risk Premium, page ___.

The statement can be taken a little further by presuming that the value of a company is directly related to its profits. This ultimately means that the value of stocks (not only corporate profits) in aggregate should grow at the overall rate of the economy. Let's say the real GDP growth (growth without inflation) is 2%. Then you could look at the above quote and surmise that corporate profits should also grow at 2%. If corporate profits grow at 2% (where corporate profits reflect charges for depreciation on capital expenditures), then the stock value should also grow by 2%. This little example would suggest that on an overall stock market it would not be reasonable to expect more of a real return than the 2% we started with.



The idea of assuming that value can continue to increase at rates that exceed economic growth is demonstrated by a little example that I constructed when challenging a high-paid expert who insisted that the real growth of stock value (the equity risk premium) in real terms is 8.7%. I made a simple simulation of the U.S. economy where I began by finding total value of equity in the economy (about 40 trillion in 2022).[29] As the rate of return is another definition of the growth rate, I made the assumption that the value of the shares grow at a rate of 8.7%. The change in value is the income earned from shares can be compared with the overall GDP, which is another measure of income (the value of GDP is about 20 trillion). When the value of shares is re-invested and the re-invested money earns a return of 8.7%, the value grows as in the grey area of the chart. When you subtract the amount of income earned from applying the investor growth rate to the current value of stocks from the overall GDP you get the amount that is left over for everybody else. This produces the absurd result where there is nothing left for anybody else in 2045. This demonstrates that evaluating concepts like the EMRP does not require some kind of highly mathematical prowess but rather a little bit of simple logical thinking.

The idea that value of stocks grow at the overall growth rate in the economy (and therefore have the same rate of return) is inconsistent with the basic idea risk and return in finance. The data analysis in this section demonstrates that equity returns have more volatility than overall economic activity and therefore theoretically require a higher return. If this added risk requires an added return, the returns on stocks (which is the increase in the value of stocks owned by shareholders) must be higher than the growth in the overall economy. This produces an increase in income for people who own stocks over time. Furthermore, the increase in income to the group of people who own shares comes at the expense of other people in the economy as measures such GDP aggregates total income. I suggest that this is a fundamental paradox that should be acknowledged as such. I cannot answer this paradox, but we can look at

[29] The total value is reported on the website https://siblisresearch.com/data/us-stock-market-value/

some data. In general terms, the data compares the value increase from some kind of index such as the S&P500 with economic data such as the level of U.S. GDP.

Data Analysis of Inflation and Long-term Stock Returns

Over the years I have looked at many studies on returns on stocks versus returns on bonds and I have been reluctant to do anything like analysis of the data myself. But in the past couple of years, data on stocks and economic activity has become much easier to obtain than it used to be.[30] Yahoo.finance reports daily values for the S&P 500 since 1927. The Federal Reserve Economic Database ("FRED") allows you to access many data series for the full length the series has been available (for example data on the GDP is available since the 1940's). The data I present on the relationship between economic growth and stock returns presents a few data analysis issues. For each of the data issues I present different ways to look at the fundamental question of growth in stocks versus growth in income. The general framework of comparing the grow in income in the economy to the growth in the value of investments poses a number of finance and data issues.

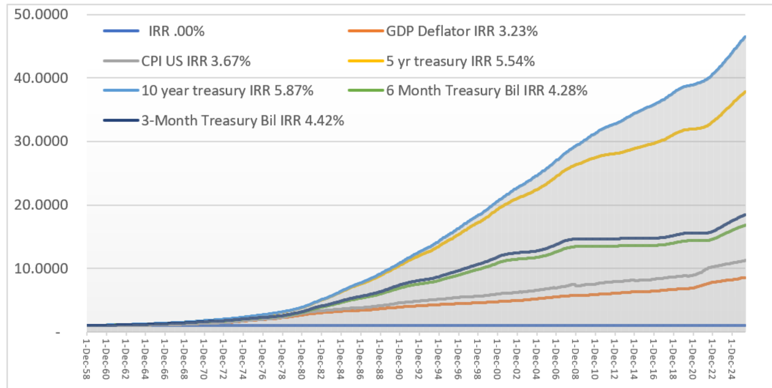
The first point involves the simple question of inflation and evaluating the data in real versus nominal terms. After the first couple of graphs below, all of the data is converted into real, inflated adjusted, terms. The graph already comes with some key lessons. First, the growth rate or the rate of return on bonds, inflation or any other series is measured by the IRR. For long-term bonds as measured by the IRR (if you invested 1 at the start of the period). Second, the longer-term bonds have higher risk that you will lose money because of changes in the inflation rate, so the longer bonds demand a higher return. Second, if investment in a stock can adjust to inflation by changing prices, it may have less risk than long-term bonds. Another implication of this graph is that the real risk-free rate over a long-term period as measured by the yield on three-month Treasury bills versus the CPI is about 1%. Note that the starting point for the 6-month Treasury bill is December 1958 and the graph is adjusted to start at that date.

[30] You can go to my website and use a python program together with excel and VBA. This is documented at https://edbodmer.com/comprehensive-stock-price-analysis/

	IRR	Vol	Beta
None	0.00%	0.00%	0.00
GDP Deflator	3.23%	1.20%	**0.00**
CPI US	3.67%	0.86%	**0.00**
5 yr treasury	5.54%	0.95%	**0.00**
10 year treasury	5.87%	0.97%	**0.00**
6 Month Treasury Bil	4.28%	0.80%	**0.00**
3-Month Treasury Bil	4.42%	0.84%	**0.00**

	Series Start	Final	Years
None	1-Dec-27	1.00	67.33
GDP Deflator	1-Apr-47	8.49	
CPI US	1-Feb-47	11.32	
5 yr treasury	1-May-53	37.81	
10 year treasury	1-May-53	46.54	
6 Month Treasury Bil	10-Dec-58	16.81	
3-Month Treasury Bil	1-Feb-34	18.45	

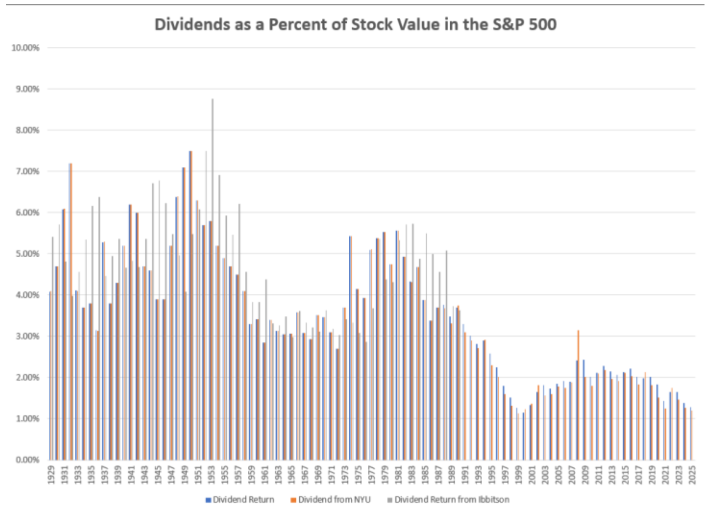
Monthly From 1-Dec-58 to 31-Mar-26



Key questions about inflation premium for accepting nominal returns and being subject to changes in the rate of inflation. Three or six month bills have a small inflation premium relative to the CPI – 1.042/1.0367 = .76%. This can be considered the real risk free rate or the preference for current consumption (that I labelled as childish in Chapter 3). For the 10-year debt, the risk premium for inflation is 2.1%. This may seem surprising as when include a credit spread of 1.2% to 1.5%, the return earned on bonds can be more than the overall economic growth rate of about 2% and the argued prospective return on equity capital.

The second issue addressed is measuring the rate of return or the IRR on stocks. For the US, the S&P 500 comprises about 80% of the total equity value of companies with publicly traded shares. The IRR from investing in the S&P 500 could be measured by assuming that you invest one dollar in the index and then compute the compound growth after a certain period. For example, you could invest your dollar in 1927 and then sell your index in 2026. The IRR would then be the compound annual growth you receive on your investment. But if you do this you are ignoring dividends you would receive from the shares. If you review studies of the return to stocks relative to the return on bonds, the basis of the change in equity value is the S&P 500 index should be adjusted for dividends you receive. The assumption is that any dividend received is re-invested in the same group of stocks as are in the S&P 500 and then, when you finally sell your shares the index that includes your re-investment. It turns out that the issue of re-investment when measuring the IRR is a difficult issue in measuring returns when you receive dividends.

When evaluating returns earned on stocks, data that can be retrieved for the S&P 500 from yahoo.finance since 1927 but the data does not include the dividends.[31] Without adjustment, the S&P 500 does not mean very much. After 1988 data exists on the S&P 500 plus dividends (called the S&P total return), but not before. Data from a study by Ibbitson and Sinquefield can be used to make the adjustment for dividends (you can compare the daily S&P 500 with the implied daily return from the Ibbitson data).

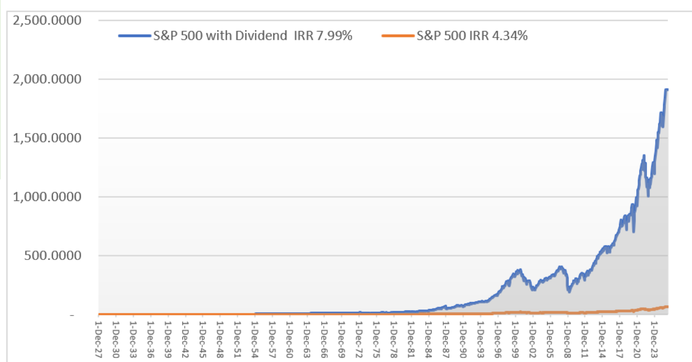


S&P 500 data show that the dividend yield (dividends relative to total market value) has changed significantly over time. In the 1950s, dividends were a larger share of investor returns as companies paid out more cash. By contrast, many companies in the 2020s—especially in technology—retain earnings to fund new products, acquisitions, and data centres. As a result, reinvesting dividends matters more in earlier periods than it does today, as the adjacent chart illustrates. The chart below compares stock returns with and without dividend reinvestment from 1927 to 2026. In nominal terms, investing at the end of 1927, reinvesting dividends, and selling in 2026 produces an IRR of 7.99% (often called the geometric return). Some sources report an average annual return instead, but that figure is harder to interpret.

	IRR	Vol	Beta	Avg Ret
S&P 500 with Dividend	7.99%	21.25%	1.00	9.48%
S&P 500	4.34%	18.64%	**1.00**	6.04%
		0.00%	**0.00**	0.00%
		0.00%	**0.00**	0.00%
		0.00%	**0.00**	0.00%
		0.00%	**0.00**	0.00%
		0.00%	**0.00**	0.00%

	Series Start	Final	Years
S&P 500 with Dividend	1-Dec-27	1,913.96	98.33
S&P 500	30-Dec-27	65.46	
	FALSE	1.00	
	FALSE	1.00	
	FALSE	0.00	
	FALSE	0.00	
	FALSE	0.00	

Monthly **From** **1-Dec-27** **to** **31-Mar-26**



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[31] You have do a little trick and use the option to download the index on a daily basis (not a weekly or monthly basis).

The fact that these sorts of returns starting in 1927 are suggested to have any relevance to valuation is surprising. The seeming theory that is not explicitly mentioned is that if you use long enough data where investors can choose between investing in stocks and bonds and that if returns on stocks is too low relative to their risk, then investors will sell stocks and with the lower price the future return will be higher. Alternatively, when stocks have too high a value relative to risk-free bonds (again adjusted for risk), then the price will be bid up, and the return will be higher. I ask myself now how I could have ever accepted this idea as will become apparent when different periods are reviewed including the post-war expansion, the oil crisis, inflation periods, the dot com bubble, the 2008 housing crisis, COVID and much more. To suggest that there is some kind of movement back to an equilibrium risk as many studies imply cannot be taken seriously. An example of how the returns can be distorted is to imagine that you made your first investment of one dollar after the stock market crash of 1929 and then re-invested dividends and so forth. In the case from 1927, the 7.55% return over the long period of almost 100 years grows to 1,913. In the case from 1931 shown on in the adjacent table, you would earn 9.28% and your money would have grown to 4,321. This exercise not only demonstrates the effect of different starting points, but also the effect of small changes in the IRR over long periods.

	IRR	Vol
S&P 500 with Dividend	9.28%	17.70%
S&P 500	5.58%	13.25%
	Series Start	Final
S&P 500 with Dividend	1-Dec-27	4,321.02
S&P 500	30-Dec-27	167.37

Data Analysis of Inflation and Long-term Stock Returns

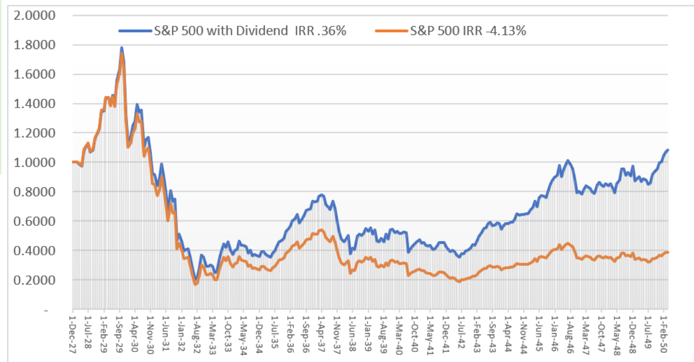
As stated above, the measurement of returns is heavily dependent on the time period chosen and the data that is available. This can make analysis from measuring returns arbitrary as conclusions with respect to the level of returns required or reasonable desired returns are not very useful for future investments (alternatives are suggested in subsequent chapters).

To make the presentation manageable, the last 100 years are separated into four 20-year periods. I start with 1927 until 1950; and then increment the periods. For the period starting in 1927, data on inflation and median income are not available. Subsequent periods are adjusted for inflation and include median income in the U.S. that demonstrates the income received by many people who do not own shares. The first graph below shows how dramatic the 1929 crash was and how the in twenty years you would not recover from investments made at the end of 1927.

	IRR	Vol	Beta	Avg Ret
S&P 500 with Dividend	0.36%	28.41%	1.00	4.43%
S&P 500	-4.13%	28.26%	**0.99**	-0.11%
		0.00%	**0.00**	0.00%
		0.00%	**0.00**	0.00%
		0.00%	**0.00**	0.00%
		0.00%	**0.00**	0.00%
		0.00%	**0.00**	0.00%

	Series Start	Final	Years
S&P 500 with Dividend	1-Dec-27	1.08	22.33
S&P 500	30-Dec-27	0.39	
	FALSE	1.00	
	FALSE	1.00	
	FALSE	0.00	
	FALSE	0.00	
	FALSE	0.00	

Monthly **From** **1-Dec-27** **to** **31-Mar-50**

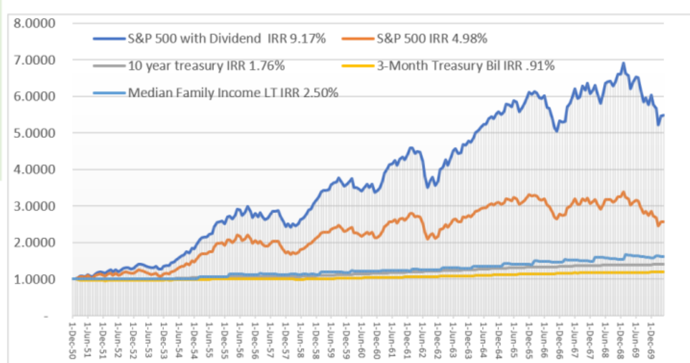


The second period displayed is for 1950 to 1970, representing the post-World War II period with high levels of dividends and returns. This is similar to the period in France named "les trente gloriouse" when appliances like washing machines were electrified, when employment was stable, when the economy was growing at a steady pace and when space exploration resulted in a man walking on the moon in 1969. The series on the graph name median family income grew at a real rate (that is after inflation) more than 2.5%[32], meaning that over twenty years int increased by 2.31 times. The rate of return on stocks, after inflation, was a surprising 9.17%, which implies that if you put one dollar in the market in 1950, that dollar would have grown to 5.49 dollars. My problem with using studies of returns since 1927 as a basis for measuring the cost of capital or evaluating desired returns on investment, is that despite what some may hope for, this period will most probably not be replicated.

	IRR	Vol	Beta	Avg Ret
S&P 500 with Dividend	9.17%	12.20%	1.00	9.54%
S&P 500	4.98%	12.15%	**1.00**	5.61%
10 year treasury	1.76%	0.63%	**0.01**	1.74%
3-Month Treasury Bil	0.91%	0.85%	**0.01**	0.91%
Median Family Income LT	2.50%	5.60%	**0.03**	2.60%
		0.00%	**0.00**	0.00%
		0.00%	**0.00**	0.00%

	Series Start	Final	Years
S&P 500 with Dividend	1-Dec-27	5.49	19.41
S&P 500	30-Dec-27	2.57	
10 year treasury	1-May-53	1.40	
3-Month Treasury Bil	1-Feb-34	1.19	
Median Family Income LT	1-Jan-54	1.62	
	FALSE	0.00	

Monthly **From** **1-Dec-50** **to** **30-Apr-70**



When moving to the next two decades – from 1970 to 1990, things were not as pleasant for investors. The biggest event in these two decades were two dramatic oil shocks in 1973 and 1979 (see Chapter 21 for more discussion) and inflation combined with limited growth. In the

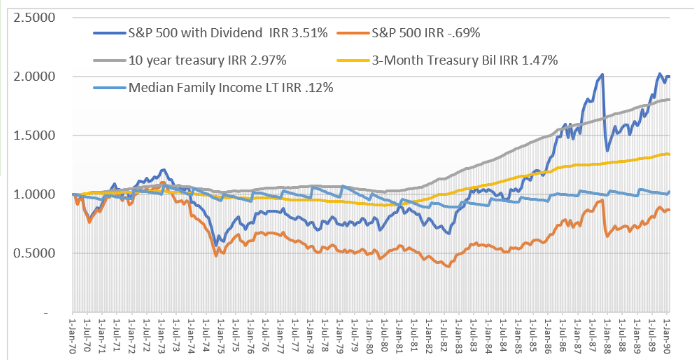
[32] Because the series began in 1954, the 2.5% rate shown on the table is lower than the actual rate which was above 3%.

US there was also worry about competition from Japan and other countries. Without considering re-investment income, stocks declined while the return on stocks in real terms was only slightly above the return on ten-year bonds. Real median income for families remained virtually flat. If you would use these numbers to evaluate an investment and somehow suggested that the realized historic return reflects the cost of capital, you would reach a completely different conclusion than if you reviewed the prior twenty years. But instead of cost of capital decreasing which is the result for comparing earned returns with bond returns, it would be reasonable to suggest that risk had increased. The volatility statistic shown in the tables shows that volatility as measured from the standard deviation of returns on an annualised basis increased relative to the prior period.

	IRR	Vol	Beta	Avg Ret
S&P 500 with Dividend	3.51%	16.02%	1.00	4.80%
S&P 500	-0.69%	16.21%	**1.01**	0.66%
10 year treasury	2.97%	1.27%	**0.01**	2.94%
3-Month Treasury Bil	1.47%	1.10%	**0.01**	1.46%
Median Family Income LT	0.12%	6.40%	**0.03**	0.31%
		0.00%	**0.00**	0.00%
		0.00%	**0.00**	0.00%

	Series Start	Final	Years
S&P 500 with Dividend	1-Dec-27	2.00	20.08
S&P 500	30-Dec-27	0.87	
10 year treasury	1-May-53	1.80	
3-Month Treasury Bil	1-Feb-34	1.34	
Median Family Income LT	1-Jan-54	1.02	
	FALSE	0.00	

Monthly From 1-Jan-70 to 31-Jan-90

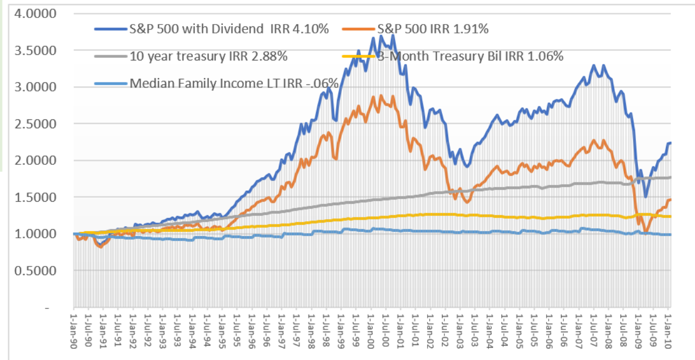


Continuing with our little history discussion, we can move to the two decades starting in 1990 and ending in 2010. This period started off well and if we would use an end data of 1999, the results would have seemed very good for investors as the internet was taking off and going to revolutionize the world. But the dot.com bubble burst in 2000-2001, New York was attacked on September 11th, and the housing crisis combined with pressure on energy prices created the great recession in 2008-2009. In the meantime, for the first of our periods, the median family income declined slightly. Using returns from these two decades as the end points, the return to investors of 4.1% was not much above treasury bond return of almost 3%. Without considering re-investment income, stocks grew at a rate of less than 2%. I emphasize the point that the starting and ending point in this kind of analysis matters a lot and you would get different results from analysis of different periods.

	IRR	Vol	Beta	Avg Ret
S&P 500 with Dividend	4.10%	15.06%	1.00	5.20%
S&P 500	1.91%	15.17%	**1.01**	3.06%
10 year treasury	2.88%	0.97%	**-0.01**	2.85%
3-Month Treasury Bil	1.06%	1.01%	**0.00**	1.06%
Median Family Income LT	-0.06%	3.37%	**0.00**	0.00%
		0.00%	**0.00**	0.00%
		0.00%	**0.00**	0.00%

	Series Start	Final	Years
S&P 500 with Dividend	1-Dec-27	2.24	20.08
S&P 500	30-Dec-27	1.46	
10 year treasury	1-May-53	1.77	
3-Month Treasury Bil	1-Feb-34	1.24	
Median Family Income LT	1-Jan-54	0.99	
	FALSE	0.00	
	FALSE	0.00	

Monthly **From** **1-Jan-90** **to** **31-Jan-10**

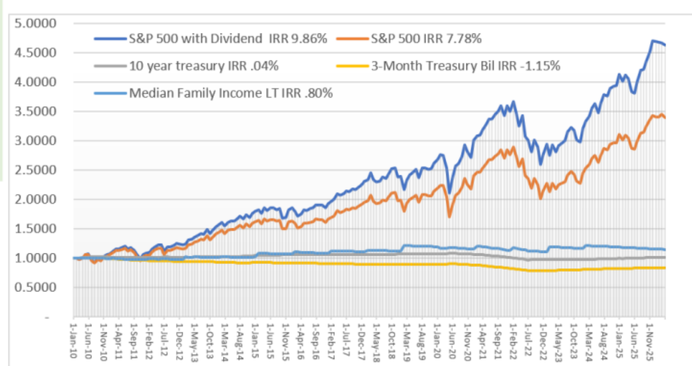


We now come to the final period reviewed, from 2010 to 2026 (remember that you can update this analysis by yourself). For this period that began with recovery from the 2008 recession, the real returns have been remarkably high, almost 10%. This has been driven from returns earned by a few of the high technology companies and from the development of shale gas and oil. If you inherited one dollar in 2010 and re-invested dividends, that dollar would have grown in real terms to 4.63 in 2026. This was far above the rates earned on bonds and the gap between the real median family income and the returns on stocks was wider than any of the other periods. Rather than suggesting that this high return can be used to impute a high cost of capital, negative return on 3-month treasury bills suggests that part of the increase in returns was due to a decline in the real cost of capital. The remarkable real return of 10% does imply that if you are evaluating an investment in an asset with relatively low risk, believing that you should have a target return of anywhere near that level is a very aggressive target.

	IRR	Vol	Beta	Avg Ret
S&P 500 with Dividend	9.86%	14.65%	1.00	10.53%
S&P 500	7.78%	14.71%	**1.00**	8.61%
10 year treasury	0.04%	0.93%	**-0.01**	0.04%
3-Month Treasury Bil	-1.15%	1.01%	**-0.01**	-1.15%
Median Family Income LT	0.80%	4.52%	**-0.04**	0.89%
		0.00%	**0.00**	0.00%
		0.00%	**0.00**	0.00%

	Series Start	Final	Years
S&P 500 with Dividend	1-Dec-27	4.63	16.28
S&P 500	30-Dec-27	3.39	
10 year treasury	1-May-53	1.01	
3-Month Treasury Bil	1-Feb-34	0.83	
Median Family Income LT	1-Jan-54	1.14	
	FALSE	0.00	
	FALSE	0.00	

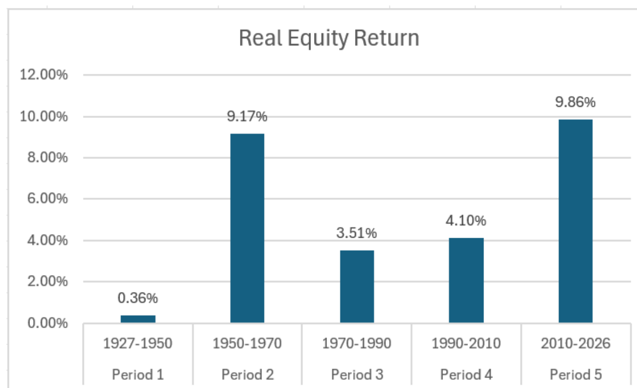
Monthly **From** **1-Jan-10** **to** **14-Apr-26**



The fact that returns of anywhere near the return show above are not logical expectations of returns or the cost of capital is demonstrated in another quotation from an article in the book "Equity Risk Premium".

This view [of having the ability to earn high returns on stocks]is now embedded into the psyche of an entire generation of professional and casual investors, who ignore the fact that much of that outsized return … [is] a consequence of soaring valuation multiples and tumbling yields. Because most investors anchor their decisions on personal experience, we have a population that largely assumes that this long-term 5 percent excess return of stocks over bonds is their birthright. This view constitutes the "cult of equities."

Putting the data together from the different twenty-year periods confirms the problem with trying to read too much into evaluation of historic returns. If the returns from the different periods are averaged, the real return, which is similar to the return relative to short-term government securities is 5.4%. Much of this return comes from re-investing dividends. When looking at the different periods, suggesting that the future returns should reflect the last 100-year history is not a reasonable thing to suggest in an investment committee meeting or as the basis for deriving the cost of capital. The data does show that if you can achieve something close to a return above the inflation rate and anywhere near 10% is an extremely good return.



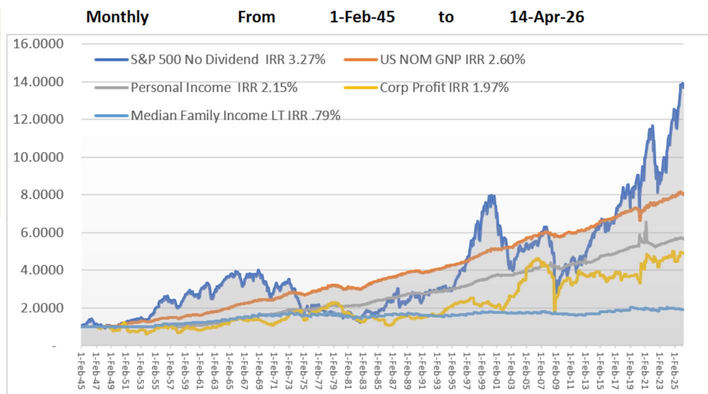
Data Analysis of Stock Prices, Corporate Profits and Economic Growth

After the little history of returns to equity investors relative to inflation and interest rates, the relationship between stock prices, corporate profits and economic growth that was introduced earlier in the chapter is ready to be re-visited. But before accepting the supposition that the relationship between profits and economic activity should be direct, the idea of re-investing dividends must be re-visited. If a corporation pays out higher amounts of dividends, there will be less money for investment, and the growth rate will be lower. This has two implications. First, during periods when the dividend payout was higher, the growth rate in profits should be less. Second, if a company pays no dividends, all else equal, its stock price and its profits will be higher. This means that when comparing equity returns and stock prices to corporate profits, the dividend re-investment should not be included in the comparison. For the overall US economy, the S&P stock index without dividends is the relevant comparator for aggregate profits. As with the last section, the data is all converted to real terms through dividing the series by the CPI.

To display the stock prices versus corporate profits and GDP[33], two data series are presented. The first is for the long period from 1945 to 2026. The first graph demonstrates that the relationship between corporate profits and the GDP in real terms has indeed been relatively stable. Further, over the long-run the stock prices have generally tracked corporate profits but with a few notable deviations (the blue line compared to the yellow line). In the 50's and 60's the stock index grew faster than corporate profits meaning the ratio of the stock prices to corporate profits or the P/E ratio increased. During this period, the growth in profits was less than the GDP growth until the late 1990's and the dot com bubble where there was a dramatic increase in stock prices relative to profits. After the dot com crash, corporate profits increased faster than the GDP until the 2008 crash. In the past fifteen years there has been another pronounced increase in stock prices and the P/E ratios.

	IRR	Vol	Beta	Avg Ret
S&P 500 No Dividend	3.27%	14.52%	1.00	4.32%
US NOM GNP	2.60%	3.60%	**0.02**	2.63%
Personal Income	2.15%	4.09%	**-0.01**	2.20%
Corp Profit	1.97%	14.14%	**0.12**	2.99%
Median Family Income LT	0.79%	5.12%	**0.01**	0.90%
		0.00%	**0.00**	0.00%
		0.00%	**0.00**	0.00%

	Series Start	Final	Years
S&P 500 No Dividend	1-Dec-27	13.68	81.20
US NOM GNP	1-Apr-39	8.02	
Personal Income	1-Feb-46	5.65	
Corp Profit	1-Apr-46	4.87	
Median Family Income LT	1-Jan-54	1.89	
	FALSE	0.00	

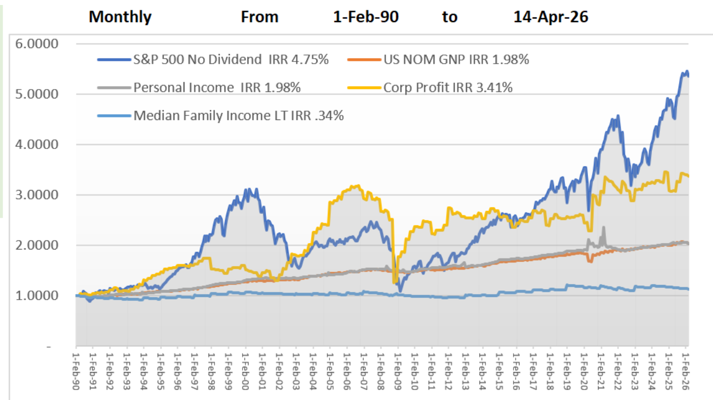


As with the previous section, alternative starting points can give you a different pictures and suggest different interpretations of the data. When changing the start date to 1990, the growth rate of real corporate profits (3.41%) has been more than the economy (perhaps in part due to lower dividend payouts and due to income tax rate reductions). In both graphs the median family income has consistently lagged all of the other series. The corporate profits shown on the yellow line on the graph below have been fairly static since recovering from the 2008-2009 recession other than a step-up from the income tax rate reduction.

[33] The standard critiques of GDP should be highlighted -- We all know, and I completely agree that GDP is not a very good statistic – divorce lawyers, medical bureaucrats, and abusive prison guards are part of GDP, but they do nothing positive for people.

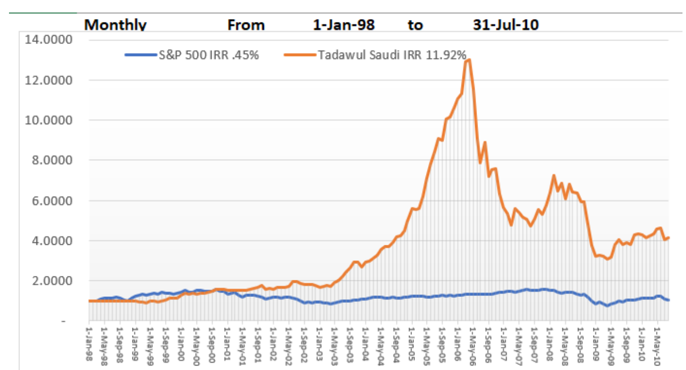
	IRR	Vol	Beta	Avg Ret
S&P 500 No Dividend	4.75%	14.82%	1.00	5.78%
US NOM GNP	1.98%	3.12%	**0.01**	2.01%
Personal Income	1.98%	5.39%	**-0.02**	2.11%
Corp Profit	3.41%	15.35%	**0.14**	4.65%
Median Family Income LT	0.34%	3.94%	**-0.02**	0.41%
		0.00%	**0.00**	0.00%
		0.00%	**0.00**	0.00%

	Series Start	Final	Years
S&P 500 No Dividend	1-Dec-27	5.36	36.20
US NOM GNP	1-Apr-39	2.03	
Personal Income	1-Feb-46	2.04	
Corp Profit	1-Apr-46	3.37	
Median Family Income LT	1-Jan-54	1.13	
	FALSE	0.00	



To understand the deviations of stock price growth from corporate profit growth in the graph we can return to the fundamental idea that value is driven by the return earned relative to the cost of capital and the expected profitable growth in cash flow (recall that if the growth rate is high but returns are equal or lower than the cost of capital, then value will be static or lower). This idea of cost of capital and growth means that the high valuation relative to profit before the dot.com crash and during the period of high valuation in 2025 to 2026 could theoretically be explained by expectations of high profitable future growth or alternatively by declines in the cost of capital (expectations of high growth are not necessarily rational). Declines in the cost of capital can just mean that stock prices are bid up and investors are satisfied with lower returns. The notion that higher returns imply lower cost of capital directly conflicts with the idea of using past returns to measure derive the cost of capital.

Some could argue that the large deviations between stock prices and In the past, the value of a corporation is directly related to the cash flow and earnings of the company. That is the way we learned things. Now anybody reasonable must ask how close the value is to the value of pure cash flows. In the old days could do accounting. Only way now is to use simple examples. Use the example of Saudi.



Implications of Data Analysis

The ultimate question addressed in this chapter is what can we say about the required return for an investment in a typical stock and the investment in a typical bond. When you read many articles on the equity market risk premium, inflation premium on long-term bonds, the rate of inflation versus the rate on short-term debt, you get a lot of different answers. For example, in terms of the overall cost of capital for equity securities or the equity market risk premium, it ranges from something around the overall real growth rate in the economy up to 300 or more basis points above the rate of growth in the economy. From our historic survey we can certainly not answer the central question of what should be the equity market risk premium, but there are a number of implications that allow some boundaries on the question. One of the central debates throughout the book is this question.

1. The first implication from this analysis is that it is ridiculous to use long-term historic returns from the last century to derive expected future returns when events in the world that affected returns have changed so dramatically. When reviewing the articles on the equity market risk premium, you will often see studies that go back to periods before the stock market crash of 1929 and suggest that over a very long-term period there is some kind of equilibrium equity market risk premium where the prices of stocks are pushed down if the implied premium is too high and the market prices are pushed up when the implied premium in prices is too low. This pushing up and down is suggested to produce a long-term stable premium. Just writing this down after the review of the actual data confirms that the idea is silly.

2. The second implication is that for many periods and over the past century, the rate of return earned on stocks has been greater than overall economic growth. This conflicts with the idea that if returns to owners of stock are greater than the overall economic growth, they will one day take over the entire economy. Much of the premium to investors in stocks comes from the inclusion of dividends as a component of return. When the re-investment of dividends is included in the analysis, the rate of return has been well above the growth rate in the economy. Similarly, the level of corporate profits that could have been earned had the dividends been re-invested (and there were available profitable investments), would have been higher than the growth rate in corporate profits had the dividends not been paid.

3. Third, along with the premium earned on stocks, the situation for people earning a median income has gone down. This confirms that proposition that investors have become richer and the rest of the people in society have borne the brunt of their enhancement in wealth. This is not some kind of socialist idea, but it comes straight from the data analysis and accounting for GDP.

4. Fourth, over a long-term period (about seventy years), the return on long-term bonds has been higher than the interest earned on short-term debt and the interest rate on short-term debt has been a little higher than the rate of inflation. The difference between rates earned on long-term bonds and short-term debt implies that the risk of the inflation rate changes is important and above 1%. The difference between the return on short-term bonds and the rate of inflation suggests that there is a small positive real rate of interest and people are impatient with their consumption.

5. Fifth, equity securities have less inflation rate risk than bonds which have a fixed nominal rate of interest as they can and do adjust their prices. This implies that if bond returns are put on an equal footing to equity returns with respect to inflation, a 2% real return on equity securities would be something like a 1% real return on long-term debt.

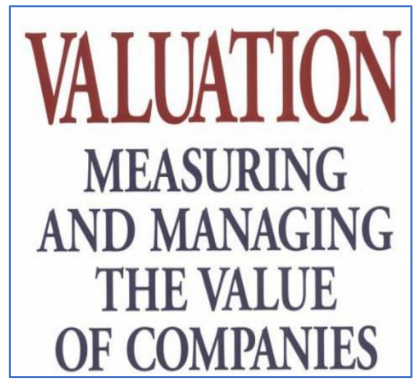
6. Sixth, the effects of the inflation premium for long-term debt and short-term debt answers the dilemma, that if bonds have a real return of about 1-2%, how can the real cost of capital for equity securities derived from the growth rate in GDP be similar to bond rates. One of the first things you learn in finance is that equity is riskier than debt which implies that the returns on stocks should be a lot higher. The answer to this dilemma is that bonds have much more inflation risk than equity securities and one could even make an argument that the inflation risk on long-term bonds can be more than holding a very big portfolio of common stocks where you take the risk of under-forecasting or over-forecasting the overall GDP.

7. Seventh, the returns can provide some boundaries for investment analysis. Assumptions that a real return of above 5% can be earned over a long-term period are inconsistent with historic returns. Reasonable returns for investments with similar risks to a large basket of companies could be between 2% and 5%.

8. Eighth, with available data from finance.yahoo and from FRED, you can make your own analysis rather than relying on academic studies that are use crazy assumptions that expected returns can be derived from the last century of returns.

Chapter 5: Stock Returns, Economic Productivity and Monopoly Profits

This Chapter moves to returns from different countries and then presents returns from different kind of stocks ranging from boring utility companies to high tech companies, and finally to assessing returns on stocks relative to something approaching a risk-free rate. Perhaps the most basic idea of capitalism is that earning high returns enhances innovation and productivity. For this to happen, the earned return must be greater than the cost of capital. In this chapter we move past the philosophic points involving the minimum required return for investments or the cost of capital and the risk premium and address earned returns. The third point involves reasonable expectations of earned returns in relation to the minimum required returns. The book which I treat as the bete noir for finance and is representative of current finance practice is "Valuation: Measuring and Managing the Value of Companies" even though a better title may be "In Praise of Monopoly Profits and Growth."



This book emphasizes that companies should look for investments that earn high returns, Notably the implications of high returns are made without discussing the point that these returns are earned by having some kind of monopoly power and increasing prices. Authors state that an economy that earns high returns is somehow better than an economy where firms earn lower returns. For example:

> ***"In addition to higher returns in the United States, P/E and market-to-book ratios have been significantly higher for the U.S. market when compared with Europe and key Asian markets … Performance differences can explain much of the difference in valuation, particularly in the case of return on capital. U.S. companies, for example, consistently earned higher returns on capital than companies in Europe and Asia… We see this as further proof that economic fundamentals drive stock markets."*** [34]

For me, this statement is both sickening and dangerous. One could just about translate it to suggest that monopoly profits define the wellbeing of a country and that American companies are better than others because they are able to earn high returns. Given that activities such as installing energy efficient systems or competitive bidding for wind projects typically do not generate really high returns, some may suggest that investments to combat climate change are bad for investors or the economy (I discuss this in the context of Shell Oil's withdrawal from renewable projects in the paragraphs below). A more subtle but important critique of this statement is that it violates the first rule of capital budgeting which

Name	Market cap
LVMH	234,370M
L'OREAL	193,764M
HERMES INTL	175,351M
TOTALENERGIES	172,529M
SCHNEIDER ELECTRIC	157,324M
AIRBUS	142,516M
SAFRAN	119,772M
AIR LIQUIDE	101,461M
BNP PARIBAS ACT.A	100,852M

[34] McKinsey, Fourth Edition,

dictates that positive net present value investments increase the value of a company. This means that investments with lower returns than current earned returns, but which still have returns above the cost of capital are good investments and increase the value of a company.

The question of whether stock market reflect productivity, Could go on and on and spend half of the book on this. From US standpoint is a nationalistic and arguably arrogant statement. 1.

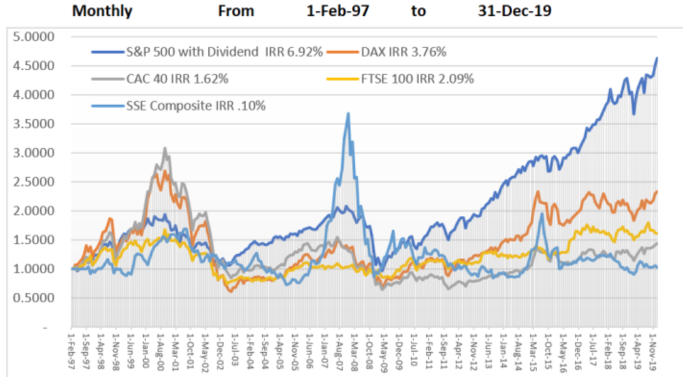
Part 2: Returns in Different Countries

The question of whether stock market reflect productivity is a big one. We could go on and on and spend half of the book on this. From US standpoint is a nationalistic and arguably arrogant statement. 1. Equation of P/E and M/B ratio is the most important. It means that returns are above the cost of capital and this is what McKinsey really seems to praise. Return on capital measurement. What does economic fundamentals mean. Has nothing to do with quality of life. Investors can invest anywhere. Companies have factories, employees and sales teams all over the world. The more interesting question is below. When you compare the stock prices, do you think that China's economy has performed worse than US, Germany, France and UK. Do you think that the poor performance of France reflects the quality of life for people who do not own one of those YSLM bags. Do you think that your life in France is worse or better because of employees in China who make the bags. The only conclusion from the McKinsey quote is related to the market to book ratio that demonstrates earning returns above the cost of capital.

	IRR	Vol	Beta	Avg Ret
S&P 500 with Dividend	6.92%	15.26%	1.00	7.93%
DAX	3.76%	23.10%	**1.12**	6.46%
CAC 40	1.62%	20.53%	**0.99**	3.76%
FTSE 100	2.09%	15.61%	**0.70**	3.30%
SSE Composite	0.10%	27.20%	**0.43**	3.84%
		0.00%	**0.00**	0.00%
		0.00%	**0.00**	0.00%

	Series Start	Final	Years
S&P 500 with Dividend	1-Dec-27	4.64	22.91
DAX	30-Dec-87	2.33	
CAC 40	1-Mar-90	1.44	
FTSE 100	3-Jan-84	1.61	
SSE Composite	2-Jul-97	1.02	
	FALSE	1.00	

Monthly **From** **1-Feb-97** **to** **31-Dec-19**



Companies and the Economy in General Do Not Need Really High Returns from Monopoly Profits to Thrive

Economy as a single company. Half the population are investors. Half are employees who do not earn shares. GDP accounting: Price of products in the economy. The economy starts small and then grows at 2% while the company earns a return of 15%. The sales grow with the economy and the investors keep earning a return of 15%. What happens to value.

The high return desired by US companies compare to companies in Europe and Asisa is illustrated in the table below which I have extracted from Bloomberg. When you look at the bottom three rows of the table you can compare the equity returns on solar and wind projects for 2019 and 2021 in Germany, the UK, and the US. In the low case for wind projects the equity return was 4% in Germany and 8.8% in the US. If the cost and performance of wind projects were the same in the US as in Germany, this suggests that the price would be a lot lower for the same project in Germany than in the U.S. Alternatively, if the price is given, then there would be a lot more projects developed in Germany than in the U.S. But this does not mean the value of stocks in Germany would be below the value of stocks in the U.S.

Bloomberg Return of Equity/Cost of Equity

Countries	Wind Onshore 2018	Solar Low 2019	Solar High 2019	Solar Low 2021	Solar High 2021	Wind Low 2021	Wind High 2021
India	12.00%	11.50%	13.30%	11.00%	12.80%	10.80%	13.00%
Australia	9.00%	7.50%	11.00%	6.50%	11.50%	6.50%	11.50%
China	10.00%	8.00%	10.00%	6.50%	8.00%	8.00%	8.00%
Philippines	10.00%						
Vietnam	12.00%						
Thailand	10.00%						
South Korea	9.00%						
Indonesia	12.00%						
Japan	8.00%	6.00%	7.00%	5.00%	6.00%	4.50%	5.50%
Malaysia	10.00%						
Germany	5.00%	5.00%	5.00%	5.00%	5.00%	4.00%	5.00%
UK	8.00%	7.00%	8.00%	6.50%	7.00%	7.00%	8.00%
US	9.00%	7.00%	7.00%	8.00%	8.00%	8.80%	8.80%

Many investments in renewable energy and adaptation to climate change do not involve businesses that can easily gain monopoly power and earn the same high returns as investments that realize monopoly power and are touted by McKinsey. For example, you cannot easily differentiate solar panels or energy efficient windows like you can prompt people in Wisconsin to buy big pick-up trucks. Similarly, you probably cannot realize the same return on an agriculture project that involves putting up-front capital for nurseries is resilient to climate change as you can by selling cruises to old people where they travel around half the world and have dinners on really big ship with people from their own country. The desire to earn returns on invested capital of 7% to 25%, all of which are likely to be above a cost of capital that includes an after-tax debt cost of around 2-3% are illustrated in the accompanying box which is extracted from the McKinsey book.

EXHIBIT 2.5 **Translating Growth and ROIC into Value**

Value,[1] $

Growth \ ROIC	7%	9%	13%	25%
3%	800	1,100	1,400	1,600
6%	600	1,100	1,600	2,100
9%	400	1,100	1,900	2,700

But not making investments because they do not earn a very high return or because you do not earn as high a return as the return on existing investments runs counter to the most basic rules in finance. These rules are either that you can increase value by making investments where the IRR is above the minimum required return or stated differently you can increase value when the NPV is positive. Focusing on historic returns also violates the basic sunk cost principle in economics where you should concentrate on new investments without thinking about how lucky you were to make projects with really high returns in the past.

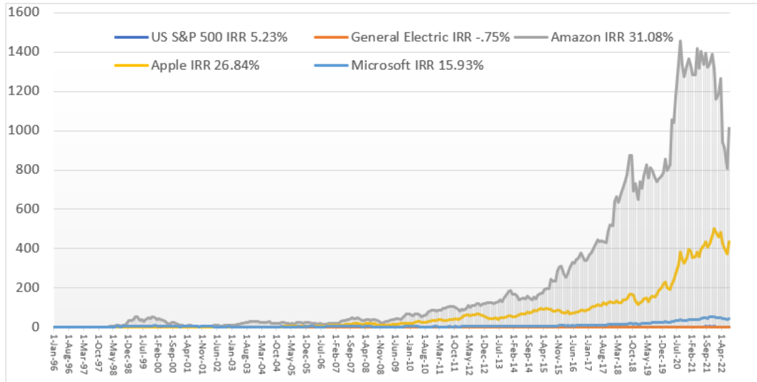
While every investor wants high returns and if you are making a single investment, it is better to have a high return than a low return, foregoing good investments because the return is not as high as other investments will reduce value (I am in no way saying that the return can be below the cost of capital). Further, if different lines of business have different risks and different costs of capital, trying to maintain monopoly profits by not investing in businesses with lower return implies that investors are stupid and cannot figure out that a company can have multiple lines of business with different risks. This is a different way of saying that financial markets are not efficient. Stated more bluntly, just because an investment in renewable energy cannot earn returns like Nike, Apple, Starbucks or Disney (companies that have been successful in making consumers become addicted to their products) does not mean that these investments do not add value.

As with many issues throughout this book, I demonstrate a financial idea with a simple financial model. In the model I compute the value of a company assuming that it earns a return of 15% and grows at a rate of 5% (for example, a company that earns a lot of monopoly profits by making its customers addicted to its products). I then assume that the company makes investments in less profitable climate change investments that earn a return of 6% and have a cost of capital of 4%. I assume that the added climate change investments grow at a rate of 7%. The table illustrates that even though the new investments have a lower return, they add value to the company. This s nothing more than proving the basic net present value rule.

	ROI - Current	ROI - 20 Years	Cost of Capital	Growth Rate	Investment Initial	Value	Price to Book	Price to Earnings
Without Renewable	15.00%	15.00%	7.00%	2.00%	2,000	3,709.42	1.85	12.36
Renewable Investments	7.00%	7.00%	5.50%	6.00%	1,000	1,209.01	1.21	17.27
Total with Renewable	12.33%	10.92%	6.63%	2.98%	3,000	4,918.43	1.64	13.29

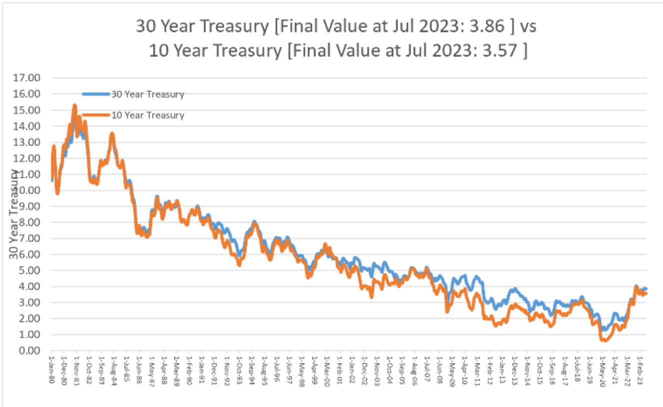
Even if an economy current has a lot of monopoly power where firms earn high returns and these high returns are expected to continue, if investors are to benefit from the high returns, these high returns must grow at a faster rate than the overall growth in the economy. A basic idea that the earned return on historic investments is not the same as the expected return on future investments.

Up to now we have discussed the debt structure of project finance which is the majority of the cost of capital. While the equity cost of capital which is a much smaller component of the capital structure. To see what IRR really means in project finance (certainly not the discount rate that makes the net present value equal to zero), start by considering the movements in the price of a stock. If you invest in a stock, you may receive dividends and when you sell the stock you will receive a capital gain. If there were no dividends, the growth rate in your money is measured as the compound annual growth rate from the date that you invested your money until the date the stock was sold. This is exactly the same as the IRR. If there are dividends, you can assume that you take the dividends and re-invest them in the stock at the then current stock price. You can then adjust the stock price and re-compute the IRR. This is what Finance.yahoo.com does when it presents the adjusted stock price, and this price allows you to compute the IRR. To illustrate consider the case of Amazon and Jeff Bezos. Amazon's IRR from the 1990's has been above 30%. This may not seem that much, but it is enough to make Mr. Bezos the second richest man in the world. This IRR has allowed him to pay his ex-wife 38 billion USD in a divorce settlement. The example demonstrates I hope that expectations of high equity IRR's are not realistic.



Stock markets in the US have grown faster than the overall economy since the 1990's and also faster than markets in the UK and France. Does this mean that companies are more efficient in the US or that companies have been able more money through raising prices. If you are making investments, do the stock price increases mean that should be your target return or to the contrary that the cost of capital has decreased.

The final possibility suggesting that expected returns can increase faster than either corporate profits or the overall GDP growth would be that price to earnings multiples increase.



In the past P/E multiples have risen because of declines in the real cost of capital (again you can see this in the graph above). Any analysis of the cost of capital should contain the adjacent graph showing declining returns in the back of your head. Despite some bumps, nominal interest rates on long-term government bonds have had a continued and dramatic reduction for many decades.

PART II – Rate of Return – IRR versus NPV, Fixing IRR and ROIC

Chapter 6: Corporate Finance Equations from Growth, Return and Cost of Capital

In defining what finance is all about – assessing an investment decision and then measuring benefits versus costs of the decision through computing a rate of return. The next chapters in this section of the book address various issues associated with defining different measures of the rate of return. This first two chapters of the section (chapters 14 and 15) introduce return and growth as the fundamentals of any business strategy and a framework to assess risk. Issues related the rate of return include the phrase that if it sounds too good to be true (earning a high return in a competitive industry) it probably is; and if you have a business that is not earning a reasonable return, you should get out of the business instead of imagining that you can solve the problem by growing the business. The subsequent chapters of this section deal with IRR, ROE, NPV, Earned Risk Premium and other measures of return. Subjects include defining IRR (not as the discount that makes the NPV equal to zero) and a discussion of why the IRR statistic has taken over the world. Nuanced problems with the IRR are then addressed through explicitly computing the amount of money an investment earns relative to the risk-free rate as an alternative measure of the costs and benefits of an investment. The final two chapters of this section discuss evaluating performance of investments with rate of return using accounting data.

Rate of Return and Management Strategy

Finance and economic analysis can be reduced to a couple of simple and fairly obvious ideas that are often not explicitly covered in basic courses in corporate finance; but which should be the starting point in finance. The most basic idea of valuation is that you try to find something good – an effective strategy that can generate a high profit -- and then grow that good thing you have found by making new investments in the activity. In the context of finance, you should find business activities that earn a return above the minimum acceptable growth rate adjusted for risk (i.e., the cost of capital) and then make investments (whether the investment is for capital expenditures, advertising, education of employees, development of new information technology systems, inventories etc.) to grow these parts of your business. Alternatively, if your return is low, you should get out of the business and stop making investments – this can be a lot more difficult to do than growing a business. Any rate of return or interest rate can be thought of as a growth rate as it measures the incremental increase in your investment -- income divided by prior level of the investment.

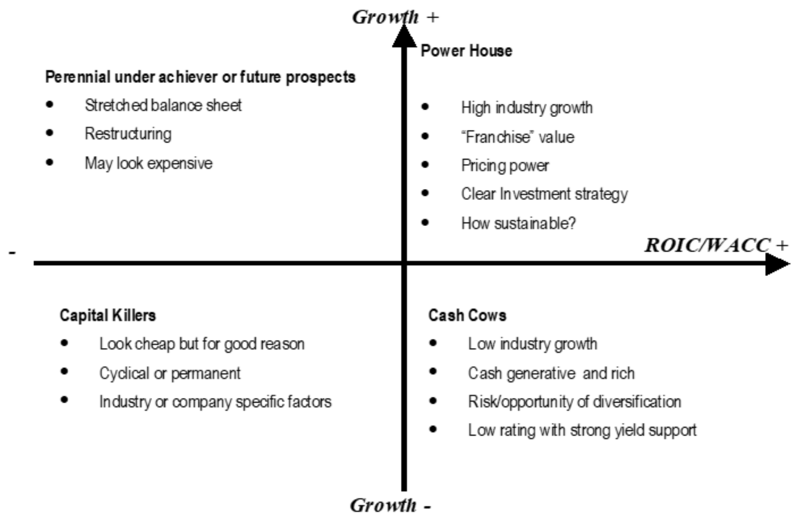
A second and related fundamental idea of finance must be that any valuation of a bond, a stock, a strategy, a factory, an education, gambling or even a decision like getting married comes from two things. The first is making a forecast of happiness -- future cash flow (that depends on both returns and growth in investment). The second is anxiety -- assigning risk to that cash flow. All subjects in finance deal directly or indirectly with these two things: (1) prediction of future cash flow, and (2) risk associated with that forecast. It may seem pretty simple that all you have to do is make a prediction and then assign risk to your projection of the future; but making prognostications of the future and coming up with a way to measure risk of future uncertainty are the foundation of many if not most issues in economics.

A basic philosophical problem with the basic notion of finance is how and whether we can really measure risk. If you use the cost of capital to measure risk (the minimum required growth in your money given the level of risk), then the cost of the capital can be thought of as your minimum desired rate of growth in cash flow. Your basic objective is to find investments where the projected (uncertain) rate of growth is above the minimum rate of growth required to accept the risk of the project. This may seem very basic, but understanding fundamentals of what is return, what is an investment, what is the cost of capital are at the bottom of finance and should be the starting point of a finance text.

Classic Competitive Strategy Matrix

Many years ago, I was asked to lead a valuation course and to discuss issues in the context of the valuation matrix replicated below. I generally don’t like this kind of management consulting presentations, but I thought this graph with four boxes could be a good way to think about competitive strategy. The vertical axis is growth, and the horizontal axis is the return on investment relative to the cost of capital, so the matrix incorporates future cash flow (return and growth) and the risk of the cash flow which are the drivers of value. The simple idea is that if you can grow and earn a good return relative to the risk you take, you will become rich and successful and land in the powerhouse company box. To get to the powerhouse square, you are supposed to have a sustainable competitive advantage by managing all sorts of aspects of the company well from product development to quality control to cost management developing the skills of the staff. While the boxes may be a good framework for thinking about valuation, I hope you find comments inside the boxes a little repulsive. For example, the diagram inappropriately implies that the bottom left square – capital killers -- is the worst place to be and includes meaningless statements like a cash cow has a “low rating with yield support.”

The matrix may be a reasonable starting point for valuation analysis or understanding financial analysis. While I continue to use the matrix as a framework for discussion, I will argue that this graph is not only simplistic, but the idea of always wanting to get to the powerhouse square is wrong. You can think of valuation as directly or indirectly assessing changes in return, growth and risk and whether potential change in these three things have already incorporated correctly in the value of a company. For example, valuation involves assessing whether return will decline with more competition in the industry or whether the cost of capital will decline as a proof of concept has been achieved. Thinking about whether returns can be maintained; if growth rate will stabilize or how the risk profile of a company or project will change contrasts with the obsession that valuation analysts have with short-term earnings per share that does not explicitly consider the investment you need to achieve growth.



The three inputs for the above graph – ROIC, growth and cost of capital -- can be directly translated to value if we make the heroic assumption that: (1) return on invested capital (ROIC) can be properly defined (it cannot); (2) we can reasonably measure risk with the cost of capital (you cannot); (3) we can define what represents growth (you need investment); and (4) the return, cost of capital and growth do not change over time (this is the whole point). Assumptions that you can measure these things are obviously crazy and coming up with ways to deal with the problems in measuring the drivers underlies the central theme of this book. Serious issues relating to evaluating the return on invested capital are related to defining investment, measuring depreciation of investment, writing off investment, taxing returns on the investment, making adjustments for the age of investments, and whether you should use equity or overall returns on all of the debt and equity investment.

Problems with measuring cost of capital are even bigger as anybody who has spent time critically working through details of the CAPM knows. Estimates of the equity market risk premium (EMRP), the beta, the country risk premium and even the risk-free rate are not only vague, but they are generally upwardly biased. Alternative cost of capital estimates computed from derived cash flow depend on a reasonable terminal value which falls apart because of simplistic formulas using distorted multiples or crazy constant growth models that do not even account for variation in capital investment driven by changes in growth. The third item in the graph – growth projection must depend in one way or another on the investment that is made.

Incorporating estimates of growth in long-term valuation explicitly through terminal growth rates or through implied growth in multiples generally is arbitrary and ignores the most obvious fact of economics that you must make some kind of direct or indirect investment (and periodically replace that investment) in order to grow.

Profit from Making People Addicted to Your Products and Danger of People Copying You

If the graph represents a static point in time, value is highest in the power-house square when you have continuing monopoly power and lowest not in the bottom left box but rather in the left upper box where growth is high, and return is below the cost of capital. When the valuation matrix is discussed in the context of valuation, the fundamental objective of a business can be thought of as trying to get to the power-house box; the ability to remain in one of the good squares; and consider the danger of getting into the worst throwing money away/surplus capacity square with low returns and high growth. A big problem is that when a company gets into the power-house square, other companies want to do a similar thing and a lot of capital expenditures are made with optimistic expectations. Then supply in the industry increases when a lot of companies make investments to enter the business. With increased supply, returns decline and you quickly arrive in the worst square because of overcapacity. The real disaster occurs when the investments are long-term and the growth rate in the industry slows down.

In thinking about this diagram, I remember the comments of an engineer when we were discussing the potential to earn high returns from manufacturing solar panels. Somehow the discussion moved to the rate of return Apple makes on iPhones. The young engineer made the point that you cannot compare returns earned on iPhones with returns on solar projects because people have an addiction to their iPhone that has been carefully developed and managed by Apple. We can read up a lot about sustainable competitive advantage and Porter's five forces, but I found this basic point about making monopoly profits by getting people addicted to a product a better way to explain value and strategy then most of the stuff you are fed in business schools.

You want some monopoly power through brand loyalty (the notion of getting people addicted to your products like Coke, Apple, Disney, McDonalds, Starbucks, Tesla); innovation that is difficult to copy; size and economies of scale that create barriers to entry; and a variety of other things that result in what economists call economic rent (that is bad for overall society). Then, once you have a sustainable competitive advantage, you want to grow your economic rent by making people desperate for the latest version or by making old versions of your products obsolete so you can grow. We can all think about these philosophical ideas in working through the valuation objective of achieving high IRR's (compound growth rates), but for the moment I can only focus on the financial mechanisms rather than the social implications.

Evaluation of Business Cases should Begin with Considering the Earned Return

I have followed MBA finance courses thirty years after I was in a similar program. These days there are more case studies and excel files are provided that go along with the cases. I was review a course in private equity, a course in mergers and acquisitions and a course in financial equations like duration as well as courses that focused on diversity in the workplace. I found two things remarkable when reviewing the case studies and discussion. The first was the lack of discussion about fundamental questions surrounding return on investment and limited discussion of whether the prospects for a company make sense in terms of competitive strategy. The second thing that I found irritating was the presumtion that you can easily and objectively compute cost of capital from the CAPM (equity market risk premium and beta) without seriously questioning the model and without understanding that small differences in assumptions that drive the CAPM can have a large impact on value and investment decisions. I have been called an angry old man for questioning some of the basic ideas.

Proof of the Value Formula that Includes Return, Cost of Capital and Growth Under Completely Stable Conditions

In the McKinsey book a formula appears from nowhere (1-g/ROIC)/(WACC-g) and seems to be some kind of magic equation that can be used in valuation. Instead of just presenting the formula I think deriving the formula should be a starting point in the study of finance (I did not see this formula much less its derivation in Harvard Case Studies or MBA programs). Before working through the problems with measuring each of the variables – these problems strike at the very heart of valuation and finance – we can see how the fundamental return and growth parameters translate into value. When you see the value driver formula: Value = Earnings x (1-ROI/Growth)/(Cost of Capital – Growth) that considers the three fundamental drivers of value - return on investment, growth, and cost of capital, I think anybody who dreams of using this formula should be able to prove it. You should also be able to do a little algebra to adjust it for evaluating price to book, enterprise value to invested capital, price to earnings. Finally, you really should understand why the formula is not very useful without adjustments for changing returns and changing growth. To begin deriving the formula, understand that if you save money instead of spending money, your money will grow by the rate of return you earn on your investments:

Wealth Growth = Savings Percent x Return on Savings

Wealth Growth = Savings Percent x Return on Investment

The second formula above uses the return on investment which is the income received divided by the investment made (I use the return on equity which can be replaced return on invested capital if you assume that the company is all equity financed with total investment equal to equity). If the income is re-invested in the company, the company then grows by the return on investment. The investment grows by the return (you can see that return and growth are essentially the same thing which is arguably one of the biggest issues with capitalism in the world today). As the growth continues from the earning the return, the growth can be expressed as return on investment multiplied by the investment. On the other hand, if you do not retain any income and instead pay it all out, then the investment will not grow. This means that the growth rate can be expressed as the return on equity (abbreviated as ROE) multiplied by the amount of income retained which is one minus the dividend pay-out ratio (abbreviated as 1-DPO). These two formulas as shown below:

$$\text{Value} = D_1/(k\text{-}g)$$

$$\text{Growth } (g) = \text{ROE} \times (1\text{-DPO})$$

While these two formulas are the basis for valuation, they are useless in terms of terms used in valuation these days (unlike the 1950's were nice and boring dividend growth for companies like General Electric, Consolidated Edison and General Foods were the basis for valuation). First, dividends are driven by growth and not the other way around (you do not want companies like Amazon to pay dividends if the company can grow) and the focus is on earnings rather than dividends. You can then re-arrange the growth formula and use the fact that dividend per share is the earnings per share multiplied by the dividend pay-out ratio to derive the dividends (D = EPS x DPO). This leads to the classic value driver formula where value is driven by return (ROE), growth (g) and the cost of capital (k).

$$\text{DPO} = 1 - g/\text{ROE}$$

$$\text{Value} = (E_1 \times \text{DPO})/(k\text{-}g)$$

$$\text{Value} = E_1 \times (1\text{-}g/\text{ROE})/(k\text{-}g)$$

Earnings can be expressed as return multiplied by the book value of investment -- E_1= ROE * B, and then a number of variants of the formula can be used to illustrate valuation ratios if you assume that return can be computed, and you assume that cost of capital can be computed. We will return to these equations later, but let's look at a couple of them. The first, [P/B = (ROE-g)/(k-g)] illustrates that price to book is driven by the ability to earn a return above the cost of capital. If ROE is equal to k, the P/B is one. What a nice trick this would be to find companies with P/B equal to 1.0 and then find the ROE. This is then the cost of capital. This formula can be extended to derive the following:

1. The P/E ratio: [P/EPS_1= (1-g/ROE)/(k-g)]. This comes from defining Value as P and dividing the equation by EPS.

2. The cost of capital: [k=E_1 /P x (1-g/ROE) – g]. This comes from re-arranging the equation and demonstrates how cost of capital can be derived from expected cash flow.

3. The enterprise value: [EV = $NOPAT_1$ x (1-g/ROIC)/(WACC-g)]. This is the same formula as above, but earnings is replaced by earnings before financing (still after tax), return is

replaced by return on invested capital, and the cost of equity is replaced by the overall cost of capital for both debt and equity that finance the total investment.

4. EV as a Function of Invested capital: [EV= Invested Capital $_0$ * ROIC$_1$ x (1-g/ROIC)/(WACC-g)]. This formula is the same as above except that income (NOPAT) is replaced by = Invested Capital $_0$ * ROIC$_1$.

5. The price to book: [P/B = (ROE-g)/(k-g)]. This comes from the equation that income = ROE x Book Value of Investment. When the ROE = k, the top and the bottom of the equation are the same and the price to book is 1.0. This implies that if you find companies that have a price to book of 1.0 with a consistent return, this return is about the same as the cost of capital.

6. The WACC: [WACC = EV/Invested Capital * (1-g/ROIC) – g]. This is like the formula for k above but allows you to derive the WACC.

Why the Formulas do Not Work in the Real World

It took me many years to work through and think about the simple formulas, but instead of being useful in valuation, they highlight the distortions from computing returns from accounting data. Take the notion that cash flow comes from net income versus payout and then value comes from the present value of the resulting dividends. For a growth company, return will not directly generate dividends because capital expenditures are greater than depreciation and there is less money for dividends. Similarly, the rate of return statistic is distorted by straight line depreciation, write-offs and other adjustments.

Chapter 7: What does the IRR Measure Anyway and NPV versus IRR

This chapter introduces a few concepts related to valuation that are different than the general idea that NPV should be used as the basis for measuring the value of investments – the method typically taught at the beginning of the first finance course. While the NPV is central to financial theory, the IRR rather than the NPV has taken over the world and become the pervasive method for assessing investments. The issue of using IRR versus NPV is addressed not from a mathematical perspective (this is not at all interesting), but from the standpoint of conceptual problems in coming up with a reasonable discount rate that is required in the NPV formula. The discussion covers what is the real meaning and a good definition of the IRR. Other issues addressed include why the equity IRR has become so pervasive in investment decisions; well-known problems with the IRR; problems with alternatives to the IRR; interpretation of high or low IRR's.

Is the IRR Bull Shit?

One example, I remember is when publicising one of its courses, something called the Amsterdam Institute sent out a mass promotional email proudly quoting Professor Phalippou of Oxford University who had apparently discovered that "IRR is BS." How could you not sign up for an expensive finance course with such a prominent Oxford professor who has made such a discovery?

'IRR is bullshit' says Professor Phalippou (University of Oxford) | Last seats September programs

Boîte de réception ×

AIF | Amsterdam Institute of Finance info@aif.nl via gmail.mcsv.net mer. 4 sept. 01:03 (il y a

À moi

Les images ne sont pas affichées. Afficher les images ci-dessous - Toujours afficher les images de info@aif.nl

View this email in your browser

'IRR is bullshit'

"I can observe Zidane, but I'll never dribble like him", says Ludovic Phalippou. "We tend to make people heroes and want to imitate them, but that's not how it works."

Phalippou, Professor of Financial Economics at the University of Oxford Saïd Business School, is having a beer at the Room Mate Aitana hotel in Amsterdam, having just finished his second and final day of the course on Cutting-Edge Asset Management. "Asset management works the same as in football. People see a guy who's good and say: he must be a genius. His way is the only way."

When making this statement as if he has made some kind of big discovery about finance, maybe Professor Phalippou was advocating to use NPV rather than IRR. which implicitly suggests that you should not evaluate risk with alternative scenarios and instead encapsulate all risks into the cost of capital measure. This comes from an arrogant idea made by academics that cost of capital can be measured in a precise way by using the CAPM. Perhaps he was thinking about the mathematical problem of multiple IRRs, where in the rare case where there are positive, negative and positive numbers, the IRR cannot be computed. This is a commonly discussed in finance texts; but is a rare occurrence for most investments. Alternatively, he could have been thinking about the well-known problem that the IRR implicitly assumes the money earned as dividends is assumed be invested in new investments that have exactly the same return as the investment in question (which also applies to NPV). I doubt he was thinking about the issue of measuring returns when risk changes or the question of why IRRs seem to underweight the value of long-term investments because of compounding the risk premium.

Nowadays, when you make a proposal to an investment committee, when presenting projects to the World Bank; when discussing the evaluation of an investment made by private equity, when assessing an M&A transaction and for a plurality of other investments, there is one number the investors focus on and that is the equity IRR. If you work in a project for a public institution, an investment will often be evaluated by something called an economic IRR which computed in a similar manner as the equity IRR but is supposed to account for externalities such as greenhouse gases, creating a better life of society and/or increasing employment. Over the course of my career, I have seen IRR take over the world. So, when a professor tells you this IRR number is bull shit, you may want to question him instead of the rest of the world. In this and the next few chapters the IRR is discussed and to be sure there are problems with the statistic. But we should first understand why the IRR has become such a persuasive number and what the IRR really measures. After understanding the IRR, we can address nuances with use of the IRR to measure the efficacy of an investment. Rather than spouting on about the problem with IRR the remainder of this chapter evaluates different alternatives. The alternatives either depend on the cost of capital (e.g. MIRR), which renders the methods subjective for management as most people in finance admit that cost of capital estimates is rubbish, or they ignore the timing of cash flows (e.g. the payback period).

"What is this Business of this IRR Anyway", and the Re-Investment Rate Headache

Over the years I have gained much more knowledge from general discussions with people who have endured the torture of attending my classes than by reading finance books and articles. Many times, the questions the students ask are very instructive. One example is when a lawyer from Malaysia asked me: "what is all of this business about IRR anyway," seeming to wonder why the CEOs of companies are so focused on this mysterious number. I now regularly ask a variant of this question to participants in my courses. The typical answer I receive is something like the IRR is the rate of return. This is like saying a pilot announcing that the airplane is arriving late because of the delay in the flight landing at the airport – there is no information in the answer as the rate of return is part of the very name of the IRR. But my answer to the question at the time was even worse. From some university class many decades ago, I learned that the IRR is the discount rate number that makes the NPV equal to zero and that was my response to the lawyer, and which disgusted her. Do you mean that CEOs of big companies are asking about what is the discount rate that makes the NPV equal to zero when investing in a new data centre. Not only does the answer that the not mean anything; it puts focus back on the cost of capital as the discount rate should be related to the cost of capital.

My answer and vague statements about the IRR being a return do not address the underlying idea of what IRR really measures and why CEOs of companies care so much about the number. The best answer is that IRR is the growth rate in your money from making an investment. When you see that everything in measuring the benefit of an investment comes down to compound growth rates, returns and IRR's and that capitalism is driven by growth, you have a big foundation in valuation and many other issues (I am not saying that this is good for humanity). But this growth rate has some complications.

The nice thing about the stock price graphs presented earlier that use the Yahoo adjusted close is that evaluate results of an investment in a stock can be evaluated with the IRR after the fact and this growth rate is the same as the IRR.[35] The yahoo finance adjusted close

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[35] You can work with the stock price and beta file at https://edbodmer.com/comprehensive-stock-price-analysis/ where the IRR is computed with the XIRR function and the compound annual growth rate is shown to produce the same value.

assumes that dividends received are re-invested in the same stock, meaning the growth rate in the adjusted closing price can be used to compute the IRR and we don't have to worry about the re-investment rate. In a leveraged buyout transaction, the equity investment is made at the transaction followed by a period where zero or little dividends are received. Then, once the debt is repaid, the equity can be received in a lump sum when the company is re-sold. This means that we do not have to worry about re-investment and the IRR is the same as the growth rate with no ambiguity.[36]

In the last chapter I presented the growth rates in stocks (which is the same as the IRR) for various stocks which were computed from the amount of the investment, re-investing dividends in the stock and then selling the stock. Wouldn't it be good to make the same kind of evaluation for any other investment that pays off in the future where the growth rate in our money is established. Couldn't we just replace the historic cash flow that is computed by yahoo.finance with future projected cash flow from our investment in anything else ranging from spending money on advertising to buying a company. The answer is not quite. In evaluating any investment from buying a stock to acquiring a company to investing in a hydrogen project to investing in advertising, to paying for your own education to buying a lottery ticket, we are evaluating the investment relative to uncertain future cash flow, and the success of the investments depends on some kind of explicit or implicit cash flow projections. These projections include some intermediate cash flow before the end of the project. Unlike the stock price, this cash flow cannot automatically be re-invested in the same investment and some assumption that must be made with respect to what happens to this cash flow.

Understanding that IRR is the Growth Rate in Cash

The notion that the IRR represents a growth rate is very simple to demonstrate that if there is one inflow and one outflow, the IRR is the same as the growth rate. This is demonstrated in the adjacent figure where a compound growth rate is computed over five years. The growth rate is applied to the initial investment, and this is assumed to be the amount of the investment realized. The figure demonstrates that you can convert the inflow and outflow into a very simple financial model where the IRR is the same as the growth rate.

Investment	1,000.00						
Growth Rate	6.00%						
Years Held	5						
Compound Growth	1.338226	=(1+F3)^F4					
Final Amount	1,338.23	=F2*F5					
Time Period		0	1	2	3	4	5
Outflow of Money		1,000.00					
Inflow of Money		-	-	-	-	-	1,338.23
Net Cash Flow		(1,000.00)	-	-	-	-	1,338.23
IRR	6.00%	=IRR(H12:Q12)					

The This fact that cash flow between when we first take money out of our pocket and then have many periods when we receive or pay money creates what I call the re-investment

[36] You can work through exercises in the IRR file at https://edbodmer.com/project-finance-theory-and-contracts/.

headache. The problem with the IRR statistic is that the intermediate cash flow assumes that we can invest the money at the same rate as the IRR itself. You can prove that the IRR is the growth rate with reinvestment at the IRR itself by setting up a simple little example with an up-front investment, some cash flow received and an assumed lifetime for the investment. When cash is received, you set up an investment account with an opening and closing balance and then allow the cash in the investment account to grow by investing in other projects that receive the same IRR. At the end of the life of the project, you can tabulate the accumulated cash. When you divide the ending money by the beginning money and raise it to the power of one divided by the life of the project, you get the compound growth rate which is exactly the same as the IRR.[37] This just proves something that most will now, namely that the IRR is the growth rate with a big footnote. The asterisk is that to achieve growth, the money must be invested at the IRR itself. The example in the adjacent insert demonstrates this idea. The top part shows the IRR computed for an investment that lasts for three years (using the IRR function in excel). The second part of the table proves that if you receive the cash flow and then re-invest the dividends in other investments that yield the same IRR, then the compound annual return over the three years after the investment produces the same return as the IRR. The IRR is 9.7% and the growth rate in cash flow is also 9.7%.

		0	1	2	3
Free Cash Flow					
Cap Exp		1,000.00			
EBITDA			400.00	400.00	400.00
Cash Flow		(1,000.00)	400.00	400.00	400.00
Discount Rate	6.00%				
NPV	65.29				
IRR	9.70%				
Cash Balance					
Opening Balance			-	400.00	838.80
Add: Re-investment	9.70%		-	38.80	81.37
Add: Cash Received			400.00	400.00	400.00
Closing Balance			400.00	838.80	1,320.18
Final Cash	1,320.18				
Initial Cash	1,000.00				
Multiple	1.32				
CAGR	9.70%				

The simple example of computing IRR as the growth rate of cash flow corresponds to the definition of profit maximization in economics. First, rather than accounting profit maximization, EPS growth, obtaining high return on invested capital, or achieving the highest possible NPV, let’s start by what people who are lucky enough to have some money to invest want most. If you have managed to save a bit of money, you can measure how well you are doing you can measure your performance by the growth rate in your cash flow. The growth rate is a compound growth and can be computed on an annual basis (the CAGR). When you see on television that the economy has grown at a rate of 2.1% or that stocks (including dividends) have grown at 8%, this is CAGR.

Assessing Investments Using NPV or IRR

[37] You can write IRR = (Ending/Starting)^(1/life)-1, where Ending in the formula is the accumulated cash with re-investment at the IRR itself (no circular references here).

Over the years I have had to listen many times to the tiresome argument as to the use of IRR versus net present value ("NPV"). I always thought that this dispute was meaningless as everybody should know that the IRR and NPV are equivalent decision rules because the IRR is defined as the discount rate in the NPV formula that makes the aggregate NPV equal to zero.

Defence of NPV with low cost of capital investments. Review and problem of applying same or similar cost of capital to different investments. Can increase value by investing in low cost of capital investments and growing. A good example is investing in renewable energy projects with a set of contracts and that is mature.

But in one of my classes I met a person who represented the polar opposite of Dr Phalippou. His name is Dennis, and he had worked hard as an analyst making various models for different CFO's who would give him difficult modelling requests. Denis is obsessed with presenting things in a creative and practical manner and does not pay much attention to the theory of finance. As the CFO's he worked for did not pay much attention to measures of the cost of capital, Dennis asked about finding decision metrics that do not depend on making an estimate of the cost of capital. After thinking about what Dennis asked, a bulb went off in my head and I realised that the IRR versus NPV debate is in fact much more subtle than I thought. The debate really involves the nuanced question of whether you should start with a discount rate and make investment decisions using the cost of capital as a base or whether you should search for metrics that do not directly depend on something – the cost of capital -- that is fundamentally not measurable.

For example, I ask people to define the IRR and I either receive the answer that the IRR is the rate of return (like saying the plane is late because it is delayed) or the meaningless technical jargon that the IRR is the discount rate that makes the NPV equal zero (so, the CFO's and CEO's of all these corporations are trying to find the highest discount rate that makes the NPV equal to zero). This sort of discussion is included in Part II. Later, in Part III, I work through mathematical equations and proof that the IRR is the compound growth rate in cash flow earned by making and investment. This investment has a big caveat. That caveat is that the growth rate assumes re-investment of dividends occurs at the same rate as the IRR itself. In Part III I also present an alternative for computing the risk premium earned by an investment relative to the risk-free rate.

Capital Investment and Assessing the Value of Justin Bieber Songs

Before discussing the nuances of project finance analysis and the problems with corporate finance as well as how to integrate project finance ideas into corporate valuation, I begin with a basic capital investment analysis. You can think of this as the decision of a corporation to invest in a new factory or a new hotel. Alternatively, you can ponder the value of getting married or the value of investing in an MBA degree. Later chapters will move to project finance valuation and then discuss how projects can be combined to simulate the value of a corporation.

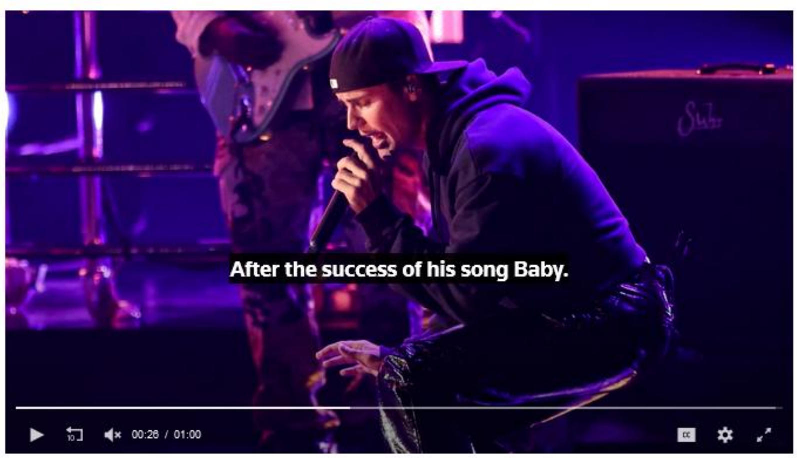
To illustrate issues associated with basic investment rules, I try to construct as simple and as general investment as I can imagine. My example comes from something I heard about on television. I am sometimes forced to listen to the local television shows in the U.S. (that typically promote celebrities and Disney and then have advertisements about drug companies). A local news station reported a story about Justin Bieber selling rights to his songs for US 200 million to the private equity company Blackstone. I assume that upon listening this story, anybody reading this book would think about how to assess the value of Justin Bieber's songs using IRR, NPV or some better method (I admit that I could not name one of his songs, but I have found that many young people in my classes have no idea who the Beatles are.)

When you think about the value of cash flow from these songs, they may increase in popularity or maybe they will be forgotten. Maybe the songs of Justin Bieber will be like the works of Beethoven and be played for hundreds of years. To simulate the value of Justin Bieber music I have taken five minutes and constructed a financial model that hopefully illustrates the essence of NPV and IRR. I have assumed different economic lives and different cash flows defined by growth rates as it is reasonable to assume that we are not very sure about the life and the level of the future popularity of the music. When I began writing this chapter, I constructed a more complex model, but I have found that this simple model is more effective. Figure xxx illustrates results of the different lives and cash flow growth using a data table.[38]

In studying finance at university, you would be taught to measure the value of Justin Bieber's songs by estimating the future cash flow and then using a discount

Justin Bieber nears $200 mln deal to sell music rights - WSJ

Reuters



Dec 21 (Reuters) - Pop star Justin Bieber is nearing a deal worth about $200 million to sell his music rights to Blackstone Inc-backed (BX.N) Hipgnosis Songs Capital, the Wall Street Journal reported on Wednesday, citing people familiar with the matter.

The potential deal includes the Canadian artist's interest in both his publishing and recorded music catalog, according to the report.

Hipgnosis buys song catalogs from artists and earns revenue when their music is streamed online or used in movies or advertising.

[38] You can find the spreadsheet associated with this example at www.edbodmer.com

rate to bring the value back to today – the present. If the value of the future songs is larger than the $200 million paid, the investment is good, and it should be made. There are many problems with the NPV as a decision rule including something called the capital budget constraint and dealing with different asset lives. But the worst problem with NPV is that a small change in the cost of capital that people think of as some kind of variable that can be easily established is there. If the NPV is very high with a 5% cost of capital, it may turn to negative at 6%. Another smaller investment may have positive NPV at both 5% and 6%, but if you believe the NPV rules and you have made a fancy cost of capital analysis suggesting 5% is the cost of capital, you will select the investment that can turn negative with a slight increase in the discount rate.

To illustrate problems with the NPV rule I present a little table that contains different scenarios with respect to the remaining life of Justin Bieber's songs. I have made different assumptions about the growth in the value of the songs and different predictions of the remaining life over which people will continue to pay for the music (of course, you could be much more sophisticated). The simulations are summarized in Figure xxx. The Figure demonstrates that if the future cash flow is discounted at a relatively high discount rate, the NPV is low and negative in most cases (the 10% case). On the other hand, if the discount rate is low (the 5% case), then almost every scenario except the case where the songs are forgotten after 10 years has positive value relative to the $200 million invested. The point is that Figure xxx demonstrates how the net present value depends on the cost of capital rate applied. In Figure xxx, the IRR is equal to the discount rate when the net present value is zero. For example, in the left-hand side of the table, the NPV is zero when the remaining life is 100 years, and the growth rate is zero. This implies that the IRR is equal to 10% using the life and growth assumption.

Cost of Capital 7%

Life	IRR: No Growth	IRR: 3% Growth	IRR: -1% Growth	NPV: No Growth	NPV: 3% Growth	NPV: - 1% Growth
10	0.00%	2.45%	-0.82%	(278)	(194)	(303)
15	5.56%	8.27%	4.65%	(83)	83	(131)
20	7.75%	10.59%	6.81%	56	311	(13)
25	8.78%	11.68%	7.81%	155	501	66
30	9.31%	12.24%	8.33%	225	657	120
35	9.60%	12.55%	8.61%	275	786	157
50	9.91%	12.90%	8.92%	355	1,054	210
75	9.99%	12.99%	8.99%	392	1,268	230
100	10.00%	13.00%	9.00%	399	1,350	233
120	10.00%	13.00%	9.00%	400	1,378	234

There are also practical problems with the NPV in terms of ranking investments. Say you have a really big project that results in a quite large positive NPV because the IRR is a smidgeon above the cost of capital. Maybe you could use the NPV of 241 with the 3% growth case using 15 years and 5% cost of capital in the right-hand side of Figure xxx. But this same scenario results in a negative NPV when using the 10% cost of capital. In theory, making the Justin Bieber investment is better than a bunch of small projects with much higher IRR's if you apply the 5% cost of capital. But if you get the cost of capital wrong and increase it a bit, the whole thing reverses, and the big project with positive NPV becomes negative. Further, if the big project has a longer life than the small projects, the NPV for the small projects should include replacement projects and the NPV does not account for the potential replacement of project.

In preparing for my teaching assignments, I have read the McKinsey Book a few times. The first time I read the book I thought it was a powerful explanation of how to apply financial ideas. The second time I read it I was much less impressed. The third time I read it I thought it was dangerous in its emphasis on using WACC in evaluating the return on investment and over emphasizing discounting cash flow. One of the things I liked in the first version I read was the statement that analysts tend to overestimate the cost of capital and then compensate for this high cost of capital with over optimistic assumptions. When I looked for this in later versions the statement disappeared.

Problem with the NPV Method: Any Suggestion that the Cost of Capital Can be Accurately Measured is Nonsense

The cost of capital consumes three chapters at the end of the book. I have purposely put the cost of capital at the end of the book and not the beginning because it is not reasonable to claim you can compute a The cost of capital is defined as the minimum expected rate of return investor will accept for a given level of risk. This is a mysterious number where you searching for the lowest acceptable number. The minimum return cannot be found on the internet (like you can find credit spreads and interest rates) and it does certainly does not come from a survey of Chief Financial officers tell you (they will give you ridiculously upward biased numbers because they naturally want to earn high returns). The best way I can think about the definition of the cost of capital number is to imagine a bidding scenario.

Say you have multiple bidders sitting in a meeting room in Dubai who want to win a contract to construct a solar project. In order to win the bid, you must offer the lowest price. Further assume the equipment is mandated in the bid and the estimates of the cost are very similar for different bidders. I mean to construct this example so the only real way to win the bid is to push the rate of return to as low as you possibly can and still earn a return that's acceptable given the level of risk. When you are sitting at the table you may have to make a cell phone call to the CFO to push him down as far as he can go. You need to make the CFO complain, swear and sweat. That minimum level is exactly what the cost of capital is supposed to be.

With all of the business schools, professors, and Nobel prizes it is remarkable that the NPV/IRR debate continues, and finance has not come up with a good way to measure the value of an investment. I ended the last chapter with the mathematical fact that small differences in the earned or desired return (compound growth) can make a big difference in the value of a corporation as the time-period for the evaluation of a corporation is indefinite. This is the same way of saying that small differences in IRR are not trivial. As we proceed with discussion of valuation, I will generally use the IRR as the most reasonable way to measure return (for example, as compared the ROIC). My problem with the IRR is not the problem that is often taught -- the mathematical issue that you sometimes it cannot be computed if the cash flow sign changes. Problems with the IRR really come from the reinvestment headache described below when you must make some kind of assumption with respect to what happens to money that you receive – dividends -- before the end of the project. In writing this book I do discuss a resolution to this issue with a method I name the risk premium method that computes the earned risk premium above the risk-free rate. But in the real world the IRR is used, and it is doubtful that anybody will pay attention to other measures.

Chapter 8: Problems with, and Alternatives to the IRR – Hydro Projects in Africa

No Magic Pill. Instead, Some Suggestions to Improve Your Critical Thinking About Finance

The Oxford professor who complained about IRR may have had various reasons for his critique. I doubt his problem was a nuanced argument that both the IRR and the NPV techniques implicitly compound risk premia in evaluating investments and while that may apply to some investments, it certainly does not apply to all. IRR gives no value to cash flow far in the future or that the IRR does not directly measure the effect on returns from changing risk. The real issue is coming up with a good alternative and understanding why IRR is computed.

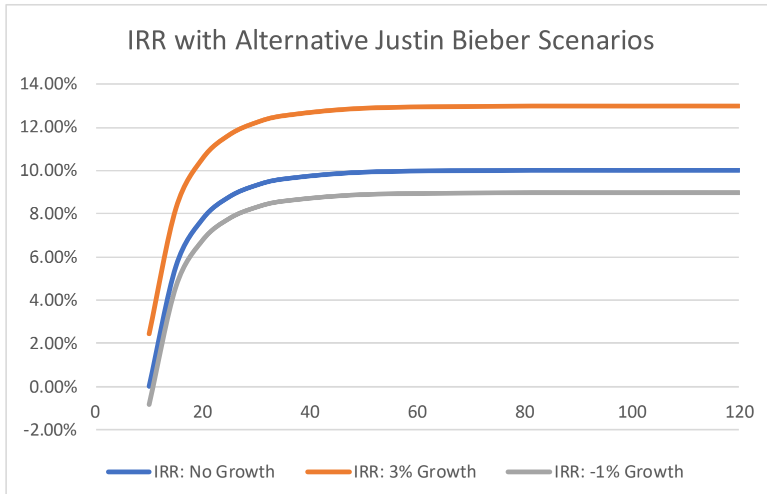
The MIRR is the modified IRR where you put in a re-investment rate that could be the WACC. You can set up an account where the opening balance receives a rate different than the IRR itself. You could assume that the re-investment rate is an estimate of the WACC. If there are no intermediate cash flows (like equity cash flow in a private equity transaction for example), the re-investment rate does not matter. But in more typical situations, the project produces continual cash flow and re-investment income can easily be more than the nominal cash flow itself. The big problem with the MIRR which means it should not be discussed further is shown in the table xxxx. In this table, the cost of capital changes and there is no change in their IRR because the IRR does not depend on the cost of capital. The NPV declines as the cost of capital increases. I defy you to interpret this IRR for projects with different sized projects and with projects that have different lives. Now look at the MIRR row. The MIRR is just matching the cost of capital, so this statistic is essentially a copy of the cost of capital. Worse yet, the MIRR goes up when the cost of capital and supposedly the risk goes up.

		Life - Years				
	MIRR					
		15	30	50	100	Ratio
	3.00%	3.78%	5.81%	5.75%	5.09%	1.35
	4.00%	4.26%	6.31%	6.27%	5.64%	1.32
	5.00%	4.74%	6.84%	6.83%	6.26%	1.32
Re-invest	6.00%	5.24%	7.40%	7.43%	6.94%	1.33
Rate	7.00%	5.74%	7.97%	8.06%	7.68%	1.34
	8.00%	6.25%	8.56%	8.72%	8.46%	1.35
	9.00%	6.77%	9.17%	9.41%	9.27%	1.37
	10.00%	7.30%	9.80%	10.12%	10.10%	1.38
	11.00%	7.84%	10.44%	10.86%	10.96%	1.40
	12.00%	8.39%	11.10%	11.61%	11.82%	1.41
IRR	9.45%	4.50%	9.45%	10.46%	10.69%	2.38
Rp	5.68%	0.65%	5.68%	9.51%	17.14%	
Rf		3.50%	3.50%	3.50%	3.50%	
Rf+Rp		4.15%	9.18%	13.01%	20.64%	4.97

	Cash Flow				
MIRR					
	80	100	120	140	Ratio
3.00%	5.02%	5.81%	6.45%	7.00%	1.39
4.00%	5.53%	6.31%	6.96%	7.51%	1.36
5.00%	6.05%	6.84%	7.50%	8.05%	1.33
6.00%	6.60%	7.40%	8.05%	8.61%	1.30
7.00%	7.17%	7.97%	8.63%	9.18%	1.28
8.00%	7.75%	8.56%	9.22%	9.78%	1.26
9.00%	8.36%	9.17%	9.83%	10.40%	1.24
10.00%	8.98%	9.80%	10.47%	11.04%	1.23
11.00%	9.62%	10.44%	11.11%	11.69%	1.21
12.00%	10.28%	11.10%	11.78%	12.36%	1.20
9.45%	7.40%	9.45%	11.34%	13.12%	1.77
5.68%	3.49%	5.68%	7.86%	10.05%	
	3.50%	3.50%	3.50%	3.50%	
	6.99%	9.18%	11.36%	13.55%	1.94

Alternatives to IRR Other than the NPV in Measuring Growth and Value

I have struggled with the re-investment rate problem for a long time, and I have largely given up on finding a better alternative than using the IRR itself as the re-investment rate (with the exception of the IRR premium below). Winston Churchill's famous quote that "democracy is the worst form of government besides all the rest" is overused (I think his quote "the best argument against democracy is a five-minute conversation with an average voter" is much better). In terms of IRR compared to alternatives that may be used, the typical alternatives to IRR include MIRR, MOIC, payback, and NPV.



I computed the XMIRR. Somebody said in fancy language that this is demonstrably better and I got half way through a McKinsey article. Nothing here.

The classic decision rule for any investment is to first come up with a discount rate that reflects the risk of a project and then compute the net present value. In general, arguments about NPV versus IRR silly because the IRR is just another way of expressing the NPV (the IRR is the discount rate that makes the NPV equal zero). But the NPV (that accounts for the up-front investment and prospective cash flow) gives you a number that is not useful from a psychological perspective. The number is above zero when the IRR is more than the cost of capital, blah blah blah. The practical contrast between the NPV and the IRR is a bit more interesting and involves two things. First, for the NPV calculation you need a measure of the cost of capital which as I keep repeating is at best a vague number. The idea of presenting the dramatic change in value that results from small changes in cost of capital demonstrates why people do not want to rely on the number. Second, the number given by the NPV is not a practical way to rank investments. Note that I include APV – adjusted present value in this discussion. The APV just uses a different way to compute the cost of capital and does not really add anything.

The thing that is attractive about the IRR is that we do not have to make any assumptions about the most controversial part of valuation, which is the cost of capital. So, when the big boss looks across a whole bunch of different investments; or a private equity firm receives proposals from developers desperate to get money; or you are deciding which stock to buy after you have a very good model with careful evaluation of the terminal value; or you are deciding whether to invest in another child (probably a negative IRR, especially after you add in the cost of carbon emissions), you can compute the IRR and quickly compare the IRR's across investments. You can rank IRR's and find the best thing to do (if you have small projects, you can invest in a lot of them). If we could only get around the nasty reinvestment issue. I discuss IRR problems with changing risk, different lives, positive – negative – positive cash flow and high IRR long-term investments in Chapter 3.

I have reviewed Harvard case studies and the kind of analysis that is discussed in expensive MBA programs. The framework for these cases is to start with the cost of capital using the CAPM with some kind of given arbitrary equity market risk premium. When Dr Phalippou exclaims that IRR is BS, he is most probably advocating this kind of academic treatment of value that depends on the cost of capital assumption. Like the typical case studies, he probably assumes a cost of capital using a high equity market risk premium. But given the craziness and vagaries of computing cost of capital, any method that depends on cost of capital is rightfully rejected as a preferred method by people who make investment decisions in the real world.

Multiple of Invested Capital and Payback Period have the Assume no Re-investment Rate

For many transactions it is becoming common to show the multiple of invested capital and if you have not seen this it may seem sophisticated. In fact, it is very simplistic and completely ignores any income at all from re-investment. The payback period also just accumulates cash flow and counts how many periods (years) it takes to recover the initial investment. The payback period can be a little intuitive if somebody tells you that you get your money back in six years and then all the rest is upside. But the payback period ignores the cost of money, and it does not quantify the upside. The MOIC, like the payback period, ignores any cost of money and it does not directly account for the time-period it takes to get back the investment. The MOIC can be computed for a given time-period, and it is then very similar to the payback.

The real problem with the MOIC is similar to the IRR problem in that it does not account properly for the timing of cash flows – the dividends received – over the investment period. If dividends are received almost immediately (like tax equity investments in the U.S.), this is ignored in the calculation. The MOIC is the multiple of invested capital which is simply the total cash inflow divided by the cash outflow for the investment. I also compute an alternative multiple of invested capital that includes re-investment earnings. The payback is the number of periods it takes to payback your investment. The premium above the risk-free rate measures the total cash flow inflow compared over and above the inflow you would get if you invested at the risk-free rate.

In working on financial models over the years, I have tried to come up with methods that address the problems associated with the IRR, particularly the reinvestment headache.

Before writing this book I had just about given up. But when thinking about the CAPM and debt where cost of capital is expressed as the premium relative to a risk-free rate, I have developed an alternative were returns can directly be compared to the equity risk premium and/or credit spreads. I am not suggesting that the risk premium method will be adopted, but you can use the approach as an alternative and demonstrate distortions in the IRR.

Earned Premium versus Risk Free Rate

Mechanics of Risk Premium Method – Three Steps and Simple Example

Easy to compute the premium versus the risk-free rate. If the IRR is the risk free rate there is no premium.

Can Spread out the premium over the life in different ways. One way is to use the PMT formula and spread out the premium at the risk-free rate.

After compute the levelised premium, can divide by the initial capital expenditures.

Assumptions				
Life	1	One Period Case		
Rf	3.00%			
Cash Flow	0	1	2	3
Flag		TRUE	FALSE	FALSE
Cash Flow	(1,000.00)	1,100.00	-	-
IRR	10.00%			
IRR - Rf	7.00%			
Steps				
NPV at Rf - Step 1	1,067.96			
Divide by Initial CF - Step 2	1.07			
Aggregate Risk Premium Earned	6.80%			
Level Payment of Risk Premium Earned - Step 3	7.00%			
Proof				
Rf Investment with PMT		1,030.00	-	-
Premium Earned		70.00	-	-
Percent above Rf		7.00%	0.00%	0.00%

Start with one period case where the answer is clear. Here the cash outflow is 1,000 and the cash inflow is 1,100 meaning the return is 10% (1,100/1,000)-1. The risk-free rate is assumed to be 3% and so the earned premium is 7%. You could just subtract the IRR from the risk-free rate to get the 7% premium. Alternatively, you can compute the PV of 1,100 at the 3% risk free rate giving you 1068. Then the 6.8% can be computed with the PMT function for one period giving you the same 7%. Finally, you can prove that 7% really is the risk premium by creating a level payment for a one-year risk free security. This would give you 1,030 as shown on the bottom of Table xxxx.

To further explain this process, I have created a two-year and a three-year case. In these cases you cannot simply subtract the risk free rate from the earned IRR to compute the earned risk premium. The underlying problem is the discounting of the risk-free rate.

Use an example with one outflow and a set of cash flows

In the second case the IRR is 6.6% with two years of cash flow. If you subtract the risk-free rate of 3% from the IRR, you get a risk premium of 3.6%. But this calculation neglects the mathematics that premium is computed over two periods. When computing the present value at the risk-free rate, the value you would pay for a risk-free stream is 5.24% more than the investment. Dividing this premium by 2 gives you a period-by-period premium of 2.62%. This 2.62% is not precise because it does not recognize the value of the risk-free investment over time. You can use a levelizing formula to compute this which accounts for the accumulation.

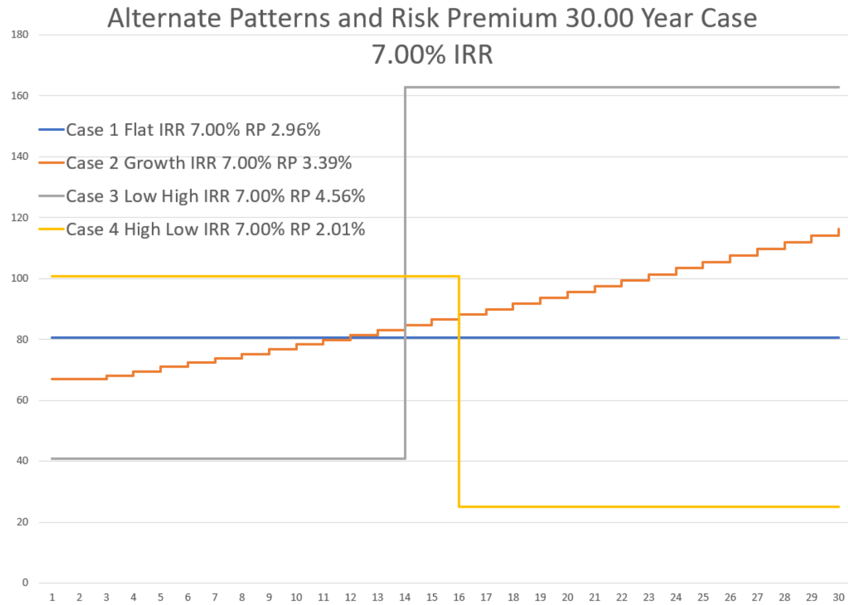
Rf	3%										
Growth	2%										
Target	7%										
Life	60.00										
				0	1	2	3	4	5	6	7
Life Flag	60.00				TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
First Portion	30.00				TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
Second Portion	31.00				FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
Discount Factor Target	7%			1	1.07	1.14	1.23	1.31	1.40	1.50	1.61
Discount Factor Rf	3%			1	1.03	1.06	1.09	1.13	1.16	1.19	1.23
Growth Index	2%			1	1.02	1.04	1.06	1.08	1.10	1.13	1.15
		Base	NPV	Investment							
Case 1 Flat	7.00%	71.23	(0.00)	(1,000.00)	71.23	71.23	71.23	71.23	71.23	71.23	71.23
Case 2 Growth	7.00%	52.95	-	(1,000.00)	54.01	54.01	55.09	56.19	57.31	58.46	59.63
Case 3 Low High	7.00%	105.65	0.00	(1,000.00)	52.83	52.83	52.83	52.83	52.83	52.83	52.83
Case 4 High Low	7.00%	39.01	-	(1,000.00)	78.02	78.02	78.02	78.02	78.02	78.02	78.02
Case 5 Low High Growth	7.00%	65.91	-	(1,000.00)	33.62	34.29	34.97	35.67	36.39	37.12	37.86
Case 6 High Low Growth	7.00%	30.36	-	(1,000.00)	61.93	63.17	64.43	65.72	67.03	68.37	69.74

Simulation of Why this Makes a Difference

First, the model. Use the solver to find the cash flow that gives the same IRR. In this case the cash flow is set in cases with different patterns and different lives to give a value of 7%. The case demonstrates that the same IRR gives different risk premium figures. Again, there is no judgmental discount rate. Remember, the IRR is the same, but because of the re-investment assumption, the economic evaluation of different cash flow patterns are distorted.

The cash flow patterns are shown in the graph below.

In the table below, the premiums for the longer-life are increased even though the IRR has not changed.



The problems highlighted from the methods above are that we do not want to use the cost of capital and we would really like to get around the problem of the re-investment rate. Further there is a problem with the IRR when evaluating long-lived assets (and high returns). This problem is illustrated in table xxx below. In table xxx you can see that with longer lives, doubling the life of an asset results in a very small increase in IRR even though the cash flow has more than doubled. In table xxx, the IRR for a project with a life of 45 is 10.45% while the IRR for a 90-year project has an IRR of 10.69%. This is mathematically correct but not at all intuitive. The change in the cash flow received on the project is shown by the multiple of invested capital which is ___ for the 45-year life and increases to ___ for the 90-year project. One way to address this is to compute the premium earned relative to making an equivalent investment in a risk-free asset. I believe this is not a new idea. Compute the cash flow you would receive from using your investment and assuming you get cash flow from the risk-free rate. This should be something like the rate of inflation. Discussion of tax equity. Get the equity out immediately versus a leverage buyout where have to wait.

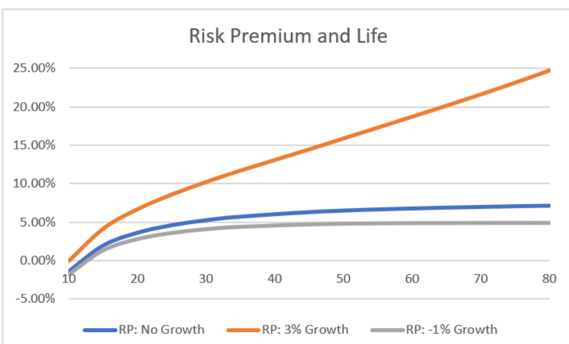
30 - year case	PV at Rf	Factor	Aggregate	Levelised Risk Premium
Case 1 Flat	1,579.53	1.58	0.58	2.96%
Case 2 Growth	1,664.11	1.66	0.66	3.39%
Case 3 Low High	1,908.71	1.91	0.91	4.64%
Case 4 High Low	1,394.67	1.39	0.39	2.01%
Case 5 Low High Growth	2,006.34	2.01	1.01	5.13%
Case 6 High Low Growth	1,440.33	1.44	0.44	2.25%

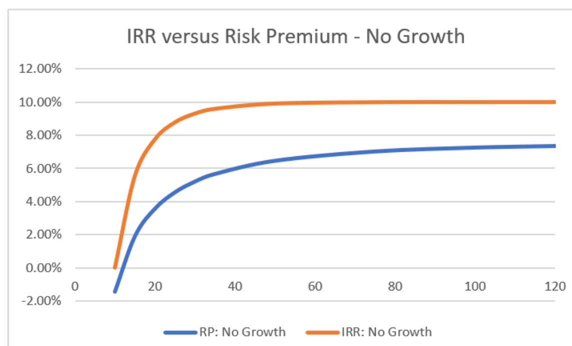
60-year Case	PV at Rf	Factor	Aggregate	Levelised Risk Premium	60-year vs 30-yr
Case 1 Flat	1,971.31	1.97	0.97	3.51%	18.70%
Case 2 Growth	2,347.18	2.35	1.35	4.87%	43.67%
Case 3 Low High	2,741.79	2.74	1.74	6.29%	35.75%
Case 4 High Low	1,686.82	1.69	0.69	2.48%	23.25%
Case 5 Low High Growth	3,399.19	3.40	2.40	8.67%	68.85%
Case 6 High Low Growth	1,864.57	1.86	0.86	3.12%	39.06%

		0	1
Free Cash Flow			
Cap Exp		1,000.00	
EBITDA			1,100.00
Cash Flow		(1,000.00)	1,100.00
Risk Free Rate	2.00%		
IRR	10.00%		
IRR versus Rf	8.00%		
Investment at RF	1,020.00		1,020.00
Premium			80.00
Periods	1		
Value of Premium	78.43		
Levelised	1.02		
Annual	80.00		
Premium	8.00%		

		0	1	2	3
Free Cash Flow					
Cap Exp		1,000.00			
EBITDA			400.00	400.00	400.00
Cash Flow		(1,000.00)	400.00	400.00	400.00
Risk Free Rate	2.00%				
IRR	9.70%				
IRR versus Rf	7.70%				
Investment at RF	346.75		346.75	346.75	346.75
Premium			53.25	53.25	53.25
Periods	3				
Value of Premium	153.55				
Levelised	0.35				
Annual	53.25				
Premium	5.32%				

How to calculate. How to Use. Graph or Table of How much Really Means





	RP: No Growth	RP: 3% Growth	RP: -1% Growth	IRR: No Growth	IRR: 3% Growth	IRR: -1% Growth	NPV: No Growth	NPV: 3% Growth	NPV: - 1% Growth
10	-1.43%	-0.03%	-1.84%	0.00%	2.45%	-0.82%	(278)	(194)	(303)
15	1.92%	4.16%	1.30%	5.56%	8.27%	4.65%	(83)	83	(131)
20	3.59%	6.70%	2.76%	7.75%	10.59%	6.81%	56	311	(13)
25	4.57%	8.62%	3.57%	8.78%	11.68%	7.81%	155	501	66
30	5.22%	10.24%	4.06%	9.31%	12.24%	8.33%	225	657	120
35	5.68%	11.72%	4.36%	9.60%	12.55%	8.61%	275	786	157
50	6.47%	15.90%	4.77%	9.91%	12.90%	8.92%	355	1,054	210
75	7.03%	23.16%	4.88%	9.99%	12.99%	8.99%	392	1,268	230
100	7.27%	31.51%	4.83%	10.00%	13.00%	9.00%	399	1,350	233
120	7.36%	39.18%	4.78%	10.00%	13.00%	9.00%	400	1,378	234

Chapter 9: Financial Statement Analysis and Difficulty in Finding the Earned Return

Stamp Out Chartered Accountancy

Rate of return is a measure of the benefits of an investment relative to the cost of the investment. It drives both the assessment of an investment and measurement of whether an investment is performing better or worse than expected. Now, I began my career in an accounting department, and I feel a little bad in asserting that accounting gets its most fundamental objective wrong. My critique in this chapter is divided into the following four parts:

1. Why an unbiased and accurate measurement of return is important.
2. What are reasonable expectations of return in the long run.
3. Why classic financial statements of a corporation result in biased measurements of return.
4. What can be done about measurement problems resulting inaccurate performance evaluation.

Monty Python Accountant

A key idea in Chapter 2 and Chapter 3 was to demonstrate that calculation of return is behind a lot of valuation. The theme of evaluating rate of return will continue in our discussion of performance evaluation in Chapter 5, in discussion of multiples in Chapter 6, in developing terminal value in Chapter 7 and throughout the rest of the book. This chapter is about the mechanical computation of returns from financial statements and whether it is possible to derive a useful estimate of return can be established. In order to make a valuation we go back to the strategy graph of value drivers (the return versus cost of capital and growth) and the points about competitive strategy that can result in value creation.

Why Unbiased Return Statistics are Essential from Financial Statement Analysis

Imagine the following situation. You know the rate of return for current investment projects in a corporation. You have studied the market prospects for the company, the competitive landscape and the cost structure in the industry and you are convinced that the current level of return on investments (the IRR) will decline by a modest amount over the next five years and the potential for finding new investments (the growth rate) will also decline. You have your own idea about the minimum IRR that you will accept for taking risks for the company and that your forecast will be wrong (this is the definition of the cost of capital). In this imagined case with IRR information of on individual projects, you could make a reasonable valuation of the company. Maybe you could use the value driver equation introduced in Chapter 2 with changing returns and growth. Better yet, you could develop a simple financial model that includes separate investment projects with changes in the return. This is the way valuation is supposed to work.

The problem with accounting data is that you cannot do either of these things with financial data. Maybe you can make an earnings projection from company provided guidance or from the earnings forecasts made by investment analysts. But when it comes to the long-term prospects for earning a return above the cost of capital you get stuck. You do not have information on individual projects, and you only have return on investment measured from operating income and the balance of net plant, both of which are affected by depreciation expense. If you do not start with a correct measure of the rate of return and the future return is distorted because of accounting information, you cannot make a good assessment of the returns that can be generated from new projects. All of your work that evaluates details of company strategy and industry economics will or will not generate high or low returns cannot be effectively used in valuation. For example, say the rate of return computed from financial statements is overstated because the assets are old or there has been an impairment write-off and/or the prospective return is understated because straight line depreciation. You cannot then apply your analysis of the competitive position of the company and its management skills in maintaining economic rent.

I argue that the fundamental goal of financial statement data is computing the return on investment and accounting data badly fails in this respect.

Once we have the return on capital, we can make some kind of prognosis about what will happen in the future to that return. In the end, the most basic objective of financial statement analysis is to get Some of the reasons that the one think you want from the accounts is the rate of return on capital include:

1. You could then apply the value driver formula (1-g/ROIC)/(Required Return-growth) to derive how much you would pay for an asset. If we want to do this, we need an accurate picture of the past return so that we can assess the future prospects. Without knowing the return, this little exercise will not get you anywhere (Chapter 2).
2. The understanding of P/E and EV/EBITDA multiples depends in part on the changes in the rate of return. For example, if the return is expected to increase, the earnings multiple should be much higher. Further, even if a company grows a lot, if the return is

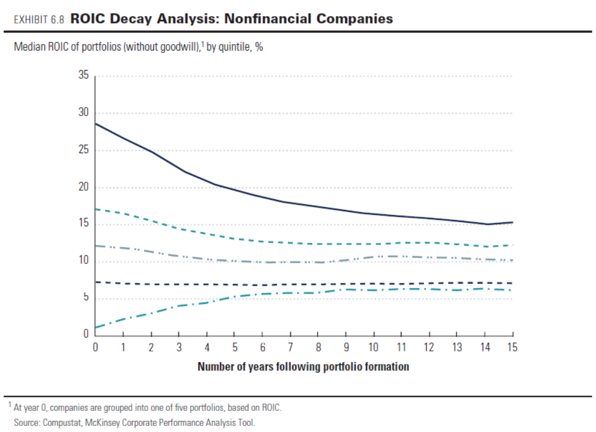
low the multiple should also be low. To evaluate changes in the rate of return you would require reasonable data on both the historic return and the prospective return (Chapter 6).

3. Terminal value calculation and philosophy (Chapter 7) depends on an assessment of whether you believe that current levels of return can be continued and/or when and whether you believe the return will decline. To make judgments about the terminal value you again should have an assessment of current returns relative to the long-run potential.
4. In evaluating individual projects and corporations, I suggest that the first test should be whether the projected return is reasonable given competitive landscape. If the projected return is high, you should ask tough questions about competitors entering the market. This assessment of whether the return is reasonable in part comes from evaluation of historic returns (Chapter 5).
5. A simple way to think about acquisition analysis is to look for companies in your industry that are earning a low return on investment which implies that you as an acquiror can improve the return. If you do not have reliable data on the historic return, this assessment cannot be made.
6. It is one thing to balance the balance sheet in a model. Assessing the reasonableness of a corporate financial model is another matter. I suggest that the way to start making an assessment of a forecast is to compare the projected return on investment with the projected return on investment (not the return on equity). If the return is distorted, this first test cannot be made.

From these points I hope you agree with me that if financial statement analysis cannot be used to evaluate the rate of return, then it is not very useful.

Three Graphs that Demonstrate Problems in Measuring the Rate of Return

One more demonstration of the notion that evaluating the rate of return on invested capital is data presented by McKinsey. Figure xxx taken from the 6th edition of their book is supposed to illustrate how returns decline over time but high returns remain high and low returns remain low. (For some reason they do not include goodwill in the analysis even though it represents part of the cash that is invested to purchase a company. I discuss this later). The graph is also meant to illustrate that returns do not completely converge to one another, but instead companies that have been earning high returns continue to earn high returns. This is all very nice and may be true. But if the returns are distorted because of aging assets, impairments, goodwill, asset allocations, and many other things, this graph cannot be based on meaningful data. Furthermore, if you somehow still believe that WACC means anything after completing this book, the returns in Figure xxx certainly cannot be compared to any kind of



WACC number because of the distortions in computing the return.[39] Psychology. Think made a big discovery and cannot admit that the numbers are worthless because of accounting rules. If was true than could get fancy with terminal value. Understand if wrote 800 page books and consulting is centred on the idea. Needs to be proprietary because would be such a mess.

Requirement for Economic Return in Assessing Forecasts

As an example, consider the forecast made for Air Arabia made by an analysis used to construct a valuation of the stock. The one number that would matter to me would be the 10% ROIC in 2016. This number is a lot higher than the historic numbers and bigger than the estimates made for the earlier years (this higher return comes along with a high rate of revenue growth). The 2016 ROIC drives the terminal value which is the biggest number in valuation. In this example, the first question must be what is the story behind the increased return and how can this return be sustained. Not surprisingly, the projected stock price was triple the actual price. The points I am trying to emphasize in this chapter is first the usefulness of looking at the ROIC to test the financial projection and second the problem that this key number is distorted by accounting mechanics.

[39] McKinsey Book 6th Edition. Page

The reason I suggest using ROIC rather than ROE is that a financial model can easily change the capital structure. For example, if the model builds-up surplus cash or borrows short-term debt with cash flow after capital expenditures, the return on equity will be affected. If a lot of cash goes on the balance sheet and the earnings on the cash is just about zero, then the return on equity will decline because the equity balance increases with the cash and the cash earnings push down the earnings. The ROIC is supposed to be more pure where you can assess

Is it going up because of higher prices. Because of Operating Leverage. But real problem is if it is going up because of lower capital expenditures. Address more important problem of how many capital expenditures in the terminal cash flow later.

Key Ratios

	2011	2012	2013 e	2014 e	2015 e	2016 e
Financial Ratios						
Liquidity						
Current Ratio	2.11	1.50	2.04	1.87	0.94	0.97
Quick ratio	2.10	1.49	2.03	1.86	0.94	0.97
Margins						
Gross Margins	13%	18%	19%	20%	21%	25%
ETIBDA Margins	15%	19%	19%	18%	23%	28%
EBIT	10%	13%	12%	11%	13%	19%
Net Margins	11%	14%	14%	14%	16%	22%
Profitability						
ROE	5%	8%	8%	8%	11%	15%
ROA	4%	5%	4%	4%	5%	8%
ROIC	4%	6%	5%	5%	6%	10%
RPK (Revenue Passenger Kilometer) (AED bn)	9.60	10.80	11.40	12.44	14.65	17.11
ASK(Avaliable Seat Kilometer) (Km bn)	11.70	13.00	13.72	14.97	17.67	20.68
Load Factor	82%	82%	83%	83%	83%	83%
Efficency						
Receivables Turnover	62	57	56	56	57	57
Payables Turnover	111	105	144	140	135	130
Asset Turnover (x)	0.34	0.37	0.31	0.29	0.35	0.39

Thinking of ROIC and Project IRR Forecasts for Valuation in Statistical Terms

In evaluating the value of a corporation and in particular the terminal value, I argue that you should make a forecast of the ROIC and the growth. If you knew the future trends in return on invested capital and the growth, you could use this data to back into the cost of capital if you know the stock price. If you make a forecast with the ROIC rather than the alternatives that use multiples or terminal growth, you implicitly making a capital investment forecast that is consistent with both the growth rate and the return.

In discussing valuation from discounted cash flow, I have heard people being worried that the terminal value is a large part of the overall value. I hope you see that this is silly as the terminal value is supposed to be a big part of the value of a corporation because any corporate valuation or any multiple implicitly assumes that a company will last indefinitely. Arguably the biggest question in valuation is what will happen to the return on invested capital over the long-term. To make this assessment, an obvious place to start is what has been the return on capital in the past. For a company such as Carlsberg beer, or Flower Foods the company is probably already in a stable equilibrium state, and it may be reasonable to assume that the return on capital is consistent with historic levels. For this, you clearly need an unbiased estimate of the historic return on capital. It is also better if you have a long-term estimate.

In this chapter I discuss the rate of return as a statistic where history can be used as a potential guide and a starting point. The main point is that the rate of return can be very ambiguous to calculate, and it can become a biased or useless measure. If we had good historic data on the rate of return that tell you how much a company has earned in the past and you have some judgement about what kinds of things will happen in terms of competitive position to access prospects for future returns, you could then have a pretty good idea about the valuation of a company. But when you see the way that this all-important statistic is computed in practice, these ideas fall apart. I suggest that spending time looking at investor analyst reports on the rate of return can be a waste of time.

Earnings Forecasts Don't Tell You Much

You can ponder a case where you have no idea how to project the future rate of return. You could then do what most people would do, and make a forecast of earnings or earnings per share using some kind of historic growth estimation that includes the earnings guidance made by the company. You may make a careful forecast of two of the three operating factors – the revenues and the expenses. But you would have no idea how to forecast the last part of the big three – the capital expenditures and other investments. Without any idea of how to make capital expenditure forecasts – the required capital expenditure to generate the rate of return, you forecast is most probably meaningless in terms of the ability to think about its value.

Rate of Return and HBS Cases

Case study of Burton Sensors. Simple case and not a real company. Assumes that continue to grow without making capital expenditures. Do not include return on invested capital in the case. If computed return on capital it increases. Need to get back to a normal return in the competitive business. Will address this case in terminal value.

Exhibit 4 Comparative Data for Four Publicly Traded Sensor Manufacturers, 2014–2016 ($U.S. millions)

	TE Connectivity (TEL)			Ametek (AME)			Opsens (OPS)			Cyberoptics (CYBE)		
	2014	2015	2016	2014	2015	2016	2014	2015	2016	2014	2015	2016
Net sales	12,233.00	12,238.00	13,113.00	3,974.30	3,840.09	4,300.17	5.21	9.60	17.75	41.13	66.24	53.33
Operating profit	1,992.00	1,936.00	2,201.00	944.32	841.40	931.89	(5.13)	(8.49)	(6.38)	(2.20)	6.15	1.02
Net income	2,420.00	2,009.00	1,683.00	590.86	512.16	681.47	(2.88)	(9.28)	(6.54)	(2.10)	11.56	2.00
Assets	20,589.00	17,608.00	19,403.00	6,660.45	7,100.67	7,796.06	12.76	16.86	27.61	44.74	59.58	59.50
Total debt	3,884.00	4,070.00	4,344.00	1,866.12	2,062.64	1,866.17	3.69	5.58	5.30	–	–	–
Total liabilities	11,004.00	9,123.00	9,652.00	3,405.82	3,844.16	3,768.43	6.87	9.55	9.64	8.68	10.68	7.22
Shareholders' equity	9,585.00	8,485.00	9,751.00	3,254.63	3,256.51	4,027.63	5.89	7.31	17.97	36.06	48.90	52.28
Operating margin	0.16	0.16	0.17	0.24	0.22	0.22	(0.99)	(0.88)	(0.36)	(0.05)	0.09	0.02
Profit margin	0.20	0.16	0.13	0.15	0.13	0.16	(0.55)	(0.97)	(0.37)	(0.05)	0.17	0.04
Shares outstanding	405.00	366.00	355.00	239.91	232.59	230.23	60.18	66.74	80.95	6.71	6.83	6.95
Market capitalization	24,959.14	24,618.77	33,490.92	12,748.27	15,280.00	16,940.38	51.75	108.11	90.67	51.30	191.30	114.61
Equity beta*	1.30	1.26	1.24	1.29	1.16	1.25	1.32	1.17	1.02	0.82	0.80	0.85
EPS	5.98	5.49	4.74	2.46	2.20	2.96	(0.05)	(0.14)	(0.08)	(0.31)	1.69	0.29
P/E	10.31	12.25	19.90	21.58	29.83	24.86	NA	NA	NA	NA	16.55	57.30
D/Marketcap	0.16	0.17	0.13	0.15	0.13	0.11	0.07	0.05	0.06			

*Based on previous five years.

Part of the problem is evaluating how to evaluate cash amounts that are on the balance sheet. Invested capital should include cash but not surplus cash. It is generally inefficient to hold cash on a balance sheet – one could say that the cash is sleeping. So, unless there are large balances of cash, it is pretty reasonable to assume that the cash is necessary for ups and downs in revenue collections and required payouts.

When making valuations, students of finance will quickly learn about net debt. Maybe they could be told that cash is like negative debt and that any cash that is not used to manage short-term liquidity needs could be used to pay down debt. The students learn that a lot of cash and/or short-term investments on the balance sheet make the cash flow less volatile (because of the earnings on the cash and investments). So, for example, when betas are "unlevered", the surplus cash is supposed to be treated as negative debt. Further, when you compute return on invested capital, the numerator should only include cash flow from operating activities – this means no income on surplus cash. Similarly, the denominator should only include invested capital related to operating activities. This means that if invested capital is computed from equity invested plus debt invested, then any cash or other investments that are not related to operating activities should be subtracted from the other invested capital.

Let's deal with the problem of what to do about how much cash you need how much liquidity do you really need to keep running your business and how much cash is Surplus cash and how much cash is necessary to run the business. Something I have observed and something I have done myself is trying to find a rule somebody else does then having some kind of reference. One example of this is rules on what is surplus cash and what is cash needed for running a business. One example is an arbitrary rule that 2% of revenue is necessary to run the business. Another rule I have heard about is a little fancier where you compute the standard deviation of the ratio of cash to revenues and then put if the ratio is more than one standard deviation away from the average, the average plus the standard deviation is used for the operating cash. It sounds pretty sophisticated, but it is the rule is meaningless. In the case of Amazon and GE, I assume all of the cash is needed for liquidity.

Separating the Balance Sheet and Finding Core Operating Activities - Mechanics of Computing ROIC

You make a little column that says invested Capital Computing from Finance alternatively you go right next door and make a second little column next to the balance sheet and say Capital computed from direct Investments that are made to finance the core operations. An example of this calculation in the case of Amazon is shown in Figure xxx below. The Core Business of the asset and when you do that don't include Surplus cash but you do include things like inventories and accounts receivable very importantly the net plant assets the long-term assets of the company things that are related to financing the other business from alterations sprayable and you have to struggle with some deferred taxes and other liabilities and those sorts of items footnote you can see how this works by going to their website and seeing the mechanic okay so the graph below shows the turn on invested Capital overtime for our two companies Amazon and the we show this in two different cases where you use difference different assumptions Surplus cash and other items that's our first ambiguity.

I could complain about the difficulty in segregating ambiguous accounts in the critique of financial statement analysis.

Figure xxx with segregation of income statement and balance sheet

Financial Statement Analysis and How Much Does Apple Make when You Buy and iPhone.

For a few reasons which I don't want to write, I have not been able get myself to buy and iPhone. One of the reasons is that I want to know how much Apple would be earning when I would buy the iPhone. To see how much shareholders get when buying an iPhone you could go the Apple's financial statements and compute the return on investment.

I use net debt and the case of Apple to illustrate why one can suggest using return on invested capital as a statistic to evaluate future prospects of a company rather than return on equity or some other measure that measures cash flow after debt.

In the graphs of return on invested capital for GE and for Amazon, understanding that the effects of straight line depreciation in the in the calculation return on invested completely distorts the data. because very problematic issue companies assets that are aging will have a higher return on invested Capital because they also they need to subsequently increase the return on invested capital the return on your does not Paramount write-offs but jump in the invested Capital as we saw in the graph for General Electric now hey.

We have to make some judgments another understand we are trying to look at the core assets of the business a few years ago have billions in cash on its balance sheet I don't know exactly why it was there. But I understand it was about re-patriation. Apple held its cash and they would have labeled this cash.

Accounting Problem 1: Return on Invested Capital and Asset Life

One reason for the problems with measuring the return on invested capital is the age of assets. If you think about a single asset with cash flow that is received constant over the life, the return on investment increases over time simply because the asset depreciates and the net capital associated with the asset declines to zero. This means that if assets are older for one company than another company, the return on investment will be higher. I was not going to bother with this, but you may have to demonstrate this to consultants. Three scenarios. No replacement and replacement fast.

Accounting Problem 2: Research is Different from Development and Just What Exactly is An Investment

I watch YouTube videos sometimes (never about finance) and I am way too cheap to pay for the thing that allows you to skip the advertising. If you don’t turn off the adds, you will quickly come across something like the possibility to make hundreds of thousands without working and without making an investment. As the size of investment and capital expenditures seems to be minimized relative to earnings, I struggle in thinking about whether you can generate returns without making some kind of investment. When you think about economics and try to find how you can receive money without doing anything at all. You could wait for money to come from the sky. You could wait for somebody to die and receive inheritance. Maybe you can trick somebody rich to marrying you. But other than a few things like that, to get something in the future, you have to make an investment. The fundamental question in finance is what kind of return you can earn on your money and how can you find people to invest in your project if you don’t have your own money

Think differently about investments and do not use an accounting definition that is something like something where the asset lasts longer than a year. This is nothing. The definition of an investment should be something – money, time or pain – that you make and that yields future benefits that are generally uncertain. This can be advertising, inventory, software development, acquiring permits, employee training and many other things. Think of an irritating interview with an actor in a Disney movie talking about the deepness of the themes and the skills of the team making the film. This is an investment.

Cannot remember the definition of investment.

We are looking for ROIC or IRR. But what is an investment. Again, the definition of investment by accountants, that an investment is where the benefits are longer than one year is worthless. There is a big danger of falling into the trap of believing the definitions. capital expenditures, inventories, advertising, research and development, software development.

Accounting Problem 3: Mental Gymnastics and Goodwill versus Gains on Sale of Assets in ROIC

Years ago, when we were discussing the return on investment in a class, I remember a student in Prague asking about the specific formula for return on invested capital versus return on capital employed. The notion that McKinsey would exclude Goodwill in the calculation of return on invested capital (I have no idea, whether intangible assets are also excluded) demonstrates how you cannot apply standard formulas when computing the return on capital. I have already addressed issues associated with separating the balance sheet and income statement when computing the return and demonstrating that there is a lot of ambiguity. I believe that pondering this kind of question is a worthwhile exercise. Goodwill and internal growth versus growth by acquisition.

Accounting Problem 4: Effects of Kitchen Sink Quarters on the Prospective Return on Invested Capital – the Case of Macy's

Academic papers in finance generally collect a lot of data, write down some kind of fancy formula with an integration sign, and then have an empirical proof of a proposition with some t-statistics. Sometimes rather than evaluating financial issues with this kind of approach, it can be more effective to examine case studies for selected companies. At the onset of COVID and lockdown, I was asked to make a Zoom presentation on the effects of COVID on financial analysis and modelling in a webinar. I decided to look at Macy's (the fancy retail stores in New York and around the U.S.) as an example of a firm that should have been having problems from on-line competition before COVID and that were aggravated with COVID (I also looked at

United Air Lines). Figure xxx shows stock price trends and Figure yyy is a presentation made by Macy's of their return on invested capital.[40]

[40] To make this graph, go to the database menu of edbodmer.com and select the stock price database. You will then be guided to a page that explains how to make this graph.

Chapter 10: Resolution of ROIC Problem with Economic Depreciation and Reversing Write-offs

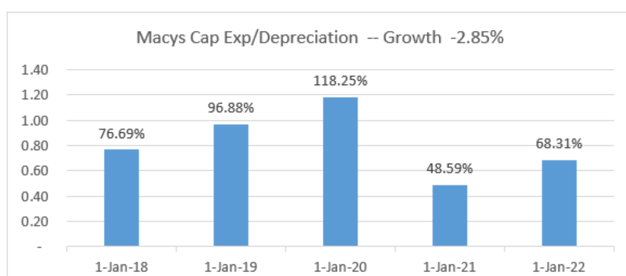
Return on invested Capital for Dow 30 Companies

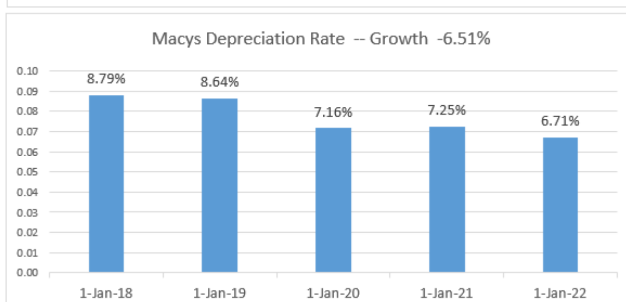
Return on investment is the focus of this section of the book because it addresses the fundamental issue of making an investment – the denominator of the statistic – and the benefits from making the investment – the numerator of the return calculation.

Summary of Problems in Measuring ROIC

One day, if companies would report returns, debt capacity and risks for individual projects in a structured manner (whether project financed or not), financial statement analysis and valuation could be significantly improved as analysts could really see where the value of a corporation is coming from (and where it is being squandered). For now, it is helpful to see how projects that are comprise a portfolio to form a corporation are valued. Unfortunately, the way in which ROIC is measured from accounting data has a number of serious problems. Some of the key points in this chapter include:

1. Evaluation of a Corporate Forecast and Returns --return on invested capital (before tax) is driven by the three fundamentals: capital expenditures, revenues and operating expenses and working capital investments. Capital expenditures over the long term can be the difficult thing.
2. When using standard financial statement analysis, return is understated for periods early in the life of a project and overstated in late in the life of a project. In evaluating issues like the terminal value and multiples, the true ROIC which is the project IRR should be found.
3. Why impairment write-offs distort the possibility of making valuation analysis from ROIC and growth.





4. How goodwill and asset write-ups distort return measurement
5. How the value driver formula (Value = Income x (1-growth/Return)/(COC-growth) can be used in the context of a portfolio of investments

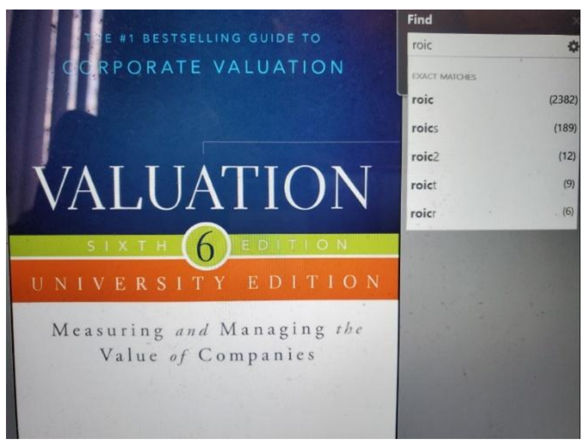
McKinsey in Malaysia

For many years I have been able to teach classes in Malaysia for a company with a whole lot of engineers. Each year I listened to complaints from hard working people about and how investments that seemed to be obvious could not be made because of the ROIC was less than the WACC. One example was an engineer who came up with a creative and relatively simple idea improving the efficiency of power plant. He was told that the investment could not be made because the ROIC was less than a WACC. The WACC in turn was dictated by consultants at McKinsey (who apparently had read the McKinsey book that I am so obsessed about). Risks of different projects were shoved into the WACC instead of evaluating specific risks for different projects.

Valuation from individual investments rather than accumulation.

Project Finance, Project IRR and ROIC

My idea in this chapter I try and move to some solutions to problems with financial analysis and valuation rather than just moaning about the problems. I suggest that some creative new ways to think about all kinds of financial issues can be found in studying the ideas underlying project finance. I have been able to work on both project and corporate finance modelling classes over the years and the contrast between the two is stark. I suggest that the two branches of finance should be integrated and that teaching of valuation and financial statement analysis should start with project finance instead of the traditional subjects of free cash flow, CAPM, multiples and terminal value. So, in this chapter I move to project finance where the measurement of returns, modelling, risk analysis and valuation is highly structured. In project finance you do not waste time trying to dissect financial statements, there is no terminal value calculation, WACC should not be calculated, and valuation does not use anything like EV/EBITDA multiples. In project finance, everything starts with measurement of different returns and bankers give you answers about risks that can be accepted.



This is the first of three chapters where I try to apply project finance ideas to other areas of finance. I introduce basic project finance concepts and address valuation using the idea that any corporation is a constellation of separate projects before discussing issues with multiples and terminal value calculation. By evaluating the rate of return and the valuation of individual projects, the ROIC can be evaluated in theory, and one see biases in corporate financial statement analysis. In this chapter I begin with fundamental return analysis while in the next Chapter I move to more nuanced valuation issues associated with individual projects related to changes in risks over time and derivation of return requirements from risk assessment made by lenders.

Nuances of Project Finance in Valuation

A general theme of this is book is that you should look further than current methods applied in finance. Some of these ideas include the issue of how to interpret and adjust multiples; how to resolve problems with terminal value; how to come up with alternatives to the CAPM; how to evaluate the true return on invested capital; and how There are a lot of lessons from project finance including how to deal with development and start-up type risks; how to derive the required return (i.e., the cost of capital) for individual projects; how to consider upsides and capital gains from projects as they progress from high-risk to low-risk projects; how to evaluate financial ratios such as EV/EBITDA and Debt/EBITDA and for individual projects; and how to evaluate the value of projects as a function of their age. All of these issues have implications for the valuation of a corporation even if using the project finance concepts are not directly incorporated into individual terminal value, cost of capital and other valuation formulas.

Why obsessed with project finance. Why discuss. Need risk and cash flow. Need to be more nuanced about risk than CAPM. Want the equity value of a corporation. Could compute the value of corporation. Would not need terminal value, this is the really big deal. Can use to prove value. Again, will build this up in a portfolio. Build up value and build up cash flow.

Returns are the centrepiece of value and come from contracts. No terminal value. Debt structuring defines risk and can come up with reasonable estimate. Cover some issues in project finance as a way to think about corporate valuation. Do not discuss general stuff like technical details of contracts, but only present valuation issues to think about. Much less magic potion. Normally teach project finance with diagrams and structuring. That is fine. Discuss here some of the nuances in valuation.

Project Finance addresses risk, return and valuation for individual projects and it is generally treated as a completely distinct subject from corporate finance. Corporate finance covers things like DCF valuation, multiples, CAPM and corporate credit analysis. Project finance deals with debt capacity and debt structure, valuation using IRR, and cash flow from individual projects over their life. This chapter discusses how the two branches of finance should not be divorced from each other and why project finance ideas like risk reduction in assets over distinct periods of their lifetime and using financing structure to evaluate overall risk of an asset can be the foundation for many valuation issues for corporations, start-up businesses, personal finance affairs, stock valuation and other subjects. The chapter homes in on IRR problems that arise from changing risk; I demonstrate how economic depreciation is an essential idea in understanding valuation and reconciles ROIC and ROE with Project IRR and equity IRR; illustrates how the age and lifetime of assets causes biases in comparative P/E and EV/EBITDA multiples; and discusses how development premiums can be a way of evaluating start-up businesses, research projects and other innovations needed for corporations to survive in the long-term. It is also instructive to see what the MBA programs do not have. There were no courses in project finance much less do they recognize the nuances in project finance where financing is driven by the economics and the risks of individual projects.

We will also introduce the idea that financing can be a better way to find out about implicit risk and why the ideas of a true hero in finance – Merton Miller – do not apply in project finance. How solar plants work. To introduce mechanical issues with ROIC use a second branch of finance project finance. In project finance project IRR. No terminal value. Most financing comes from debt and lenders credit analysis provides a guide for the investment. Can see the cash flow on a transparent basis. Risk directly evaluated and little or nothing directly about diversifying risk. Most important the investment is made from evaluating financing. After project finance corporate finance becomes extremely frustrating.

Project IRR and Return on Invested Capital

Issues and with depreciation for that analysis we are going to move to project Finance. In project Finance we don't measure return on invested capital. Instead, we measure project IRR and equity IRR. In the next paragraph I'll demonstrate welcome to the true irr of a project if we straighten line straightened out if we correct the depreciation and if we use economic depreciation then find depreciation. I have been thinking about this since the 1990's. I have looked at betas for companies with merchant risk like Exelon compared to betas for companies with no merchant risk like ConEd. Generally I cannot find anything. I then tried some kind of Monte Carlo simulation to illustrate risks. Again this did not get me anywhere.

So finally, I ask investors what kind of equity IRR they need. I put in much less favourable financing in for the merchant case (cash sweep, shorter tenure, less debt) and then back into the project IRR you would need to achieve the same equity IRR. You could also add a point or two to the equity IRR. Of course one could critique this, but for me it illustrates how project finance structuring is a good way to find a real quantification of the risk of a project.

Merton Miller, FCFF, DCF, Free Cash Flow, ROIC and ROE

When I discussed the famous finance professors at the start of the book, I perhaps should have been more nuanced. Each of the finance Gods did make important contributions. For example, I am not asserting the Markowitz's ideas that the variability of cash flow can be reduced from diversification. More importantly, the ideas of Merton Miller (that debt is not relevant) have led to use of unlevered cash flow to compute value, adjusting beta for leverage, using ROIC rather than ROE to assess the competitive status and prospects of a company. The latter point is essential for beginning the discussion of how we can evaluate the future value of a company and assess the reasonableness of a forecast. If the company's capital structure has changed in the past or is expected to change in the future because of new debt issues or retirements, if the capital structure implicitly changes in the forecast because of an assumption that the company retains large balances or if any other change such as stock buybacks, the return on equity is affected. These changes in the return are not related to the fundamental things the company really does (a very bad interpretation of Miller's ideas). This is why in the remainder of this chapter I focus on the ROIC and the project IRR rather than the return on equity and the equity IRR.

Searching for the Holy Grail – The True ROIC and IRR

If the ROIC was the same as the IRR and you could have really good data on the individual projects. But the ROIC that you can measure for a corporation is not the IRR that you measure for an individual project. The ROIC can be derived from financial statements but not the IRR on individual projects. For example, GE is in many businesses ranging from electricity generation asset construction to financial services to making airplane engines. We really want to see the future IRR prospects for each of these businesses to gauge what the value of the company but because of accounting we cannot get anywhere near this data. Could then use the value driver formula and see if market expectations are right. Could then evaluate performance. Could then evaluate whether new investments can really earn. No discussion of terminal value. No discussion of P/E or EV/EBITDA ratios. No discussion of near-term EPS. So much comes down to the ROIC or ROE.

Project IRR from Capital Expenditures, Revenues, Operating Expenses and Working Capital

Standard financial model to forecast earnings. You can think of ROIC as you would think about other statistical data. Cap Exp is the big deal.

ROIC = (Revenues – Op Exp)/Investment. If you project capital expenditure and if it is not consistent with ROIC. Use crazy cap exp to sales which is meaningless. Investment is so important. Capital expenditures to sales may have problems. In sum, the process is a big mess.

In project finance returns are explicitly the criteria (maybe the only criteria). If you could add up portfolio of projects could derive value. Also the risks are carefully defined. One day will provide some kind of asset portfolio.

Why did it take me so long. Get very confused by forecasting process. General process of variable expense and fixed expense. Gross margin. Revenue growth. But what to do about capital expenditures. Capital expenditures are the problem. EPC, O&M and PPA. Capital Expenditure to sales. Capital Expenditures to Depreciation, Growth Rate in Capital Expenditures. Importance of capital expenditures.

ROIC and Project IRR

The simplest way to think about return on investment is to pretend you are operating in Abu Dhabi with no taxes and you have an investment that is all financed by equity. Assume that you are investing 1,000 today and expect to get 1,100 back in a year (there is an equal upside and downside probability). Then the IRR on your investment – whether advertising, inventory, gambling or capital expenditures is 10%. You could also compute the return on invested capital as the amount you get in a year – 1,100, less the allocate cost of your investment – 1,000. This gives you income of 100. And the income 100 divided by the initial investment also gives you 10%.

If you have to wait two years to get back your investment and you get back 550 per year, then things get more complicated and the return on investment falls apart as a statistic. If you go to excel and compute the IRR, your return is now down to 6.60% (you need excel for this). If you allocate the investment of 1,000 over two years giving an allocated cost (depreciation or amortisation) of 500, then the income is 500 per year. But the invested capital on you balance sheet starts at 1,000 and then goes down to 500 in the second year. This gives a return on capital that is lower than the IRR of 6.6% in the first year – 5% -- and is higher than the IRR in the second year. Further, the average of the ROIC is not the same as the IRR. The example is illustrated in table xxx.

	0	1	2
Capital Expenditure	(1,000)		
EBITDA		550	550
Free Cash Flow	(1,000)	550	550
IRR	6.60%		
Amortisation		500	500
EBIT (Income)		50	50
Investment End of Period	1,000	500	-
ROIC (Income/Initial Inv)		5.00%	10.00%

Straight Line Depreciation Distorts Return on Investment for a Single Asset

The return on investment, whether the return on equity or return on invested capital compares investment to the money that comes to investors. The money that comes to investors begins with EBITDA which measures real cash. If this was where the return on investment stops, there would be no big accounting issues. But the money that comes in is after depreciation expense, impairment expense, interest expense and taxes. The problem is that depreciation is distorted and leaves ROI to be a mess. If a company has old assets, the ROI will be very high relative to the true earnings because of the manner in which depreciation is computed. But DA is a problem, so EBIT is a problem, and it is the basis for computing ROIC and even ROE. Depreciation is the change in value. Can only make it allocate the total value if the IRR is used to make value. NPV at IRR is the value of a project. At the first year, the NPV at the IRR gives you the total value. This value declines to zero over the life of the project.

Not only straight-line depreciation, but the also the economic life of a project. If you could find this true return you could then measure the long-term portfolio of projects. To demonstrate problems in the calculation of ROIC, move to project finance. If you have ever worked on project finance, you may be thinking that ROIC is virtually never computed as a part of transactions and how formulas related to the IRR can translate directly into the ROIC if depreciation is accounted for properly. We will see how IRR and ROIC are growth rates and value comes from cash flow growing at a faster rate than the cost of capital.

Economic Depreciation and IRR/ROIC Reconciliation

Start with the time series of value over the life of an asset. Figure xxx shows the trend in value for three cycles of an asset. The calculation is simple, the EBITDA is flat and the EBITDA less taxes drive at the value. If assets are lumpy like this, then the present value goes down and up when the assets are replaced. Can see a lot from this. EV/EBITDA and price to earnings completely change over the life of an asset. Value is not constant. Return on investment is not constant. Value goes down as plant ages simply because there is less cash flow. Value does not go down on a straight-line basis because the discount rate is not zero. The pattern of value decline is driven by the Why need the true ROIC on investments. There is a true IRR. This is the project IRR in project finance. Value for a single asset does not change on straight line basis.

	0	1	2
NPV at IRR	1,000	516	-
Change in Value		484	516
EBITDA		550	550
Economic Depreciation		484	516
EBIT - Economic		66	34
ROIC (Economic)		6.60%	6.60%

Graph does not show what happens if you have productive assets that are fully depreciated. Keep coming back to the conclusion that financial statement analysis is utterly worthless.

Deferred Taxes in Computing Return on Investment

More illustration of how to think about computing the return on investment and segregating operations from financing. To illustrate the idea of thinking about items on the balance sheet rather than using some kind of prescribed formula, I discuss deferred taxes in this chapter. If you think about deferred taxes maybe you easy and say oh I don't want to get into this understandable account. But deferred taxes can be related it's the valuation of derivatives the fair valuation of derivatives that you can see on a balance sheet. In this case the Deferred taxes would clearly not be related core operations. on the other hand some of the Deferred taxes could very well be related to the and this is accumulated defer taxes some of the accumulated defer taxes could be related to could be related to the difference between and the tax depreciation kind of that classic items could be very I'm in the end it with no let's go back to the

Deferred taxes can a deferred taxes what you would do is if your Computing invested capital and your

ILLUSTRATION OF STABALISATION WITH GROWTH

Computing how much capital is used to generate net operating profit which is the core operating profit which does not include I'm from things like cash Investments that we talked about or doesn't pay any interest expense it's got the non-financing the pure earnings of the corporation agree with that does not include derivative gains from the change in the market value of derivatives or the if these are on the balance sheet. In this case the of the company so you can do this and mechanically you can work through the balance sheet and could compute invested capital in two different ways that's it is to identify financing of a corporation that's related to the Core Business of the assets. So let's go return to the Apple example in the Apple example we had all of that Surplus cash the balance remember you don't have to be an accountant to know that the balance sheet balances you can even be an engineer and I understand that the word balance sheet means to balance the balance sheet.

And if we have a whole lot of cash on the asset side of the balance sheet that's being financed play or explicitly by debt and equity make that cash into a lot of things with that cash we could go on a holiday we can pay for bonuses we could pay dividends we could use it to buy back stock with debt plus cash must be is not related to the Core Business and so you take the debt and the equity and subtract that Surplus cash that's one way to do this and in order to do this mechanically you work through the one next to the Surplus cash.

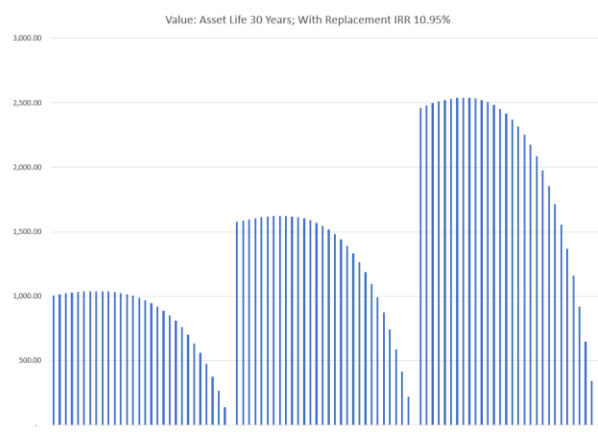
Chapter 11: Modelling a Corporation and a Portfolio of Assets to Resolve Accounting Issues

Theoretical Value of a Corporation

Imagine everybody in finance knows some distortions and that value comes from earning a return. Imagine everybody thinks of a corporation as a portfolio of assets. Imagine that everybody knows that IRR will resolve to ROE over the long-run.

Effect of Growth Rate and Plant Age on Rate of Return

You can use the idea of economic depreciation to illustrate the bias in rate of return from companies with different growth rates. I have made a simple simulation where there is investment build-up with different growth rates. In the first case, the return is 10% and the growth rate is 4%. The true rate of return is computed with economic depreciation and the this rate of return over time is compared to the rate of return computed from straight line depreciation. There is a second graph where the depreciation rate does not reflect the true economic life. The average age is shown along with the accumulated depreciation to the value of the investment.



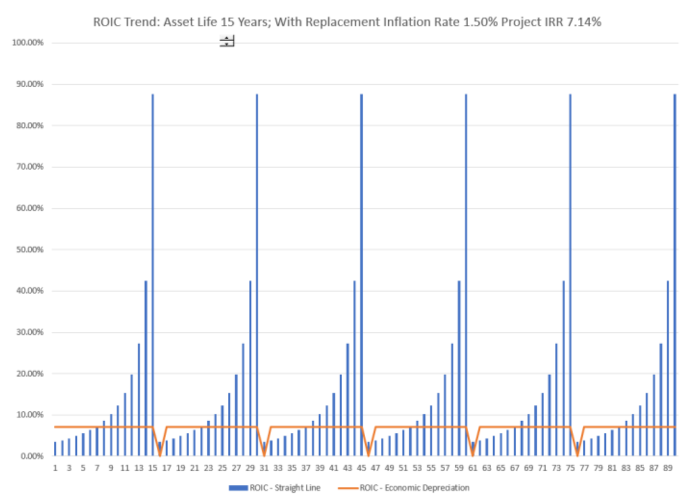
Alternative graphs is shown for different growth rates and different asset lives.

Work through economic depreciation with different scenarios. Use an oil example with declining balance (you can use the VDB function in excel). Criticize a lot and must include accountants. Had to teach a class in financial statement analysis. It thought it should be about how to arrive at the ROIC so that we can assess performance and potential to earn future ROIC. Straight line depreciation, deferred taxes, R&D expense all make computing the ROIC impossible from accounting. The class failed by the way. I also tried to contrast project and corporate finance.

Performance Measurement with Return Computed Using Economic Depreciation

Figure xxx illustrates how you can use economic depreciation for evaluation the performance and more importantly the prospective return after a change in the performance. The top shows the return without any adjustment. In this case with economic depreciation is the same as the IRR. To compute this you compute the value of the plant at the IRR. Then you compute the change in this value. Because you use the IRR and not another rate, the value is the same as the capital expenditure. This is the basic idea that the NPV using the IRR is equal to zero or, without the initial capital expenditure, it is the capital expenditure.

The second part of figure xxx shows what happens when you use the same depreciation. Note there is no impairment. In this case the ROI goes down for three years. Now, you may want to evaluate the potential future return. You want to do this because you may want to assess new investments. You may not have a model and want to evaluate the future prospects of the project. The 6.88% IRR does not mean anything to you anymore. This was for the initial investment. The actual has come down and you have some history. At the end of the day did your IRR would be 6.86%. But you do not know what will happen in the future. Is the 4.61% a better way to evaluate future prospects. If the reduction in cash flow continues you will earn something like 4.5%. It is true that you could compute the reduction.



Base Case			0	1	2	3	4	5	6	7	8	9	10
EBITDA	100	0%		100	100	100	100	100	100	100	100	100	100
Cap Exp	1,000		1,000										
Cash Flow			(1,000)	100	100	100	100	100	100	100	100	100	100
IRR	7.75%												
Value			1,000	978	953	927	899	869	836	801	763	722	678
Depreciation				22	24	26	28	30	33	35	38	41	44
EBIT				78	76	74	72	70	67	65	62	59	56
ROI				7.75%	7.75%	7.75%	7.75%	7.75%	7.75%	7.75%	7.75%	7.75%	7.75%
Performance													
Base EBITDA				100	100	100	100	100	100	100	100	100	100
Reduction						30	29	28	27	26	25	23	22
Adjusted				100	100	70	71	72	73	74	75	77	78
Cap Exp			1,000										
Total Cash Flow			(1,000)	100	100	70	71	72	73	74	75	77	78
IRR	5.38%												
Plant Balance			1,000	978	953	927	899	869	836	801	763	722	678
Depreciation				22	24	26	28	30	33	35	38	41	44
EBIT				78	76	44	43	42	40	39	37	36	34
ROI				7.75%	7.75%	4.61%	4.62%	4.63%	4.64%	4.66%	4.67%	4.69%	4.72%

Weighted Average Rate of Return (ROIC) versus IRR

An example of trying to find a solution. How to account for the IRR when long-term investment and really high IRR. Seems that the life does not matter. Need to give higher weight to the out year cash flow. The MIRR does not work, the NPV will use a higher discount rate. Could do this with straight line depreciation. If use the IRR itself will get the same number. But if use a different discount rate will get a lower number. Finally, the WAROIC is the return on invested capital year by year computed as the weighted average with the cost of capital. All of these alternative measures either depend on incorporating the cost of capital which people rightly try to avoid (the NPV, the MIRR or weighted average ROIC) or they do not consider any idea about future cash flows being worth less than current cash flow (MOIC, and Payback).

I kind of like the premium versus the risk-free rate. You can get some sort of risk-free rate from publicly available date (it is not at all risk free really, but at least it is objective). Make a series of cases and evaluate the probability of not earning the risk-free rate. How much do you get paid for risk. Adjust for evaluation period – two short term investments versus one long-term investment. Problem is the interpretation.

Now consider the WAROIC. (I do present a weighted average return on invested capital approach using economic depreciation which is better than the IRR.) I also try to reconcile the theory of finance with macroeconomics when discussing the philosophy of cost of capital; country risk premium; credit spreads terminal growth and other issues. A big problem with finance these days is the belief that statistical models (such as the CAPM which are unprovable) can somehow measure the preference human beings have for taking risk.

Use of project finance to prove concepts. For example, ROE and market to book ratio. Analysis of portfolio. How could nobody investigate this. Know the value if given the discount rate. No terminal value. Can compute the value from the discount rate. Then if earning the discount rate, can compare the earnings to the discount rate. Demonstrate that this only works if the depreciation is adjusted to economic depreciation. Then put in a impairment write-off. No longer works. If stable company and if no impairment then it works. Do without financing.

PART III – Analysis of Finance Biases Using Case Studies

Chapter 11: Capital Intensity, Cost of Capital and Production Cost

This chapter and subsequent chapters in this part of the book apply various analyses of investments to demonstrate how conventional ideas in finance distort decisions in a real-world context. I call the analysis of these real-world problems case studies, even though they are not written in the style of conventional case studies used in business schools. The case studies apply some of the ideas introduced in earlier chapters such as questioning the idea of compounding risk premia; evaluating whether returns should be approximately the same as the overall economic growth rate; policy implications of earning returns substantially above the cost of capital; applying returns using IRR without adjusting for compounding of risk; and measuring performance from accounting based returns. The cases also introduce subjects that will be discussed later in the book. These include contrasting project finance with corporate finance; evaluating problems with measuring terminal value; applying cost of capital to investments using alternative measures of the cost of capital; understanding implications of P/E and EV/EBITDA ratios; and methods of forecasting cash flow. The general idea of the cases introduced in this section is to various ideas to evaluate how combining different ideas affects valuation and returns.

This first case in this chapter addresses the issue of measuring the cost of electricity derived from different technologies. Financial analysis is used to evaluate whether solar energy plus storage, offshore wind, natural gas, coal or nuclear power produces the best results for society. This issue is and has been a hotly debated around the world and it can involve arguing about different cost structures, risks, environmental externalities and even whether the noise created by an off-shore wind farm causes cancer and whale deaths.[41] Measurement of electricity costs is used to introduce subjects of project finance, financial forecasting, mean reversion and cost of capital. The specific case used involves critiquing a well-known tool used by industry practitioners published by a New York investment bank named Lazard.[42] This publicly available study measures the relative efficacy of different electricity generating technologies through computing a statistic named the levelized cost of electricity ("LCOE").[43]

[41] "Tilting at Windmills? Trump's claims about turbines fact-checked", The Guardian, 28 July 2025. Helena Horton.
[42] Lazard Reference website.
[43] You can google Lazard LCOE and find the most recent version of the study.

For many years, Lazard has published studies of the LCOE that results from different electricity sources including renewable energy, natural gas, battery storage and nuclear power.

The discussion in this chapter is not intended to address many of the technical, environmental and geopolitical issues associated with energy policy but rather concentrates on methods of constructing financial analysis. The analysis demonstrates that financial issues related to forecasting capital expenditures, operating costs, taxes and cost of capital have large effects on measurement of production cost. Items that influence measurement of LCOE include financing with debt and equity, measuring cost of capital, accounting for inflation, evaluating changes in efficiency of plants as they age, considering income taxes and evaluating mean reversion when modelling cash flow. Calculation methods for evaluating cost may seem more mundane than some of the emotional questions surrounding energy policy such as the safety of nuclear plants or the danger of flooding from a hydroelectric plant, but distortions in financial analysis can result in important biases.

Measuring the cost structure of different investments in any industry can be developed by beginning with an assumed price for a product and then computing the internal rate of return ("IRR") that was discussed in earlier chapters. In this kind of analysis that begins with an assumed price, technologies that produce the highest IRR are considered more economic than technologies that result in a lower IRR. This kind of analysis can become difficult if investments with a different economic life are assessed and/or investments with different capacity utilisation are compared. An alternative to beginning with a given price is to start with the capital expenditure and operating costs and then deriving the required price. This works by applying a cost of capital (the minimum required IRR) to the investment and adding the capital cost recovery to the operating costs over the lifetime of the investment, the required costs can be divided the production. The calculation can be developed to yield the same price over the lifetime of the investment which is why the phrase "levelised" is used. As this levelised price is the same over the lifetime of the investment, investments with different operating lives and other characteristics can be compared. For example, an investment with a five-year life can be compared to an investment with a thirty-year life by using levelised cost. If a typical financial model were used where the price is given and the return is computed, the investment with the five-year life would need to be replaced six times with new capital expenditures and a re-start of degradation at each increment.

The remainder of this chapter is divided into six sections. The next section introduces the Lazard presentation of levelised cost for different technologies. After that, the specifics of the financial analysis method Lazard uses to compute levelised cost is documented. The third section introduces the notion of capital intensity to provide context for distortions that arise in measuring LCOE. The general theme of this section is that the Lazard financial calculations strongly penalise capital intensive assets relative to fuel intensive assets. After addressing the general subject of capital intensity, the next sections address specific issues that affect the LCOE calculation including (1) income taxes, (2) appropriate cost of capital, (3) treatment of inflation, (4) inclusion of environmental costs, and (5) appropriate evaluation of long-term fuel cost.

The discussion and analysis in this chapter is not unique to electricity. Similar calculations are made for different forms of transport, for example electric bus versus diesel bus where the cost comparison is called total cost of operation ("TCO"). In the oil industry the break-even price of oil that is required to produce an IRR from different kinds of oil fields can be computed. In real estate, the required monthly rental price for different kinds of lodging could be evaluated. For data centres, the cost of electricity using different kinds of technology including liquid or air cooling can be evaluated. For any of these analyses, the same biases that result from inappropriately measuring taxes, overestimating the cost of capital, ignoring environmental costs and assuming that near-term fuel prices will continue indefinitely can create large errors in the analysis.

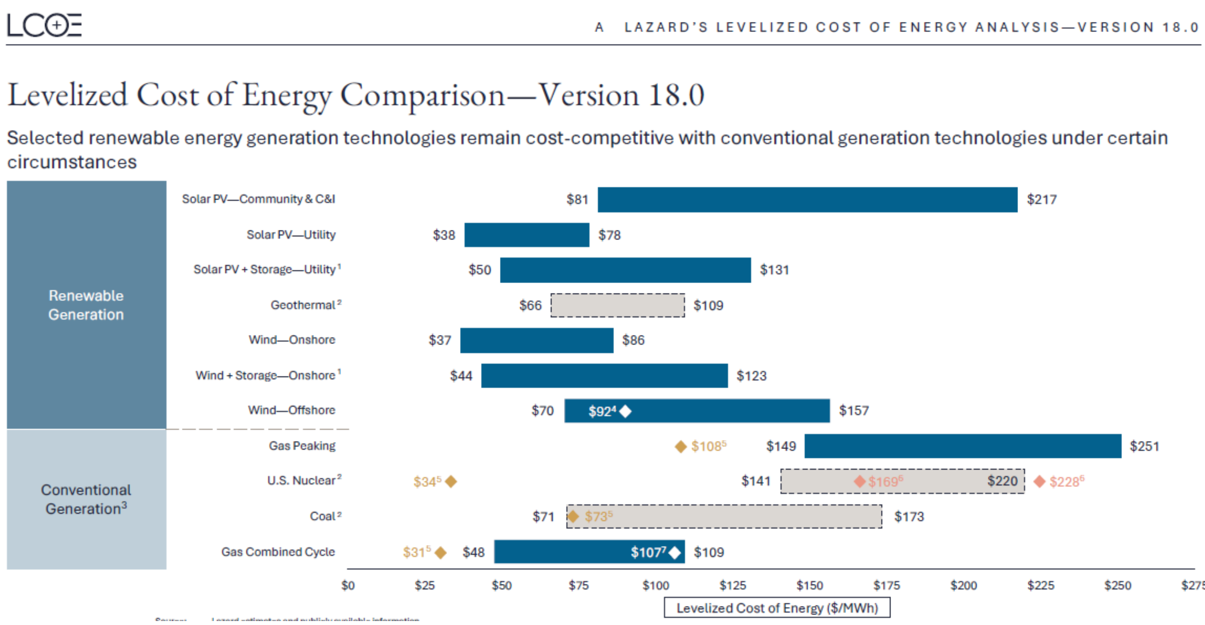
Lazard's Measurement of LCOE

LCOE calculations made by Lazard have become a well-known reference for evaluating the relative cost of different electricity technologies. A few years ago, for example, I remember seeing the Secretary of Energy in the U.S. in a television interview using a report published by Lazard to argue for expansion of solar power because the LCOE was lower than that of other technologies. The excerpt below shows one of the reports (called a football field diagram, because it goes backwards and forwards the way an American football team goes up and down the field) that is published in the Lazard analysis.[44] The x-scale on the graph is the LCOE per unit (in this case USD/MWH) and the ranges in LCOE are driven by different capital expenditure and operating cost assumptions (sometimes the cost of electricity is expressed in cents which means multiplying by 100) and then dividing per kWh (dividing by 1,000) which means the cost or required price per MWH can be stated as cents per kWh where the numbers would be divided by 10. For example, the cost of solar power without storage (for a utility scale project) in the graph ranges between 38 USD/MWH (3.8 cents per kWh) and 78 USD/MWH (7.8 cents per kWh). When the cost with storage is added to solar power, the cost ranges between USD 50/MWH and USD 131/MWH. By contrast a nuclear plant has a cost ranging from USD 141/MWH (above the high range in solar plus storage) and USD a high range of 220/MWH. Without considering the effect of emissions, the Natural Gas plant has a cost ranging between USD 48/MWH and USD 107/MWH which is lower than the solar plus storage option. If you follow the energy industry just a little, or even if you don't, you can imagine that people can become emotional about these numbers.

There are many issues about making comparisons between the LCOE for different technologies that can heavily bias the results and have nothing to do with financial questions addressed below. One example of an issue is defining use cases. For example, it is certainly not appropriate to compare a solar project without storage that only operates when the sun shines

[44] Lazard Report on Levelized cost of electricity, published in 2020 at the website.

to a nuclear plant that runs continuously for 24 hours (this is as if you compare the cost of a car that can only drive for four or five hours a day to a car that you can drive whenever you want). To resolve the potential distortions caused by different use cases, a hypothetical data centre is modelled that needs power around the clock (although the power can vary by minute). The electricity needs of the data centre can be met with nuclear, natural gas or solar plus battery storage, wind plus storage or a coal plant. The battery storage requirement for wind and solar is derived by oversizing the solar or wind to charge batteries and meet the around the clock electricity requirements from direct solar and from. Capital costs, operating costs and efficiencies assumed by Lazard are subject to a lot of controversy and may not be reasonable. But in the analysis below the Lazard costs are accepted so the focus will be on more fundamental analytical questions involving cost of capital, inflation, taxes and degradation.



Lazard's Analytical Approach and Assumptions in Measuring LCOE

In its report Lazard illustrates how their LCOE calculation is made through a cash flow forecast where the target equity return drives the required revenues to a project and the required price that covers all costs. An illustration of the financial analysis from the Lazard report is replicated below for a wind farm. The excerpt illustrates the financial model and the assumptions for a wind farm. The financial model shows the price that is flat (or levelized) in nominal terms over the 30-year life of the plant. Forecasts of operating expenses, the capital expenditures and the financing that drive the LCOE are shown on separate lines in the summary report. On the right-hand side of the excerpt, assumptions are displayed including the cost of debt and equity, the inflation rate, the tax rate and physical characteristics of the technology.

The excerpt illustrates how the flat nominal price is determined by setting the equity IRR to a target return of 12% (presumably using the excel goal seek function). The methodology and assumptions for different technologies have been replicated so that different assumptions can be developed.[45] The levelised price of USD 36.7/MWH is compared to other technologies and shown on the football field diagram (the low range). Note that taxes are included in the financial analysis and the depreciation rate applies the Modified Accelerated Capital Recovery System ("MACRS") applied in the US, meaning that the approach cannot be applied to countries with different tax rates and different depreciation systems.

Levelized Cost of Energy Comparison—Methodology

($ in millions, unless otherwise noted)

Lazard's LCOE analysis consists of creating a power plant model representing an illustrative project for each relevant technology and solving for the $/MWh value that results in a levered IRR equal to the assumed cost of equity (see subsequent "Key Assumptions" pages for detailed assumptions by technology)

Unsubsidized Onshore Wind — Low Case Sample Illustrative Calculations

Year [1]		0	1	2	3	4	5	30
Capacity (MW)	(A)		300	300	300	300	300	300
Capacity Factor	(B)		55%	55%	55%	55%	55%	55%
Total Generation ('000 MWh)	(C)* = (A) x (B)		1,445	1,445	1,445	1,445	1,445	1,445
Levelized Energy Cost ($/MWh)	*(D)*		*$36.7*	*$36.7*	*$36.7*	*$36.7*	*$36.7*	*$36.7*
Total Revenues	**(E)* = (C) x (D)**		**$53.0**	**$53.0**	**$53.0**	**$53.0**	**$53.0**	**$53.0**
Total Fuel Cost	(F)		--	--	--	--	--	--
Total O&M	(G)*		7.4	7.5	7.7	7.9	8.0	14.0
Total Operating Costs	**(H) = (F) + (G)**		**$7.4**	**$7.5**	**$7.7**	**$7.9**	**$8.0**	**$14.0**
EBITDA	**(I) = (E) - (H)**		**$45.7**	**$45.5**	**$45.3**	**$45.1**	**$45.0**	**$39.0**
Debt Outstanding - Beginning of Period	(J)		$342.0 [2]	$339.0	$335.7	$332.2	$328.4	$28.1
Debt - Interest Expense	(K)		(27.4)	(27.1)	(26.9)	(26.6)	(26.3)	(2.3)
Debt - Principal Payment	(L)		(3.0)	(3.3)	(3.5)	(3.8)	(4.1)	(28.1)
Levelized Debt Service	**(M) = (K) + (L)**		**($30.4)**	**($30.4)**	**($30.4)**	**($30.4)**	**($30.4)**	**($30.4)**
EBITDA	(I)		$45.7	$45.5	$45.3	$45.1	$45.0	$39.0
Depreciation (MACRS)	(N)		(114.0)	(182.4)	(109.4)	(65.7)	(65.7)	0.0
Interest Expense	(K)		(27.4)	(27.1)	(26.9)	(26.6)	(26.3)	39.0
Taxable Income	**(O) = (I) + (N) + (K)**		**($95.7)**	**($164.0)**	**($91.0)**	**($47.1)**	**($47.0)**	**($2.3)**
Tax Benefit (Liability) [3]	**(P) = (O) x (tax rate)**		**$38.5**	**$65.9**	**$36.6**	**$18.9**	**$18.9**	**($14.8)**
After-Tax Net Equity Cash Flow	**(Q) = (I) + (M) + (P)**	**($228.0)** [4]	**$53.7**	**$81.0**	**$51.5**	**$33.7**	**$33.5**	**($6.2)**
IRR For Equity Investors		12%						

Key Assumptions [5]	
Capacity (MW)	300
Capacity Factor	55%
Fuel Cost ($/MMBtu)	$0.00
Heat Rate (Btu/kWh)	0
Fixed O&M ($/kW-year)	$24.5
Variable O&M ($/MWh)	$0.0
O&M Escalation Rate	2.25%
Capital Structure	
Debt	60.0%
Cost of Debt	8.0%
Equity	40.0%
Cost of Equity	12.0%
Taxes and Tax Incentives:	
Combined Tax Rate	40%
Economic Life (years) [6]	30
MACRS Depreciation (Year Schedule)	5
Capex	
EPC Costs ($/kW)	$1,900
Additional Owner's Costs ($/kW)	$0
Transmission Costs ($/kW)	$0
Total Capital Costs ($/kW)	$1,900
Total Capex ($m)	$570

Understanding the Capital Intensity and Not Getting Lost in Technical Definitions

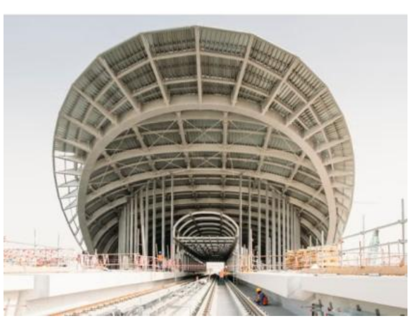
A summary of the corrections to financial analysis is presented in this section which illustrates how standard financial techniques bias investment analysis away from capital intensive assets and favours fuel intensive investments. To see how investment analysis can be distorted from alternative forecasting methods as well as financial assumptions, begin by considering some fundamental aspects of any investment. First, the drivers of any investment consists of three things -- capital expenditures, operating expenses and revenues. The capital expenditure could be the cost of building a facility, amount spent for buying a company, paying

[45] The LCOE derived by Lazard could be computed in a simpler way using a single formula LCOE = (Capital Expenditures + PV of O&M)/Annuity Factor over Life, or
LCOE = (PMT(Discount Rate, Life, Cap Exp) + Op Exp)/Annual Production). To reconcile the Lazard analysis, dates were adjusted. You can find the reconciliation at www.edbodmer.com under the LCOE section.

for an education, or putting money into a slot machine. Second, for just about any investment you generally require continuing operating expenditures after the initial capital expenditure is made. These operating costs could range from continuing education; to paying natural gas or coal costs for a power plant; to paying fuel costs for a regular internal combustion car or a hydrogen vehicle; or for paying costs for fixing substations when they are flooded. Third, for an investment to produce value, revenues received over the life of the investment must be high enough to produce net growth in cash flow to investors – the rate of return.

The key theme in evaluating the Lazard study is that financial issues in forecasting and developing assumptions have more of an effect for projects that are capital intensive such as nuclear plants then for projects that are fuel intensive such as natural gas plants. This is because cost of capital, tax and inflation parameters have a larger effect on capital intensive investments than on fuel intensive investments. To quantify the effects of different financial analysis techniques on capital intensive compared to fuel intensive investments, the definition of capital-intensive investments can guide the analysis. Intuitively, capital intensity of an asset depends on (1) the level of operating expenses relative to the amount of up-front capital expenditures and (2) the lifetime of the asset. The different capital investments compared in the Lazard Report and that are the subject of controversy have different lives and have different ratios of operating expense (for example, fuel and maintenance expense) to the capital expenditure cost of building the plants. By their nature investments made to mitigate climate change (such as nuclear plants and production of renewable natural gas from cow dung, geothermal, solar and wind) spend nothing or much less on fuel than classic thermal plants and therefore have a higher ratio of capital to operating cost. Other investments such as rail and subways, electric busses, telecom infrastructure and real estate have lower ratios of operating cost to capital cost. The sort of investments that do not use fossil fuel are also long-lived investments such as hydro plants which can last 100 years. For capital intensive investments with a long life, the revenue required relative to capital expenditure to support the total investment is lower than for revenue required for shorter-term investments because the revenues are spread over a longer period.

The term capital intensity is something that people seem to have general familiarity with, but I doubt that many who create of evaluate financial analysis think about a formal definition or the manner in which capital intensity can distort key analysis questions. To consider what is capital intensive and what is not, you can compare the two pictures in this paragraph. The picture of the little wagon is less capital intensive than the picture of the Grand Paris express project which will have four new automatic train lines. The fruit vendor must buy his fruit every day and pay his own salary which are operating costs. The life of his wagon will not be that long or a big part of the costs of his operation. On the other hand, the capital expenditure for the Grand Paris tunnel is enormous. As



the project has automatic trains, the operating expense is projected to be low relative to the capital, and the capital will last a long time.

You will probably not have to compute a statistic that measures capital intensity in the same way that you may compute a ratio that measures the rate of return or the risk of a project. But pretend that you want to show a statistic that measures capital intensity as an introduction to analysis of different investments. When you search for a definition of the term capital intensity on the internet you will be taken to Investopedia and see that capital intensity is defined as the level of assets divided by the level of revenues. This definition using a simple ratio is, as with so many things in finance, very ambiguous. This idea of questioning the meaning and essence of statistics like the IRR, the EV/EBITDA, the ROIC and many other statistics is a general theme of the book, and it applies to capital intensity. The level of assets, the numerator of the formula, is not defined to be before or after accumulated depreciation; it is not specified as being measured at current market value or invested value; it is not defined to be adjusted for associated financing and other cots. The revenue, in the denominator of the calculation, covers items that are required to provide a return on the assets. The capital intensity statistic will be higher if the return that drives revenues is lower; it will be lower if taxes are required to recover capital, thereby increasing revenues; it will be different depending on how the prices that underly revenues are adjusted for inflation.

An example of capital intensity that I use in teaching is illustrated in the side-by-side pictures below. I ask whether a refinery or a solar panel on the top of a roof is more capital intensive, and I am generally given the wrong answer that the refinery is more capital intensive. While it seems to have more equipment, the idea of capital intensity is relative; the refinery’s biggest cost is the operating expense for oil that is converted to refined products; some refinery equipment can have different lives that may not be very long; inventories of spare parts may be

necessary. When building up the components of revenues for the refinery, the amount includes a lot of costs for buying crude oil, maintaining equipment, operating the refinery and other administrative costs as well as the amount to cover costs of the initial capital.

By contrast the cost of the solar panel almost entirely consists of the up-front amount paid for the panels. There may be some operating cost, but particularly for roof-top solar these are not very high. This means that most of the solar panel costs consist of the rate of return necessary to recover the investment. If the solar plant has a longer life, the return is spread over a longer period and the effect of the return on the revenues that are needed to collect the costs are higher.

When thinking about investments that are made to combat climate change, you could make a few generalities. First, investments made to mitigate carbon emissions, by definition, do not include fuel as an operating expense and instead generally involve higher amounts of up-front capital (such as wind and solar projects). Second, investments made to adapt to or mitigate climate change tend to have a long life (such as building houses that are more resistant to heat waves and floods). The higher value of the investment and the longer life of the climate combating investments mean that on a relative basis, more capital is outstanding for a climate change investment (compared to operating cost) and that the capital outstanding for a longer period of time. These two facts mean that investments made to combat climate change are capital intensive.

Subsequent sections of this chapter argue that the Lazard study biases measurement of the cost of different technologies. Furthermore, the effect of correcting the financial analysis for each item – taxes, cost of capital, inflation, environmental costs and long-term measurement of energy prices – has more of an effect on the capital-intensive technologies than the fuel intensive technologies. The table below summarises the corrections relative to the Lazard method for different technologies that could theoretically produce power to serve the needs of a data centre which is assumed to have continuous need for power. The technologies include natural gas and coal – the fuel intensive technologies – versus nuclear power, solar plus batteries, wind plus batteries and hydro with assumed storage capacity from a reservoir. The table measures the level of capital intensity through dividing the required revenues by the initial investment.

For each of the scenarios, the LCOE as measured by the Lazard method is followed by a correction for income taxes, cost of capital, inflation, environmental costs and long-term forecasts of the real cost of natural gas and coal fuel. The summary shows that the corrections have much more of an impact on the capital-intensive investments. Note for example, that the difference between the hydro project is a cost reduction from USD 125.67/MWH to USD 44.0/MWH and the difference between the nuclear project is from USD 130.59/MWH to USD 62.26/MWH. On the other hand, the difference in the Natural Gas project is far less. Note the table will be revised for taxes and environmental costs and it will include wind and coal.

								Solar Project	Solar Project with Cleaning	Solar Project with Drone	Solar Project with Drone &	Solar with Tracking	Hyrdo Project	NGCC Project Subsidized Fuel	NGCC Project Market Price HR	Nuclear Project	BESS Project
Lazard Method	1	EIRR	12.00%	Debt	0.00%	Inflation	0.00%	36.08	36.14	35.49	36.96	30.79	125.67	92.53	127.80	130.59	
Lazard Method, Lower Cost of Capital	2	EIRR	7.00%	Debt	0.00%	Inflation	0.00%	26.04	25.57	25.14	26.05	21.73	78.35	86.31	121.59	90.70	
Lazard Method, Including Debt	3	EIRR	7.00%	Debt	80.00%	Inflation	0.00%	21.38	22.38	22.01	22.76	19.00	63.64	84.54	119.81	78.46	
Real LCOE with Inflation Correction	4	EIRR	7.00%	Debt	80.00%	Inflation	2.00%	18.53	19.07	18.77	19.34	16.16	48.64	82.54	117.82	65.90	
Country Cost of Capital, Real LCOE	5	EIRR	5.50%	Debt	80.00%	Inflation	2.00%	18.02	18.43	18.14	18.67	15.61	44.04	82.15	117.43	62.26	

Correcting the Analysis of Different Technologies for Taxes

The level of profits after paying interest drives the level of income taxes incurred by a project. Taxes can potentially also be imposed on interest and dividends (called withholding taxes). Sometimes much of the tax liability can avoided by using shareholder debt where the interest on the debt can be tax deductible and can be substituted for equity. As the amount of equity capital is relatively more for capital-intensive investments than for fuel intensive investments, the amount of tax will be higher on a relative basis for those investments that are capital-intensive. But the tax is received by the government and presumably provides benefits in one way or another to the general population. This begs the question of whether the LCOE should measure costs with or without tax. If the idea of the LCOE is to compare the overall benefits to society, it is sensible to remove taxes from the analysis as the whole idea of the process is to compare the ultimate cost of different technologies to the overall population. If one technology would cause higher taxes to be received, these taxes could in theory be used to lower energy costs.

One could argue that the LCOE is an attempt to measure the electricity price bid from an investor and this represents the price paid by consumers. The price could represent bids made by project developers or prices that are a component of an electric bill. For example, if the LCOE is intended to measure the cost of roof-top solar compared to the variable portion of current electric bills, the effect on the customer from paying taxes could be included in the analysis. If taxes are included in the LCOE calculation and the calculation uses the level payment technique, then there are two parts to the calculation. First, the cash flow to equity can be multiplied by the tax rate and divided by one minus the tax rate as illustrated below:

Total Tax Recovery = Equity Cash Flow * Tax Rate / (1-Tax Rate)

In the above equation, if the equity cash flow is 100 and the tax rate is 25%, the taxes paid are 100 * 25% / 75% or 33.33. The validity of this formula for covering taxes in revenues is demonstrated by the fact that 33.33 * (1-tax rate) = 33 * .75 = 25. Offsetting the tax on equity is a depreciation deduction. The value of the depreciation deduction depends on the length of time over which the depreciation occurs and the shape of depreciation if it is different from a straight-line approach. The effect of the depreciation deduction can be evaluated by first computing the present value of the depreciation deductions and then, once the present value is computed, levelise the present value multiplied the tax rate and then levelise the benefit. This process is illustrated below:

Step 1: Compute PV of Tax Depreciation at Nominal Discount Rate * Tax Rate

In excel with straight line: PV(Nominal Rate, Tax Life, Capital Expenditure) * Tax Rate

Step 2: Levelise the Tax Shield: PMT(Real or Nominal Rate, Plant Life, PV of Tax Depreciation)

The effect of tax on LCOE is illustrated below, where the tax life is assumed to be the depreciation life and the tax rate of 40% used by Lazard is demonstrated. In the graph below a nuclear plant is compared to a gas plant with and without taxes. In addition, the effect of the tax life is illustrated. axty cash flow without tax by one minus the tax rate so that the taxes are recovered as well as the other costs. But when computing taxes, the calculation should also account for the tax depreciation shield which is just about universally in different jurisdictions computed on a nominal basis. This implies that the more the inflation assumption, the more the effect of taxes on the LCOE.

The problem with including taxes is that for purposes of evaluating the cost of different technologies is used in assessing public policy (such as a person complaining about wind and Whales), the effects on the overall society should be evaluated. If one project pays more taxes, these taxes go back to overall society. This means that the higher taxes that cause a higher LCOE go back to the people paying for electricity and must be removed from the analysis.

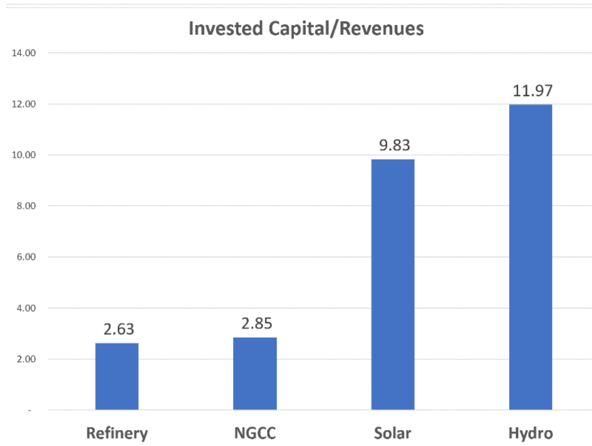
Correcting the Lazard Financial Analysis for Cost of Capital

Discussion of the cost of debt and equity that are appropriate to use in comparing different technologies like the Lazard study combines discussion in involving the real return earned on equity and government debt (Chapter 4), the discussion cost of capital (Chapter 21) and the general discussion of alternative cost of capital measurements (Part V). The Lazard study applies a cost of equity of debt of 8% and a cost of equity of 12% in measuring the LCOE. As explained in Chapter 4, the cost of debt and the cost of equity must be evaluated in the context of inflation where achieved real growth in equity and debt is reviewed. The Lazard study assumes an inflation rate of 2.25% which means the implied real cost of equity is (1+12%)/(1+2.25%)-1 or 9.53%. This rate is very high relative to overall equity returns in and real economic growth of about 2% (Chapter 4). A low required IRR or cost of equity capital is further supported by the fact that in project finance that is often used for electricity investments, contracts are structured to minimize the cost of capital (Chapter 16). A real cost of equity of 3.75% is assumed which is a nominal cost of 6.08%.

The cost of debt is also arguably high in the Lazard study. Assuming that the debt has a fixed nominal rate and is therefore subject to inflation risk, the premium relative to inflation is about 2% (Chapter 4). In addition to inflation risk, a credit spread should be added to the cost of debt. With exception of extreme periods a BBB credit spread of about 1.25% (Chapter 23) results in a real interest rate of about 3.25% which is 5.67% in nominal terms. This contrasts with the Lazard nominal interest rate of 8%.

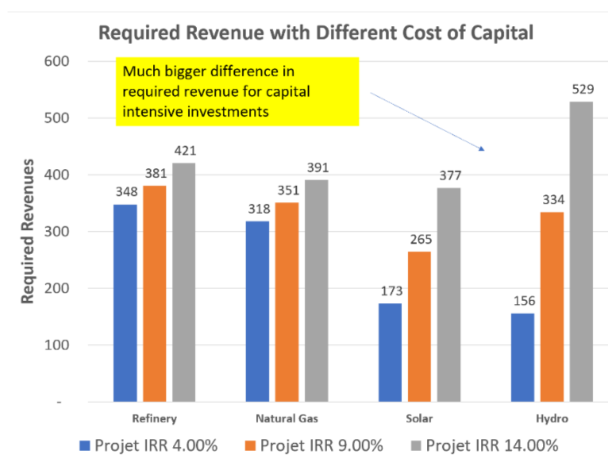
In terms of project finance, the three items for any project are represented by and Engineering, Procurement, and Construction (EPC) contracts; an O&M contract (that may include an energy supply contract); and a Purchased Power Agreement (PPA) that provides revenues. The adjacent very simple diagram of a project finance investment illustrates how capital expenditures, revenues and operating expenses drive the economics of any investment.

A more formal way of expressing the capital intensity is to compute capital investment divided by the periodic revenues necessary to produce a return. Almost by definition, investments that are made to mitigate emissions of greenhouse gasses substitute capital for fossil fuel and are more capital intensive. With more capital relative to operating expense, the cost of that capital which is more important to the overall cost in relative terms, and which is outstanding for a longer period is more important for capital intensive investments than for fuel intensive investments.



Correcting the Investment Analysis of Different Technologies for Inflation

A remarkable aspect of computing the levelised cost of an electric technology, of the total operating cost of transportation, or the required lease rate on an apartment building or the break-even cost of oil is that the measurement is often made on a flat nominal basis without any inflation adjustment to the price. In stark terms, this means that Basic idea in any analysis to evaluate real costs with real cost of capital and nominal costs with nominal cost of capital. To illustrate how capital intensity and the cost of capital affects capital intensive and fuel intensive investments, you can look at the two graphs in the adjacent inserts. The first graph shows the capital investment divided by revenues for a refinery, a natural gas combined cycle generating plant, a solar project, a hydro project and



a nuclear plant. The second insert uses the difference in capital intensity to illustrate the effects of different returns on overall capital (the pre-tax project IRR) for the most capital-intensive project (the hydro plant) and the least capital-intensive project (the refinery) and demonstrates that the cost of capital makes a much bigger difference for the capital-intensive project.

Inclusion of Externalities in LCOE

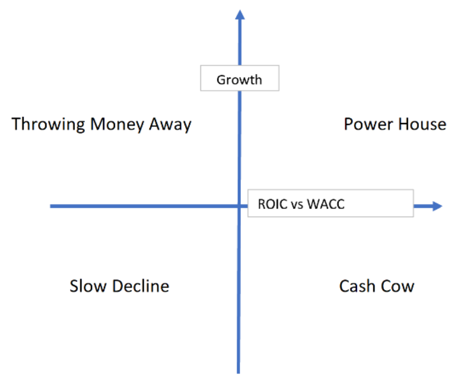
Once you have the capacity of an electricity plant it is relatively simple to compute the amount of CO_2 per ton that is emitted from a fossil fuel plant such as natural gas or coal. Computing the number is a bit more controversial for natural gas where the amount of leaked natural gas (methane) should be accounted for. Using the ratio of CO_2 equivalent tons to the amount of electricity produced (MWh), the tons can be computed and then the amount of tons can be multiplied by a price per ton of carbon such as the price per ton traded in Europe. The value is converted to a variable cost for the thermal plants and included in the economic analysis. This is the final line on the summary table above.

Chapter 12: Difficulty of Achieving Growth with High Returns and Using Greenwashing

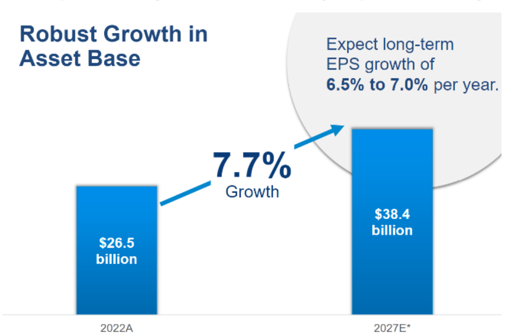
Make Utilities Boring Again

Discuss returns a lot. Returns from I begin with a different form of greenwashing that is more subtle and is an effective introduction to how finance theory should in my opinion be

introduced. The value is demonstrated with the classic value graph shown in the adjacent diagram. MBA students learn that the objective of a firm is to grow fast and earn a high rate of return. Much of the book works through the reasons why this growth objective and return object have very many nuances and ultimately refute comments by so many consultants.

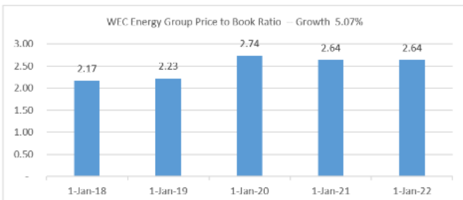


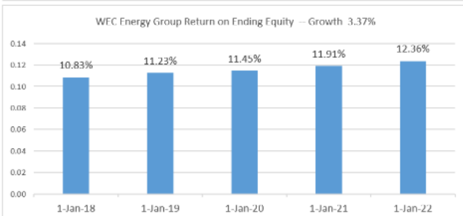
The greenwashing example I use is not an oil company investing in more production or a car company promoting pickup trucks and SUV's. It instead involves boring regulated electric and gas companies greenwashing by labelling investments as



environmentally beneficial in order to do what they really want which is to increase value to their shareholders by growing and earning returns that exceed their cost of capital. Investments made in distribution lines may have some environmental benefits, but to use the investments as a basis for asking for higher returns is an example of irritating greenwashing as well as the underlying motivations of corporations. I present this first example so that you can understand investments that are not made in a bidding context compared to investments that are labelled as environmental beneficial and increase returns to investors more than in necessary.

This regulated utility example demonstrates what should be the starting point in any discussion of finance. Investors want to earn a high return relative to risk and if this can be achieved, then they should want to grow the business. For most businesses this is a very complex process, but for regulated utility companies charge prices the basic idea is clear. The strategy has three prongs. First, achieve an allowed return that is more than the cost of capital. Second make the company a low risk as possible by gaining assurances from regulators. Third, label every investment as ESG (see the attractive couple in the picture) so you can grow your business. The pictures show this for the case of a utility company in the State of Wisconsin in the U.S. The first picture of the nice couple illustrates commitment to ESG. The second shows how they are making investments to address climate change. The third shows what they really want which is to make a lot of money for their investors as the rate of return is far higher than their cost of capital as demonstrated by the chart.





WEC Energy Group	1 Year	5 Year
Expected Growth in EPS	6.30%	5.70%
Past Growth in EPS		5.13%
Year Ago Earnings Mktwatch	4.40	
Forward P/E Ratio (Yahoo)	21.37	
P/E Ratio (Marketwatch)	22.06	
Trailing P/E (Marketwatch)	22.17	
Price to Book (Yahoo)	2.73	
Price to Book (Maretwatch)	2.60	
Return on Ending Equity		
ROIC Reported (Marketwatch)	5.56%	
ROE TTM (Yahoo)	12.39%	
ROE (Marketwatch)	12.61%	
ROE - Forward EPS	12.52%	
ROE - Second Yr EPS	12.78%	
Yahoo Beta (5Y monthly)	0.38	
MarketWatch Beta	Beta 0.54	

Illustration of Returns, Growth, Risk and Value - Simple Case to Demonstrate Value from Return and Growth

Using the value driver equation above and holding constant the current earnings and the cost of capital, I have made a whole lot of different scenarios with random draws of future return and growth to illustrate ranges in value. I have summarized the different values in the bubble chart[46] below. The graph demonstrates how value explodes as with both high return and high growth – the big blue bubbles. The graph also shows how growth with negative return can result in negative value – the circles without blue colour are negative values. The box at the bottom right shows that cash cows can still create value while the box at the bottom left shows that exiting a low return business can protect you against the worst-case values from positive growth and returns below the cost of capital. Note that this type of graph does not work with the P/E ratio or the EV/EBITDA ratio as both the numerator – value -- and the denominator – income driven by return -- change with different scenarios. The graph is made from the simplistic value equation without changes over time; the intention is to demonstrate the danger in not explicitly considering returns when measuring value.

[46] You can see how to make the bubble chart and watch an associated video at www.edbodmer.com

The bubble chart is not all that relevant or realistic because the returns, growth and the cost of capital are not constant, and companies can move from box to box quickly. When analysts make projections of a company and discuss things like how people will never be able to use a phone different from an Apple iPhone after they purchase one or how Tesla cars are so different from any other car that people will become addicted to the brand and never buy any other petrol or electric car. In short, the competitive advantage that allows companies to stay in the top right powerhouse square (not my term) may stay there for a long time because of creating addiction (think of how McDonald's starts with children and happy meals) or through real innovation (sorry about not recounting Porter's five forces in a more polite way).

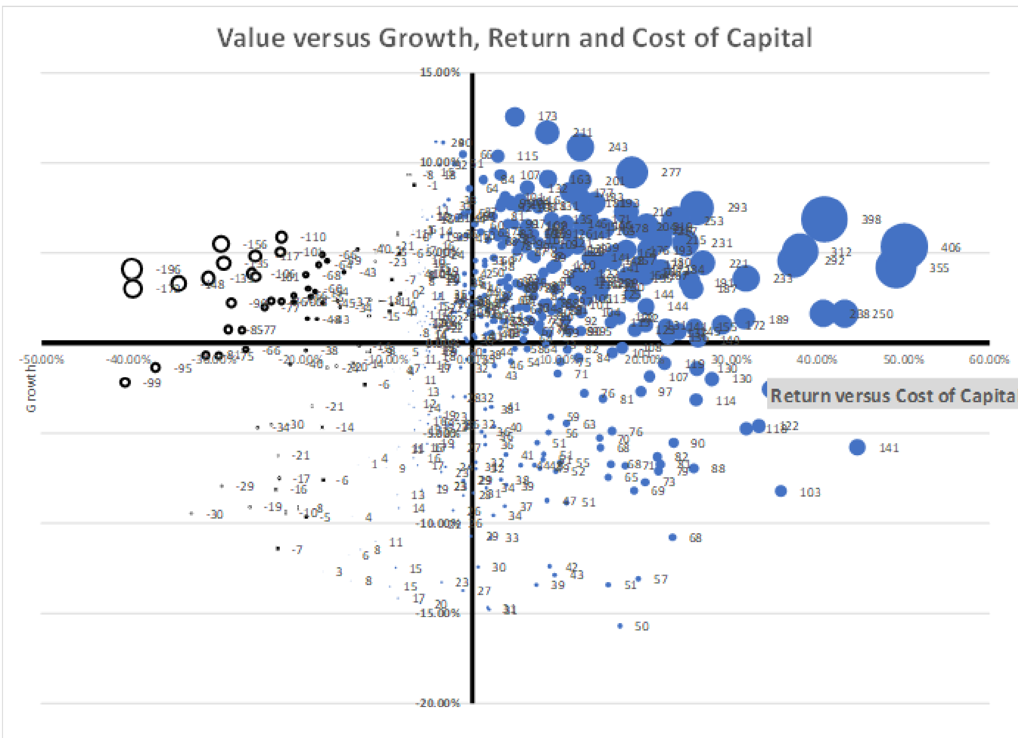


Illustration of Value Created from Assumed Stable Returns and Growth Illustrating Biggest Value in Box 1 and Negative Value in Box 2

IRR Growth and Yahoo Adjusted Stock Price from Re-investing Dividends

When you look at historic stock prices, you should use adjusted prices from finance.yahoo.com (that includes re-investment income from dividends) to compute the return (growth rate) you gained from an historic investment. This demonstrates that at the end of the day, valuation is about growth and that IRR is the same as growth rate when evaluating stocks.

To evaluate issues with valuation, growth and cost of capital I use the case of GE and Amazon at various points in this book. Not so long ago (for me because I am old), General Electric would have been considered a power-house company (the most valuable company in the world) as its CEO Jack Welch focused on earning high returns with his strong incentive programs for employees (every manager had to fire one of ten people every year) and his emphasis on growing through acquisition after which GE imposed similar policies to increase returns. There have been many Harvard case studies written supporting the policies of Welch. But things have changed a lot in the past decades. GE apparently made many acquisitions that did not work out. It became bloated and is now somewhere on the bottom boxes on Figure xxx. This is illustrated on figure xxx which shows the growth rate and an estimate of the ROIC for GE.

These days Amazon is a company that is much talked about with and high growth rate and an increase in return on invested capital (maybe it too will turn out like GE). As the return has increased and the growth is expected to continue, the stock price has exploded. This has allowed Jeff Bezos to pay his ex-wife 38 billion USD in a divorce settlement (Jack Welch only paid 180 million USD to his ex-wife in a much bitterer divorce). The Amazon case demonstrates that valuation is much about projecting return on investment – GE's ROIC declined, and Amazon's has increased. Figure xxx shows that the story of GE and Amazon can be explained by growth and ROIC for the two companies.

First Solar and Moving from the Powerhouse Matrix to the Surplus Capacity Square

In teaching my classes I have tried in the past to find case studies that are relevant to subjects I teach so I go onto the HBS website and sometimes spend money on what seems to be a relevant case. Even though the cases only cost a few dollars, they are generally a waste of money and I find the manner in which they praise companies very irritating.[47] One example is a case written by Stanford professors that praised First Solar Corporation. When the company went public, First Solar seemed to be an ideal example of a powerhouse company. According to the case (written by Stanford), the company was the leader in solar manufacturing using a production method called thin film (that now has a small portion of the market) and it was in an industry that was clearly going to grow. The case begins as follows: "Sitting in his office in Tempe, Arizona, Bruce Sohn reflected on his three-year tenure as president of First Solar, and on the remarkable achievements of the exceptional people he had worked with for the past seven years. First Solar had been in operation for only 10 years but had managed to cross the 1 gigawatt threshold in terms of annual solar module production capacity and to achieve a sub $1.00 cost per watt of electricity—the lowest in the industry." Figure XXX which is an excerpt from a Value Line analyst report shows that analysts believed growth would be above 23%

[47] FIRST SOLAR, INC. IN 2010, Stanford Business School, CASE: SM-190 DATE: 10/01/10

while the company was to earn a return on capital of 17.5% (I will explain later why these reports are not some kind of dinosaur reports that are irrelevant in the face of Bloomberg). This resulted in an estimated stock price range of between 295 and 445 as shown in the top Figure XXX. But solar panels are not like iPhones and factories that make panels are not that difficult to build. Chinese companies entered in the market and within a short period the stock price dropped to 32 as the company was in the box where there is surplus capacity and any investment made is throwing money away. This example illustrates the danger of powerhouse companies moving to the left into the worst matrix and that has surplus capacity and then not being able to exit the business.

FIRST SOLAR, INC. NDQ-FSLR | RECENT PRICE **124.65** | P/E RATIO **13.3** (Trailing: 17.8 Median: NMF) | RELATIVE P/E RATIO **0.82** | DIV'D YLD **Nil** | **VALUE LINE**

TIMELINESS 4 Lowered 5/13/11
SAFETY 3 Raised 4/3/09
TECHNICAL 2 Raised 7/1/11
BETA 1.40 (1.00 = Market)

2014-16 PROJECTIONS

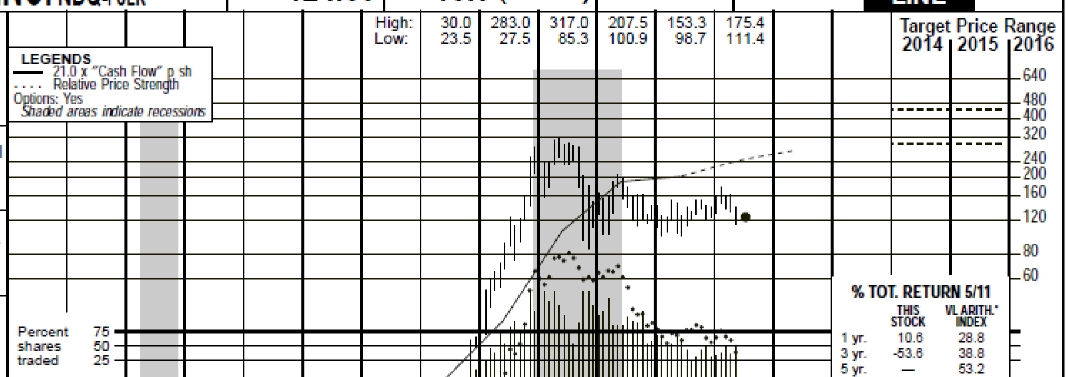
	Price	Gain	Ann'l Total Return
High	445	(+255%)	37%
Low	295	(+135%)	24%

Insider Decisions

	A	S	O	N	D	J	F	M	A
to Buy	1	0	0	0	0	0	0	0	0
Options	3	2	3	4	3	3	5	2	1
to Sell	4	4	3	6	3	4	9	5	2

Institutional Decisions

	3Q2010	4Q2010	1Q2011
to Buy	193	189	172
to Sell	148	167	191
Hld's(000)	56722	58678	62428



First Solar was founded in 1999 with the goal of applying new technologies to the process of solar power generation. The company initially conducted only research and development operations, until commercial operations began in January 2002. The company went public in November 2006, issuing 22.9 million shares at $20 each, in a deal underwritten by Credit Suisse and Morgan Stanley.

CAPITAL STRUCTURE as of 3/31/11
Total Debt $131.7 mill. **Due in 5 Yrs** $131.7 mill.
LT Debt $103.5 mill. **LT Interest** $0.1 mill.
(3% of Cap'l)

Leases, Uncapitalized Annual rentals $8.4 mill.

No Defined Benefit Pension Plan

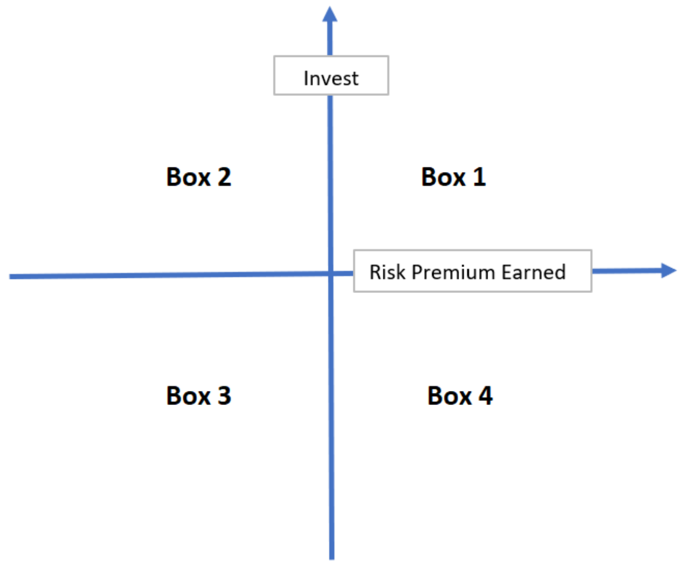
Common Stock 86,160,700 shs.
as of 4/29/11
MARKET CAP: $10.7 billion (Large Cap)

CURRENT POSITION ($MILL.) 2009 2010 3/31/11

2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	© VALUE LINE PUB. LLC	14-16
--	--	--	--	1.06	1.87	6.41	15.27	24.24	29.86	**42.50**	**53.65**	Sales per sh A	**84.20**
--	--	--	--	d.07	.20	1.73	5.00	9.03	9.55	**11.60**	**13.15**	"Cash Flow" per sh	**17.40**
--	--	--	--	d.14	.07	1.43	4.24	7.53	7.68	**9.40**	**10.70**	Earnings per sh A B	**14.85**
--	--	--	--	--	--	--	--	--	--	**Nil**	**Nil**	Div'ds Decl'd per sh	**Nil**
--	--	--	--	.94	2.12	3.08	5.63	3.28	6.86	**12.50**	**6.75**	Cap'l Spending per sh	**9.45**
--	--	--	--	.29	5.69	13.96	18.54	31.13	40.25	**48.50**	**58.65**	Book Value per sh	**81.20**
--	--	--	--	45.21	72.33	78.58	81.60	85.23	85.84	**88.00**	**89.00**	Common Shs Outst'g C	**95.00**
--	--	--	--	--	NMF	73.1	50.7	19.3	16.5	*Bold figures are*		Avg Ann'l P/E Ratio	**25.0**
--	--	--	--	--	NMF	3.88	3.05	1.29	1.06	*Value Line*		Relative P/E Ratio	**1.65**
--	--	--	--	--	--	--	--	--	--	*estimates*		Avg Ann'l Div'd Yield	**Nil**
--	--	--	--	48.1	135.0	504.0	1246.3	2066.2	2563.5	**3740**	**4775**	Sales ($mill) A	**8000**
--	--	--	--	NMF	9.6%	32.1%	39.9%	39.2%	35.3%	**30.5%**	**28.0%**	Operating Margin	**25.0%**
--	--	--	--	3.4	10.2	24.5	59.5	129.6	156.1	**205**	**225**	Depreciation ($mill)	**275**
--	--	--	--	d6.6	4.0	111.7	348.3	640.1	664.1	**815**	**947**	Net Profit ($mill)	**1380**
--	--	--	--	--	56.7%	28.4%	24.9%	6.7%	12.8%	**13.0%**	**15.0%**	Income Tax Rate	**20.0%**
--	--	--	--	NMF	2.9%	22.2%	27.9%	31.0%	25.9%	**21.8%**	**19.8%**	Net Profit Margin	**17.2%**
--	--	--	--	d7.3	336.4	616.0	695.6	956.4	1114.8	**1630**	**2205**	Working Cap'l ($mill)	**3630**
--	--	--	--	28.6	61.0	68.9	163.5	146.4	210.0	**210**	**210**	Long-Term Debt ($mill)	**210**
--	--	--	--	13.1	411.4	1097.3	1513.0	2652.8	3455.0	**4270**	**5215**	Shr. Equity ($mill)	**7715**
--	--	--	--	NMF	.9%	9.8%	20.9%	23.0%	18.1%	**18.0%**	**17.5%**	Return on Total Cap'l	**17.5%**
--	--	--	--	NMF	1.0%	10.2%	23.0%	24.1%	19.2%	**19.0%**	**18.0%**	Return on Shr. Equity	**18.0%**
--	--	--	--	NMF	1.0%	10.2%	23.0%	24.1%	19.2%	**19.0%**	**18.0%**	Retained to Com Eq	**18.0%**
--	--	--	--	--	--	--	--	--	--	**Nil**	**Nil**	All Div'ds to Net Prof	**Nil**

Alternative Competitive Strategy and Valuation Matrix

In thinking about valuation, careers and relationships, I suggest a different way to look at the competitive strategy graph to evaluate different valuation models over the life of an investment or the life of a corporation or your own life. The first thing I changed is the growth rate on the vertical axis. I argue that with the exception of inheriting money and marrying into money, you cannot realize grow without making some kind of investment. The competitive strategy graph implies that you can grow money without making investments like those adverts you get on YouTube explaining that you can make really big profits without taking any risk. Even if you have incredible skills which allow you to earn a large fortune (like Zinedine Zidane), you have to make some kind of investment in skill development to realize your return. Second, I have changed the rate of return versus WACC to the earned risk premium on your investment to emphasize difficulties in measuring return and the cost of capital. The graph with ROIC/WACC does not adequately emphasize that the bottom right box may have lower growth, but it also may come along with a lot lower risk. The ROIC/WACC scale also is deceptive in that it makes it seem that you can easily compute the WACC. So, on the horizontal scale I have put the risk premium relative to the risk-free rate. Figure xxx illustrates the revised matrix with the four boxes marked.

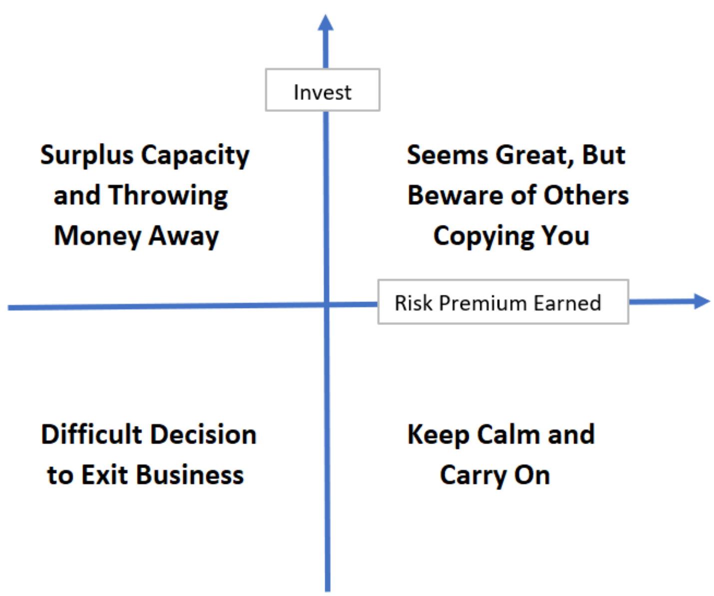


Gerald and the Queen's Handbag

I replace the trite descriptions on Figure xxx like "stretched balance sheet" which means absolutely nothing with hopefully more relevant actions related to valuation in Figure yyy. The revised matrix in Figure yyy suggests there are big risks of being in the powerhouse square (box 1); the ability to see when surplus capacity is coming (box 2); the importance of making decisions to exit failing businesses (box 3); and the benefits of a low growth and stable business (box 4) which I label keep calm and carry on. The

revised business makes me think of one of the people I admire in business, my good friend and uncle, Gerald. Gerald began working in the early 1960's by borrowing money for a VW and selling leather goods out of the back seat. In 1982 he purchased a bankrupt leather goods manufacturer that happened to have the royal warrant to sell handbags to the queen of England. Over the years he experienced quality problems; he ran a gifts business where he bought goods from Asia and sold them to teenagers; he purchased a trade magazine; he had normal difficulties with employees, and he developed the leather goods business. He made investments in developing a website; a consultant who publicized the handbags; a small showroom in London; inventories of leather raw materials from Italy; in researching different luxury good styles; and in carefully developing relationships with the royal family. During the queen's seventieth jubilee when Gerald had his 90th birthday, his success became apparent. Gerald's handbag was prominently displayed in a video with the queen and Paddington Bear and also in a drone light show. Gerald is not really rich, but he lives a comfortable life.

When I went swimming with Gerald in America a few years ago, a woman who was swimming in the pool gave Gerald some suggestions about growing his business and paying for space in department stores and dealing with the queen. Gerald is normally calm and affable, but upon leaving the pool he could not stop shout ing swear words about this woman. How presumptuous for somebody with no real knowledge of the business to give him consulting advice and in particular having him risk his competitive advantage associated with the queen. The implicit idea was that Gerald should aim for the powerhouse square with higher growth (Box 1) and turn his little company into something like Gucci. Instead of making large investments that would have been required to grow fast and probably fail (Box 1), he saw the surplus capacity coming for his gifts business (box 2) and he got out of the gifts business which left him with a warehouse of useless inventory (Box 3), and he made the moderate investments to change leather goods business to be more on-line focused that arguably made him end up in Box 4. He did not hire McKinsey; he certainly did not make elaborate financial models, and he did not measure his ROIC or his cost of capital. Instead, he made limited and flexible investments that were low risk (he could get out), and he was not afraid to exercise the option to exit investments. He implicitly used probability analysis in making his investment decisions and he knew what to do in moving from box to box in the competitive strategy graph. I have written this story to suggest that Box 1 may not be the best place aim for or to be (in project finance, the objective is to get a boring investment that insurance companies want); to emphasize that you should be



more creative in thinking about valuation analysis than trying to compute the net present value (using probability analysis and considering the flexibility of investments), and that you can assume range in upside cash flows is the same as the range in downside cash flows. I could on and use Gerald as a lesson for managing your career, but I must stay on the subject.

Small Differences in Returns Over Time Can Lead to Really Big Changes in Value

When comparing GE and Amazon, the criteria used was the growth rate of the assumed investment. If you would have invested in Amazon, an investment of 100 would have given you 80,000. Maybe with this little 100 investment, you could have bought a fancy car or funded you children's education. The example demonstrates that if you see an investment that has a return above 20% (if you are measuring returns with high inflation, this growth rate must be above inflation), you should probably be skeptical. On the other hand, if you bought GE stock, you would be anxious and frustrated and these negative feelings would be reflected in the negative IRR. So, the question addressed in much of the remainder of this book is using the IRR as a metric to assess all kinds of investment decisions.

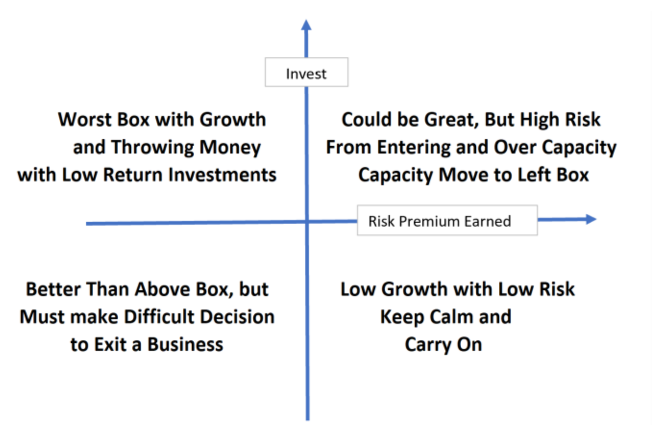
In the graph you can see that different growth rates produce dramatic results. For example, the IRR for Amazon of 30.55% does not seem that much more than the IRR of Apple of 26.41%. But this difference leads to accumulation of about 400 for Apple versus more than 800 for Amazon – you get twice as much when you look at the y-axis. The difference between the return of Siemens versus of 7.43% versus .82% for GE means that your money would have grown by 6 times if you invested in Siemens while it would have remained about constant if you invested in GE. The point is that small differences in IRR make a big difference in the money you accumulate – especially over the long term (the results would be much less dramatic with shorter lives). Another way of saying this is that the WACC is a big assumption in valuation analysis if the analysis is based on computing present value. The value of a corporation assumes implicitly or explicitly that the company with have an indefinite life – a very long-term perspective.

Thinking Differently about Growth, Return and Value from the Perspective of a Single Firm, Lower Growth and Lower Risk Can Create Value

Throughout the book I question fundamental ideas that are the foundation of risk and return and are the root of finance theory. I do this by illustrating financial model examples at the level of individual projects or companies. My approach of evaluating issues at the level of the firm is a different way of evaluating climate change issues relative to macro questions of whether a global transition can work or whether decrossiance (a French word for reduced growth) is necessary. I suggest that evaluating issues at a firm level can be extended to the entire society. For example, evaluating the costs of energy storage together with solar power, it is more interesting to study the question for a village in Africa than to listen to an Australian spout off about the number of hours of storage necessary to move power from the summer to the winter in Germany.

When listing to commentaries about climate change, I hear many people commenting on GDP growth and the suggesting that economic growth must stop for to combat climate change. I do not enter into this debate, nor whether payments to divorce lawyers that can increase GDP growth are really beneficial. But I do address the issue of growth at the level of individual firms. Growth of revenues and income for the aggregate of individual firms adds up to most of the GDP which in real terms is about 2% for developed economies. When you understand that revenue growth without return does not add value and fast revenue growth often comes along with higher risk, you can see that neither companies nor the economy as a whole needs fast revenue growth to thrive. More value can potentially be created with investments like those related to climate change which often seem a little less exciting in terms of growth and have less risk.

The matrix discussed above that shows growth, return and value can be misleading and includes nuances that involve not only the way one can think about valuation, but also about your personal life. The fundamental question is whether it is always better to take the high growth path even when this path involves taking more risk. MBA's and businesspeople certainly do strive for both high growth and high return without paying enough attention to the nuances of the cost of capital. This incentive to grow ultimately leads to consumers needing new 5G iPhones; taking an extra trip to Disney World to experience the newest ride; buying a more powerful 4x4 Ram pickup truck; installing a heated swimming pool and accumulation of many other things.



More careful thinking about finance demonstrates that graphs of growth and return do not lead to the simple idea that growth produces value. First when make some simple simulations with a little modelling, you quickly see that it is the combination of return relative to risk and growth that leads to high value. If you grow in the short-term or the long term without earning a return above the cost of capital, the growth doesn't mean anything. Second, companies with higher growth and high returns tend to have more risk associated with competitive pressure and surplus capacity which means that growth comes along with higher risk and may not produce value. When you see that it may be better to be in the keep calm and carry on box, you can extend the idea to the entire economy with the result that more value is generated from boring investments. As I have already suggested, investments that combat generally (of course no always) tend to be relatively boring and their valuation objective is to be in the keep calm an carry on box. In the next paragraphs you will see by comparing the multiples for oil companies versus renewable companies the preference for boring companies.

Example of Cost of Capital Sensitivity

Why use this company. Was testifying. Normally would not waste much time on the this kind of analyst report.

It is common to make a data table that illustrates the effects of ranges in the cost of capital and the terminal growth on the value of a company. WACC and terminal growth tables where the value skyrockets with lower WACC and with higher terminal value. This is not an accident. Small differences in IRR do produce large differences in value. These tables that show very high variation in results that depend on the cost of capital is a backwards way of saying small differences have a really big impact on value. It is understandable why when talking to people who work in financial analysis, they want to avoid the cost of capital question completely. Note that the graphs above with the IRR had nothing at all about the cost of capital.

Do analysis of actual value of the company.

We always find the greatest challenge with the ITC story coming from valuation, largely because there is no good comp group for the stock. Accordingly, we focus our efforts predominately on DCF valuation to take into account the large capital spending program over coming years and higher level of free cash generation at the end of the capital investment cycle. Exhibits 4 and 5 look at implied fair values for ITC under different discount rate and terminal value assumptions. Using the two methodologies (terminal multiple and perpetual growth), we are comfortable with a $46 fair value for the stock before taking into account the incremental value drivers identified in Exhibit 1.

Exhibit 4: DCF Valuation: Terminal Multiple

Terminal EBITDA Multiple	Discount Rate						
	5.70%	5.80%	5.90%	6.00%	6.10%	6.20%	6.30%
9.25x	43.82	42.87	41.94	41.02	40.11	39.22	38.33
9.50x	45.64	44.67	43.72	42.78	41.85	40.93	40.03
9.75x	47.46	46.47	45.49	44.53	43.58	42.64	41.72
10.00x	49.28	48.27	47.27	46.28	45.31	44.35	43.41
10.25x	51.10	50.07	49.05	48.04	47.05	46.07	45.10
10.50x	52.92	51.86	50.82	49.79	48.78	47.78	46.79
10.75x	54.74	53.66	52.60	51.55	50.51	49.49	48.48

Source: Company data, Credit Suisse estimates

Exhibit 5: DCF Valuation: Perpetual Growth

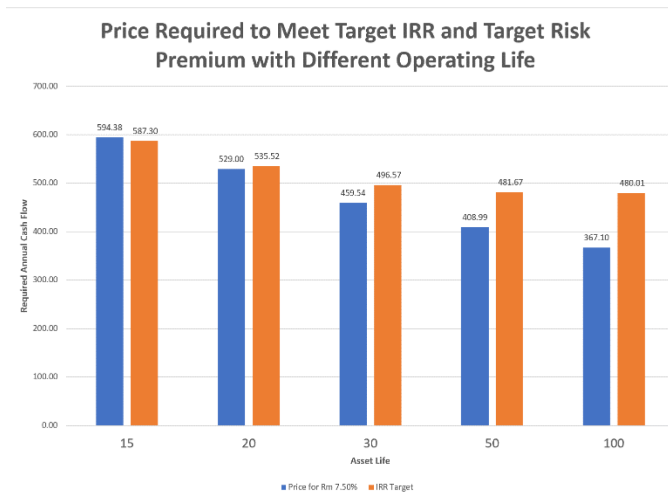
Terminal Growth Rate	Discount Rate						
	5.70%	5.80%	5.90%	6.00%	6.10%	6.20%	6.30%
2.50%	48.33	45.18	42.22	39.43	36.80	34.33	31.98
2.60%	50.72	47.40	44.28	41.36	38.60	36.01	33.56
2.70%	53.27	49.76	46.48	43.40	40.51	37.79	35.22
2.80%	55.99	52.28	48.81	45.57	42.53	39.67	36.98
2.90%	58.91	54.98	51.31	47.88	44.67	41.67	38.84
3.00%	62.05	57.86	53.97	50.35	46.96	43.79	40.82
3.10%	65.43	60.97	56.83	52.98	49.40	46.05	42.92

Source: Company data, Credit Suisse estimates

Chapter 13: Shell Exit from Renewable Energy; Rate of Return and Introduction to Multiples

NPV, IRR and Risk Premium -- Penalizing Capital Investments that Combat Climate Change by Using the IRR Metric

After reviewing the basic objectives of a corporation, I move to discussion of the fundamental rule in finance, that is to invest when the net present value is positive. This rule has correctly been changed to compare investments with different returns across different scenarios using the IRR statistic. Despite what some academics may teach you in business school, the IRR is used rather than the NPV in real world analysis these days. And using the IRR makes a lot of sense relative to using NPV to assess investments because you do not have to start with the discount rate.



But the IRR has the headache of assuming that money received can be re-invested at the IRR itself. This re-investment headache penalizes long-term capital-intensive investments such as hydroelectric, nuclear and solar which involve large expenditures for up-front capital relative to operating expenses. I argue that a better method to evaluate investments that does not penalize long-term investments is to first compute the premium above the cash flows measured at the risk-free rate and then to allocate the premium over the life of the investment. If the IRR is corrected to compute earned risk premium relative to the risk-free rate, the penalty imposed on the type of long-term investments that are essential for adapting to or mitigating climate change is reduced as shown on the adjacent graph.

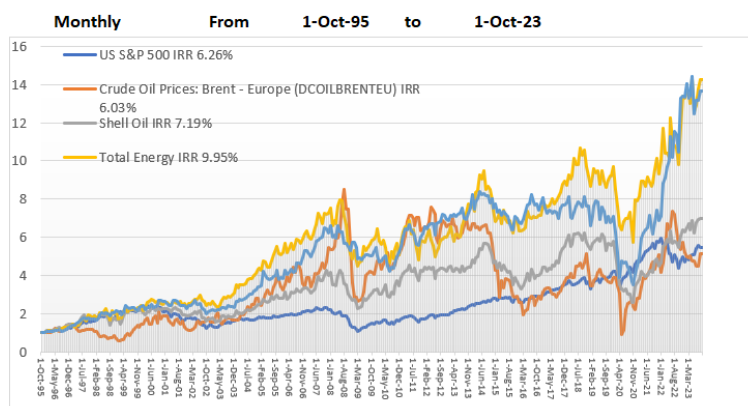
Distortions in Measuring Return and Shell's Exit from Renewable Energy Investments.

In Chapter 6 the book moves to practical measurement of the return. As the rate of return is central to the fundamental ideas in finance, the measurement of return is essential. To discuss the measured rate of return and the central problem with measuring return, I use the case of Shell Oil and its partial withdrawal from renewable energy investments to "focus on shareholder return." Shell's strategy seems to reflect the stock price increases that are lower for Shell than other major oil companies and the ROIC of Shell was lower as well as shown in the graphs. Note that the returns shown on the stock price graph are adjusted for inflation. The Shell and Exxon case may be a bit stylized, but it can be used to illustrate how conventional financial statement analysis and finance practice works against capital intensive investments with relatively low cost of capital.

> Shell's CEO Wael Sawan has revised the company strategy to focus on shareholder return. According to the company, the renewable transition must be paired with higher earnings.
>
> https://www.reuters.com/business/energy/shell-pivots-back-oil-win-over-investors-sources-

	IRR	Vol	Beta
US S&P 500	6.26%	16.31%	1.00
Crude Oil Prices: Brent - Eu	6.03%	44.65%	**-0.13**
Shell Oil	7.19%	23.60%	**0.83**
Total Energy	9.95%	24.22%	**0.80**
Exxon Mobil	9.79%	21.18%	**0.68**

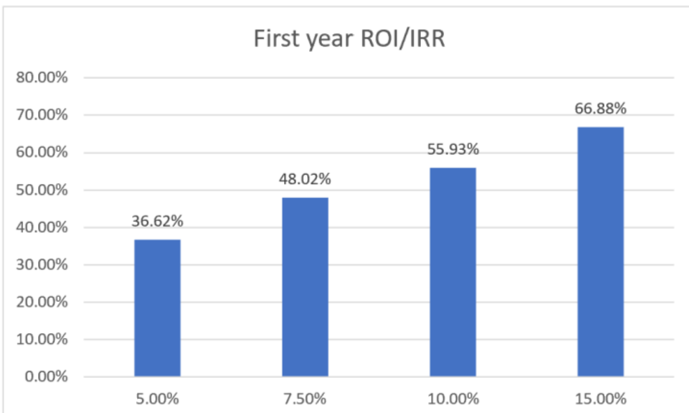
	Series Start	Final	Years
US S&P 500	1-Oct-95	5.47	28.00
Crude Oil Prices: Brent - Eurc	20-May-87	5.15	
Shell Oil	1-Nov-94	6.98	
Total Energy	1-Nov-91	14.25	
Exxon Mobil	1-Jan-85	13.67	



To contrast oil production and renewable energy companies I have extracted some companies that have a lot of renewable investments as well as some of the oil majors. You can see that the renewable companies such as NextEra, EDP and other companies have lower and more stable computed return on invested capital in the table below.

ROIC - Simple Invested Capital					
	2018	2019	2020	2021	2022
Nextera	3.98%	3.66%	4.12%	6.10%	6.74%
Ibederola	6.13%	6.49%	5.96%	6.29%	7.69%
EDP Renovaveis S/A	3.96%	4.64%	3.79%	3.20%	3.92%
ORSTED A/S	-0.22%	-0.21%	-4.58%	-1.05%	3.28%
Shell Oil	7.12%	5.03%	-3.63%	7.73%	12.90%
Total Energy	8.21%	8.16%	1.80%	13.08%	26.90%
BP Oil	5.35%	1.98%	-6.12%	3.56%	-11.66%
Exxon Mobil	5.74%	3.23%	-1.36%	8.90%	21.77%
Cheveron	6.01%	3.48%	-1.53%	7.75%	19.60%
Saudi Aramco	44.48%	33.75%	14.97%	31.19%	41.81%

Shell's change in strategy away from renewable investments is consistent with ideas propounded by McKinsey. The simple idea stated repeatedly in the McKinsey book is that a company should search out investments that earn a return on capital greater than the weighted average cost of capital. "As we will show, a company's return on invested capital (ROIC) and its revenue growth together determine how revenues are converted to cash flows (and earnings)." Investors of course want to earn a higher return all else equal and do not want companies to make investments that earn a negative return. The issue discussed in Chapter 4 involves how to measure the economic on an investment. The problem addressed is that the accounting definition of return from net operating income and net capital on the balance sheet does not reflect the growth in cash flow that is the definition of the rate of return or the IRR. This is compounded by accounting adjustments for impairments and other write-offs. For any investment that is depreciated with straight line depreciation, the return on invested capital is lower that the economic rate of return as measured by the project IRR. The discount for the initial return is illustrated in the adjacent graph where the initial rate of return from accounting statements is divided by the project IRR. When a company makes large investments and these investments have a relatively low return, the reduction in return is aggravated.



When returns are measured in the context of inflation, the true bias in accounting returns relative to project IRR is more extreme. Throughout the book, adjustments for inflation are emphasized. In the adjacent table the difference between accounting returns and the project IRR is more extreme when there is inflation. For example, if the project IRR is5% and the inflation rate is 2%, then the accounting return in the first period is only 1.83%. As assets depreciate on the books, the difference between the accounting return and the project IRR reverses, meaning that the accounting return is above the IRR. In terms of Shell and Exxon, Exxon has made lower investments than Shell in the past couple of years, which can in part explain the difference in the return. The Shell and Exxon case demonstrates the many problems with simple statements about increasing shareholder return. The difference is much more dramatic for renewable energy companies, implying that the returns cannot be compared across companies.

First Year ROIC with Different Inflation and IRR

		Inflation Rate			
		0.00%	**1.00%**	**2.00%**	**3.00%**
	5.00%	3.17%	2.48%	1.83%	1.23%
IRR	**7.50%**	5.13%	4.35%	3.60%	2.89%
	10.00%	7.27%	6.42%	5.59%	4.80%
	15.00%	11.90%	10.96%	10.03%	9.12%

Cap Exp/Depreciation	2018	2019	2020	2021	2022
Nextera	144.82%	247.32%	179.63%	185.99%	203.34%
Ibederola	175.41%	142.71%	146.25%	164.37%	144.16%
EDP Renovaveis S/A	161.31%	201.99%	249.38%	378.33%	325.47%
ORSTED A/S	245.15%	327.26%	355.20%	433.75%	338.56%
Shell Oil	102.49%	89.20%	65.20%	80.96%	98.82%
Total Energy	131.64%	75.14%	75.46%	90.86%	131.89%
BP Oil	106.82%	84.55%	80.47%	71.80%	82.35%
Exxon Mobil	108.42%	128.89%	83.44%	58.61%	76.58%
Cheveron	70.88%	75.09%	50.25%	43.11%	67.21%
Saudi Aramco	316.45%	242.32%	134.87%	139.40%	153.97%

Reconciling ROIC and IRR and Returns on Oil Production Versus Renewable Investments

Chapter 7 continues the discussion of finding the returns earned by companies and of returns and where I argue that for individual projects, economic depreciation that measures the decline in value of remaining cash flows should be used. This leaves the problem of measuring the return that is available on prospective projects. In the case of Exxon and Shell one could go back to history where John D. Rockefeller created the Standard Oil monopoly that made him the richest person in the world. But the essential question for valuation is what returns are reasonable in the future and how can one find these returns.

> Returns from oil and gas typically range between 10% to 20%, while those for solar and wind projects tend to be between 5% to 8%, according to companies and analysts.
>
> https://www.theguardian.com/business/2023/nov/02/shells-moves-ahead-with-35bn-shareholder-windfall-despite-profits-fall

The insert suggesting that oil companies can earn up to 20% on oil projects but only between 5% and 10% for renewable energy. This comment demonstrates several issues related to issues discussed in Chapter 7 and subsequent chapters. First, is there evidence that oil companies can earn the high returns on oil investments. Second, how should the lower returns be evaluated relative to the cost of capital. Third, do lower returns imply that only the oil investments should be made.

Before discussing the issues with evaluating earned returns, I recount some comments made by a student of mine who formerly worked for the investor relations department of a major oil company (Total Energies). She explained that the company received intense pressure from (English speaking) stock analysts to invest in oil investments rather than renewable investments. An old excerpt from Exxon illustrates the way presentations of returns are made to investors. The return on capital employed (ROIC) is presented next to the capital expenditures to demonstrate that the company is making investments in activities that produce the highest return. If the type of returns shown in the table for upstream oil production are really obtainable and can continue (31% and 22.7% outside the U.S.) this illustrates the kind of monopoly power that John Rockefeller must have obtained. This time the returns unfortunately come from developing countries that must have signed contracts that do not share profits in a reasonable way. If the returns are lower on renewable energy investments, this is either due to

Exxon Mobil Return on Capital Employed – Where are they making expenditures

	Earnings After Tax		Average Capital		Return on Capital		Capital Expenditures	
Financial	2003	2002	2003	2002	2003	2002	2003	2002
					(percent)			
Upstream								
United States	3,905	2,524	13,508	13,264	28.9	19	2,125	2,357
Non-U.S.	10,597	7,074	34,164	29,800	31	23.7	9,863	8,037
Total	14,502	9,598	47,672	43,064	30.4	22.3	11,988	10,394
Downstream								
United States	1,348	693	8,090	8,060	16.7	8.6	1,244	980
Non-U.S.	2,168	607	18,875	17,985	11.5	3.4	1,537	1,470
Total	3,516	1,300	26,965	26,045	13	5	2,781	2,450
Chemicals								
United States	381	384	5,194	5,235	7.3	7.3	333	575
Non-U.S.	1,051	446	8,905	8,410	11.8	5.3	359	379
Total	1,432	830	14,099	13,645	10.2	6.1	692	954
Corporate and financing	1,510	(442	6,637	4,878	—	—	64	77
Merger related expenses	—	(275	—	—	—	—	—	—
Discontinued operations	—	449	—	710	—	63.2	—	80
Accounting change	550	—	—	—	—	—	—	—
Total	21,510	11,460	95,373	88,342	20.9	13.5	15,525	13,955

lower monopoly profits or lower cost of capital or both. The lower returns in no way imply that the investments should not be made.

Chapter 8 moves to the question of whether one can assess value using multiples including the price to earnings ratio, the EV/EBITDA ratio or the price to book value ratio. The three ratios tell you very different stories and, depending on the industry, they can be inappropriate to compare companies even if they are seemingly doing the same thing. The Shell and Exxon case illustrates some of the ways the multiples can be distorted. In discussing Shell's reduction in renewable investments, Reuters presented a graph that seemed to show that a Euro or Dollar of Cash Flow from Exxon is worth more than a dollar of cash flow from Shell. This is something like the EV/EBITDA Ratio shown below. The lower earnings is not because of current lower return on one segment of the business of a company such as renewables versus oil production. It reflects expectations of changes in returns, differences in tax rates (Shell has a much higher tax rate than Exxon) and the age of assets (older assets have lower EV/EBITDA because of pending capital expenditures) among other items. Shell's very low EV/EBITDDA at the end of 2022 of 3.61 (the value can be repaid in less than four years of EBITDA) can be the result of expected declines in income. More importantly, the table below shows that investors pay a lot more for a Euro of earnings in renewable energy companies even though the returns are lower.

EV/EBITDA					
	2018	2019	2020	2021	2022
Nextera	13.75	18.57	22.26	19.85	15.66
Ibederola	8.52	9.59	10.88	8.09	7.88
EDP Renovaveis S/A	8.91	9.14	18.05	20.73	16.86
ORSTED A/S	34.70	47.28	390.11	64.85	19.12
Shell Oil	6.11	6.42	12.35	4.54	3.61
Total Energy	5.55	5.38	8.73	4.35	2.71
BP Oil	5.12	5.07	15.02	4.77	2.15
Exxon Mobil	8.52	11.13	14.76	6.26	5.13
Cheveron	6.91	8.53	14.23	7.34	6.01
Saudi Aramco	-.12	8.85	15.91	8.39	5.45

Discussion of multiples in Chapter 8 addresses differences in interpreting alternative multiples. Recall the statement made by McKinsey that "In addition to higher returns in the United States, P/E and market-to-book ratios have been significantly higher for the U.S. …" The implication of the P/E ratio is completely different than the market-to-book (price-to-book) ratio. The P/E ratio reflects expectations of growth combined with earnings above the cost of capital. The price-to-book ratio in theory reflects the success of a company in deploying the paid in capital and retained earnings put in a company by investors. Success is measured by the ability of a company to earn returns above the cost of capital (often one sort of monopoly power or another). The table below shows that renewable companies have performed well in terms of the price ratio, implying the cost of capital is much lower than that of the oil companies. One can go too far with this ratio as it can say more about monopoly power than anything to do with efficiency or productivity. More importantly the ratio can be used to evaluate the cost of capital relative to the rate of return.

Price to Book Ratio						
	2018	2019	2020	2021	2022	2023
Nextera	2.17	2.30	3.21	3.96	4.59	3.66
Ibederola	1.16	1.23	1.66	1.82	1.57	1.58
EDP Renovaveis S/A	.90	.96	1.21	2.23	2.31	1.98
ORSTED A/S	2.13	2.55	3.36	7.30	4.86	FALSE
Shell Oil	1.28	1.33	1.52	.83	.76	.44
Total Energy	1.20	1.18	1.50	.96	1.08	1.19
BP Oil	1.30	1.39	1.86	.96	1.14	1.11
Exxon Mobil	1.86	1.61	1.90	1.07	1.32	2.12
Cheveron	1.51	1.44	1.70	1.21	1.41	1.98
Saudi Aramco	.00	.00	6.54	6.33	4.86	4.47

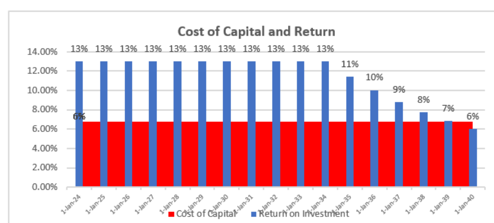
Terminal Value and Value of Assets that Depend on Fossil Fuel

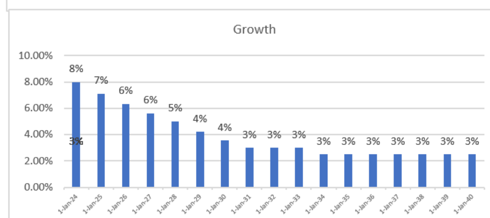
Chapter 10 addresses what may be the most subjective and uncertain part of valuation which is the terminal value. Terminal value comes from the idea that a company is assumed to have an infinite life when making a valuation. Current finance practice applies simple and arbitrary formulas to measure the value of a company over an infinite horizon without seriously thinking about where the value comes from. You must assume that future generations of managers can earn returns above the cost of capital on replaced assets. To presume that this can be boiled down to a simple formula should seem crazy to people outside of finance. I suggest a process where growth rates and returns gradually decline to reach reasonable levels. But I suggest that the issue of terminal value (that cannot be avoided) should be treated as more of a philosophic question.

Stable Period Adjstment to Growth Method — Higher Return, Lower Growth

	Theoretical Value	Growth Rate	Value Driver Basic	Value Driver Sudden	Value Driver Fade Period
Value of Corporation	**154.87**	**268.53**	**214.89**	**139.80**	**155.06**
Driver (g or ROIC)		2.50%	6.00%	6.00%	013% -- 006%

Price to Book	1.55	
Price to Earnings	11.91	Lower Final Terminal Return Ext
Explicit Period	10	
Fade Period	6	Decreasing Growth Case
Cost of Capital	6.80%	
Terminal Period	12-Jan-34	Value Driver Basic = Income * (1-g/ROI)/(k-g)
End of Post Terminal	12-Jan-40	Value Driver Basic = Capital * ROI * (1-g/ROI)/(k-g)





When thinking about issues with terminal value I thought there may be little that relevance to climate change investments.

But on reflection, comparing the value of oil companies with renewable companies demonstrates some issues discussed in the chapter on terminal value. To illustrate issues with terminal value, pretend you were valuing Exxon when John D Rockefeller after he created the monopoly. You may have assumed that the monopoly power could continue indefinitely. You may have attributed a lot of growth to cash flow which also included a high return on investment and arrived at a very high valuation. At that time how could you have predicted the break-up of standard oil and all of the events that surrounded oil production through wars, OPEC, tax rates and other events. Now, with the effects of fossil fuel on climate change, it may be reasonable to assume that Exxon's value in the long-term value could decline. It is understandable that a company like Exxon or Shell would attempt to develop other forms of energy such as green or blue hydrogen to maintain its business over the long-term. But the multiples (in particular, the low EV/EBITDA multiples) and problems for Shell demonstrate that earning profits above the cost of capital for renewable energy has turned out to be difficult. The case demonstrates that thinking about terminal value is much more nuanced than applying a simple formula.

Shell scrapped in recent months several projects, including offshore wind, hydrogen, and biofuels, due to projections of weak returns.

Chapter 14: Cost of Capital and Hydro Projects in Pakistan versus Orsted Losing Billions from US Project

So far, we have been skating around the issue the cost of capital but direct there has been no direct measurement of the cost of capital number. Chapter 13 and the remaining chapters in the book turn to direct measurement of the cost of capital. Chapter 13 introduces quantification of the cost of capital by presenting a test that can be used to determine when a company is earning more or less than the cost of capital using the market to book ratio. The test does not necessarily provide a direct estimate, but it can evaluate what the cost of capital is not in certain circumstances. This notion of finding particular cases that disprove estimates of the cost of capital can be applied to different industries as much of the cost of capital (the risk-free rate and the EMRP are economy-wide numbers). This method that I use to introduce quantification of the cost of capital contrasts dramatically with investment banks who proudly present mean reverted betas that are un-levered and re-levered using a sample of supposedly comparable companies.

To illustrate what can be done through evaluating the market-to-book ratio I begin with a statement that I have heard for decades – "we need a return in double digits." This type of statement that is almost comical does not seem to change with different inflation or interest rates or with different risk of projects means that returns of 10.0001% can be the target. The market-to-book analysis can be used to demonstrate that arbitrary targets of something like 10% with a risk-free rate of something like 3.5% implies a risk premium of 6.5%. To see what this means to capital intensive investments return to the philosophic discussion and the fact that the 6.5% which is far above the real growth in the real growth of the economy compounds to very high investor returns.

A couple of mathematical formulas can be used to demonstrate that when the market to book ratio is equal to one and the return earned on equity is stable, the return on equity is equal to the cost of equity. When the return on equity is stable and the market to book ratio is above one, this is evidence that the company is earning more than the cost of capital. The idea of using the market-to-book ratio to test the cost of capital comes from the fundamental idea that the cost of capital is part of the cost of an investment and when the returns equal costs, the market value of an investment is equal to the amount of money put into the investment. When the market to book ratio is one, there is no increase in value from earning more than the cost and no diminution of value from earning lower cash flow than the investment.

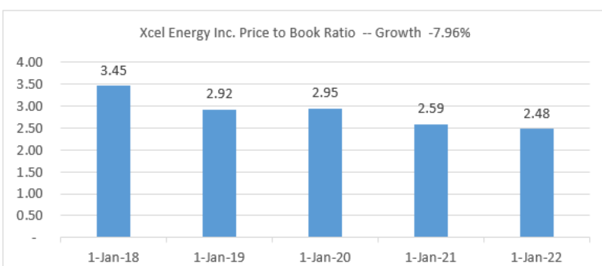
Establishing a formula for the market to book ratio is not controversial if you assume that returns, growth and cost of capital are constant. I have presented proof of some fundamental valuation formulas in Chapter 13. It is very easy to show that the market to book ratio is equal to:

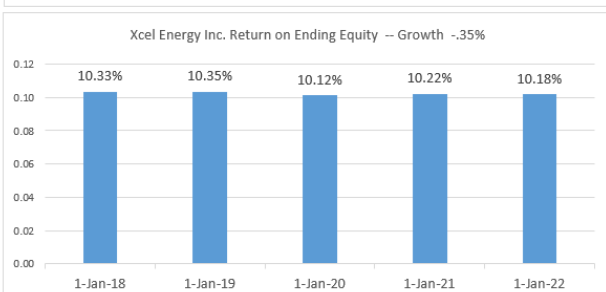
Market to Book = (ROE-growth)/(cost of equity – growth)

If you imagine that the ROE and the cost of equity are the same numbers in this formula, then the top of the equation is the same as the bottom of the equation and the market to book ratio is 1.0 no matter what the growth rate is. This is the most essential part of the equation because you do not have to get into debates about the growth rate. You can go further and demonstrate that the cost of equity depends on both the market-to-book ratio and the growth rate. This means that you must make an estimate of the growth rate and higher growth rates assumed by stock analysts imply a higher cost of capital. But if look at the formula carefully and split it up, you can see that if the market to book ratios is above 1.0, then the return on equity is above the cost of equity.

Cost of Equity = (ROE - Growth)/MB + Growth

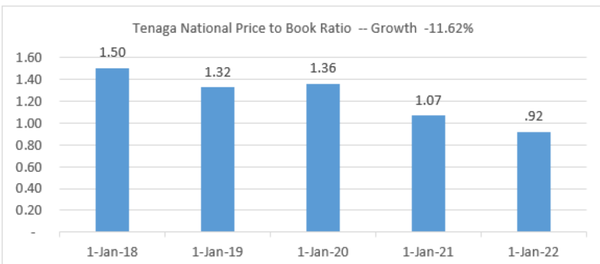
To illustrate how the market to book ratio can be used to demonstrate that the cost of equity is far below 1.0 for investments that are stable (like project finance investments) I have used two examples. The first is a utility company named Xcel Energy, which is a regulated electric company in the U.S. Xcel Energy is earning returns on equity above 10% and it has a market to book ratio of more than 2.0 demonstrating that the company is earning a lot more than its cost of capital as shown below. The decline in the market-to-book ratio illustrates the increase in the nominal cost of capital in 2021 and 2022.

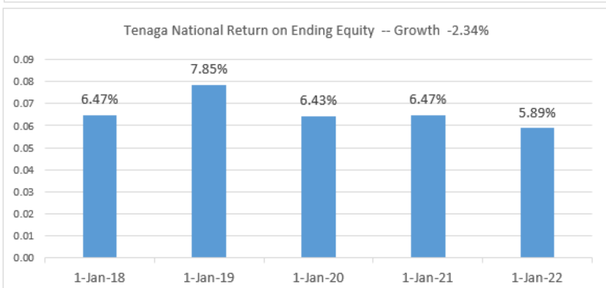




Xcel Energy Inc.	1 Year	5 Year
Expected Growth in EPS	6.80%	6.40%
Past Growth in EPS		8.55%
Year Ago Earnings Mktwatch	3.16	
Forward P/E Ratio (Yahoo)	21.14	
P/E Ratio (Marketwatch)	22.38	
Trailing P/E (Marketwatch)	22.48	
Price to Book (Yahoo)	2.35	
Price to Book (Maretwatch)	2.31	
Return on Ending Equity		
ROIC Reported (Marketwatch)	4.38%	
ROE TTM (Yahoo)	10.75%	
ROE (Marketwatch)	10.75%	
ROE - Forward EPS	10.91%	
ROE - Second Yr EPS	11.17%	
Yahoo Beta (5Y monthly)	0.42	
MarketWatch Beta	Beta 0.62	

A second example is from Malaysia with interest rates, inflation rates that are different from investments measured in Euro or USD. In addition, if you look up country risk premiums, you will find that Malaysia should command a risk premium ranging from 1.16% to 1.95% with a 2023 value of 1.89%.[48] The country risk premium is applied to overall cost of capital meaning that it would be magnified on equity returns. With all of this, the analysis of Tenaga, the large electricity company in Malaysia has a market to book ratio of about 1.0 and returns in the neighbourhood of 6%, demonstrating a cost of capital of around that number. Taking away the country risk premium of 1.89% would yield a cost of equity below 5%.



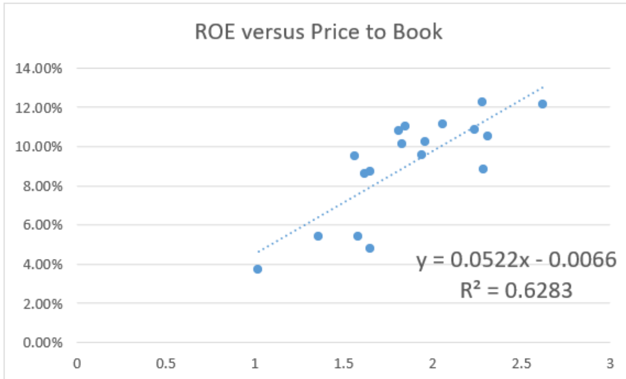


Tenaga National	1 Year	5 Year
Expected Growth in EPS	10.80%	3.00%
Past Growth in EPS		-8.59%
Year Ago Earnings Mktwatch	FALSE	
Forward P/E Ratio (Yahoo)	11.64	
P/E Ratio (Marketwatch)	FALSE	
Trailing P/E (Marketwatch)	18.89	
Price to Book (Yahoo)	0.98	
Price to Book (Maretwatch)	FALSE	
Return on Ending Equity		
ROIC Reported (Marketwatch)	FALSE	
ROE TTM (Yahoo)	4.95%	
ROE (Marketwatch)	0.00%	
ROE - Forward EPS	7.05%	
ROE - Second Yr EPS	7.27%	
Yahoo Beta (5Y monthly)	0.3	
MarketWatch Beta	Beta 0.89	

I have suggested creating a regression analysis of the market-to-book ratio and the return on equity to evaluate the level of return at the market to book ratio of 1.0. The nice thing about the graphs is there is typically within an industry a strong correlation. When I have tried this method, the implied cost of capital is a low, again meaning that capital intensive projects are favoured relative to fuel intensive investments.

[48] This comes from looking at Damodaran published numbers since 2011. The historic numbers are not published on the Damodaran website and I have put them together.

Mkt Watch



Slope	5.22%
Intercept	-0.66%
Cost of Capital	4.56%
R Squared	62.83%

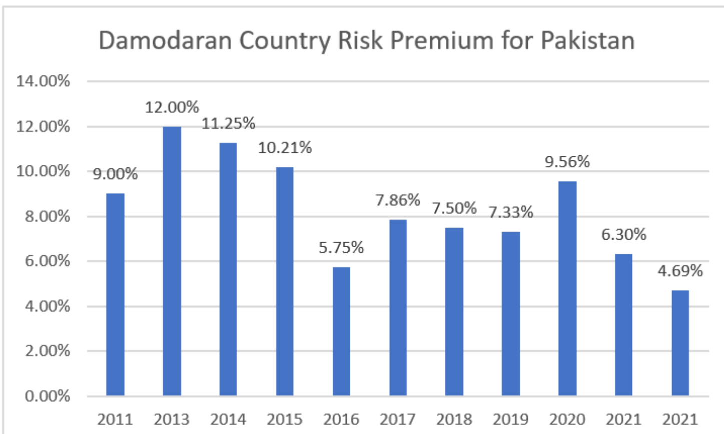
The Corruption of Country Risk Premiums: Published Estimates of Country Risk Premium Can Kill Important Climate Change Investments

I have been emotional about the way finance treats developing companies for many years. If demanded returns are high for investments in developing countries and these returns are distributed to investors outside of the country, the ability for people in the countries to experience a reasonable standard of living is arrested. The situation is very much like the GDP distribution graph presented at the beginning of this chapter where providing returns higher than the overall growth rate in an economy leaves nothing left for anybody else.

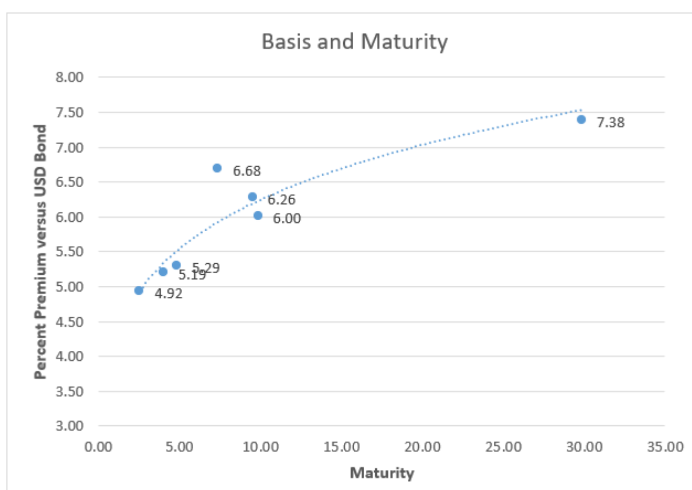
High returns that are allocated to investors outside of the country are justified by the country risk premiums that are published by a man named Aswan Damodaran, a professor at NYU Stern. Mr. Damodaran applies traditional finance like the CAPM and high estimates of the equity market risk premium. His numbers on the country risk premium are very easy to download and are high. Dr. Damodaran seems like a very pleasant man, but he does not seem to understand the very serious implications of his published statistics. Further, he does not address items that are contrary to his numbers including credit spreads by local banks in developing countries, implied probability of default in his data, implied cost of capital from price to book ratios.

If these numbers are used in measuring the cost of capital for investments that can combat climate change are applied to investments in Africa, the effect on investments can be dramatic. For example, I understand that a solar project in Saudi Arabia using Chinese modules can obtain prices of less than 2 USD cents per kWh. A project with similar modules and similar sunlight in Chad costs 15 USD cents per kWh. The primary difference between the projects is how they are financed. I hope you now understand my emotional reaction.

When working on a project for measuring the cost of capital in Pakistan for the National Electricity Regulatory Agency I made an effort to study what is behind the country risk premium. I read the articles from Mr. Damodaran and compiled some historic data. As I have mentioned above this kind of project where vested interests attack my work involves more critical evaluation than any peer review that I could imagine. This research from my project in Pakistan demonstrated that: (1) country risk premiums are not consistent or logical over time; (2) most of the country risk premium comes from evaluating the country risk rating from U.S. credit rating agencies with no adjustment for the tenure of the debt; (3) the country risk premiums result in implied probability of default that makes no sense in the context of actual defaults and (4) the credit spreads used by Damodaran are completely inconsistent with credit spreads charged by local banks.



In compiling the quoted country risk premiums, I have read articles written by Damodaran and compiled historic data. The accompanying insert shows that the country risk premium has ranged between 5.75% and 12% before 2021. In 2021 Damodaran published two estimates, one for 4.69% and 5.3% while the yield on the bonds ranged between 4.92% and 7.28%. These risk premiums are taken from either credit spreads on sovereign debt in USD or the credit spread on bonds with equivalent credit ratings. Some increase in the



risk premium is added for taking equity risk rather than credit risk. In 2013, the risk premium was 12% meaning that within seven years the earned credit spread would pay for the entire of a loan or equity investment (1+12%)^7=1.97. This implies that lenders would receive the entire proceeds of the bond twice on top of earning the USD interest rate. As shown above, the typical credit spread for a BBB bond is about 1.3%.

When evaluating credit spreads there is a basic formula to evaluate the minimum credit spread that will compensate for losses when there is a default. This formula is a simple one that defines the credit spread or the premium on debt as a function of the probability that the loan defaults and, if the loan does default, what will be the final loss.

Minimum Credit Spread = Probability of Default x Loss, Given Default

Probability of Default = Minimum Credit Spread/ Loss, Given Default

For a one-year loan, the implied probability of default may be reasonable. But as the credit spreads compound, the results become extremely high as discussed in the section on philosophy. The table below shows how the implied probability of default with different debt tenures assuming that there was no default until the particular year. For the BBB credit spread of 1.32%, the implied probability increases to 16%, meaning that without any default until year seven, the loan can default 16 times out of 100 and the lender will break-even. For the 4.69% credit spread, the probability of default increases to 63% and for the 12% credit spread, the probability of default is more than 100% to by year five. When you suggest to somebody in Pakistan that the probability of default can be 50%, they will tell you that you are crazy as there have not been any defaults in the past.

	1	2	3	4	5	6	7
Credit Spread	1.32%						
Compound Rate	1.00	1.01	1.03	1.04	1.05	1.07	1.08
Loss Given Default		50.00%	50.00%	50.00%	50.00%	50.00%	50.00%
Implied Probability of Default		**2.64%**	**5.31%**	**8.03%**	**10.77%**	**13.55%**	**16.37%**
Credit Spread	4.69%						
Compound Rate	1.00	1.05	1.10	1.15	1.20	1.26	1.32
Loss Given Default		50.00%	50.00%	50.00%	50.00%	50.00%	50.00%
Implied Probability of Default		**9.38%**	**19.20%**	**29.48%**	**40.24%**	**51.51%**	**63.31%**
Credit Spread	12.00%						
Compound Rate	1.00	1.12	1.25	1.40	1.57	1.76	1.97
Loss Given Default		50.00%	50.00%	50.00%	50.00%	50.00%	50.00%
Implied Probability of Default		**24.00%**	**50.88%**	**80.99%**	**114.70%**	**152.47%**	**194.76%**

When studying the cost of capital in Pakistan and reading annual reports from individual companies, you see something surprising. The credit spreads charged by local banks look a lot more like the 1.32% BBB credit spread than the very high credit spreads on sovereign bonds as shown below. The graph of local interest rates is in local currency. When adjusted for currency changes and inflation, the local interest rates are far below the rates paid by the government for sovereign debt. This phenomenon of local rates being below sovereign debt is apparently common for other developing countries and dismissed by Mr. Damodaran (maybe because the local banks are not located in New York). But the difference between interest rates represents a situation where two things that measure the same thing – the probability of default -- cannot both be correct. If Mr. Damodaran is correct the banks in Pakistan would be bankrupt. A more logical explanation is that the Western financial institutions are earning a large profit that more than compensates for risk.

10.1 The Company has total working capital finance facilities of Rupees 11,308 million (2019: Rupees 12,289 million) available from banking companies out of which Rupees 5,528 million (2019: Rupees 3,896 million) remained unutilized at year end. These facilities carry mark-up at average offer rate for 1 month to 3 months KIBOR plus 0.30% to 2.50% (2019:

Effective Interest Rate in USD = (1 + Euro Interest Rate)/(1 + Forward Exchange Change) – 1

Chapter 16: Discount Rates and Risk Measurement Used in Public Policy

Application of Financial Theory to Public Policy

The case discussed in this chapter involves the importance of measuring the discount rate in policy analysis. The issue of measuring the discount rate involves fundamental questions of investment (on behalf of people in a society), estimates of future cash flow and attaching a premium to recognize risks. The relationship between discount rates and economic growth is addressed and the manner in which resources are allocated. The notion of placing arbitrary risk premiums is revisited. For example, the Based on 2026 data, the US government often utilizes a 7 percent "base case" social discount rate for regulatory analysis, as recommended by the Office of Management and Budget (OMB) guidelines.

In the prior chapters the central aspects of financial analysis were introduced related to measuring costs and benefits using different rate of return statistics. The book now turns to assessing the rate of return and measures of risk into valuation. Some of the subjects include how the valuation of an investment can be assessed using project finance; how P/E and EV/EBITDA multiples can be applied in evaluating the price of a stock; how cost of capital can be measured when gauging the rate of return; how different measures of terminal value can be developed; how investments in new developments or new research can be assessed; how the risks associated with political uncertainty can be gauged; how … The idea is to see biases in financial techniques with an overview of how things fit together and how the biases and problems have affected important questions in the world.

To introduce the different issues of investment assessment and valuation I discuss various different issues related to questions of energy. The idea of using some examples from the energy industry is to see how different valuation metrics relate to each before discussing technical details of different subjects. Discuss all sorts of investments and companies – renewable energy, oil companies, nuclear power, public utility companies. Include issues of greenwashing, biases in cost of capital, contracts to encourage efficient construction and operation and other issues. With this diversity, can cover

Evaluation of investments can be made from a personal perspective such as buying or selling a stock. Financial analysis can be made by managers of a corporation that could involve making capital expenditures or putting money into the development of a new venture. Cost and benefit analysis may also involve public policy where investments are made to potentially improve future lives of people. An example of assessing investments from different perspective that I use are decisions related to climate change. The investments can be made on a global basis from a public policy standpoint, from a corporate perspective, or from a personal standpoint. Decisions about investments implicitly or explicitly are evaluated using financial analysis where rate of return measures the risk adjusted benefits relative to the costs. To see how some of the ideas about financial analysis that are different from typical IRR, DCF, WACC, ROIC, CAPM, P/E, EV/EBITDA methods I use some different aspects of climate related investments from a public policy perspective and from the perspective of private agents deciding how to invest. Issues addressed with different ways of thinking about financial issues are questions such as whether it was good policy of Germany to set fixed price tariffs to encourage efficient investment in solar power; why did Shell Oil exit much of its investment in renewable energy; is it more effective to power very large data centre capacity in Abu Dhabi with nuclear power, gas power or a combination of solar and battery capacity; whether electricity distribution capacity to provide for battery powered electricity vehicles should be promoted by allowing companies to earn high returns on their investment; and, how can you promote development of climate change investments in developing countries.

The idea of the discussion in the next couple of chapters is not to make arguments about climate policy – maybe you are like people in the adjacent picture, and you would rather the world invested in more cruise ships. My idea is to pick a case study/issue which you can use to think about earned IRR versus cost of capital, measurement of the cost of capital, alternative ways to think about risk with project finance, assessing the venture capital stage of investments with probability, I Whether or not you are interested in the climate debate but to illustrate the importance of bias in investment decisions. I highlight the essential points made in the chapter without delving into all of the technical details. Other more nuanced issues and more technical discussion are elaborated on in the body of the chapter.

[In this section I work through each chapter and discuss how ideas that question the current practice of finance theory affect investment decisions and policy related to climate change.] You can think of this as a case study in applying the various ideas that run counter to much of the traditional finance that is taught in business schools and applied by investment banks. I work through a case involving climate change for each chapter to demonstrate key implications of the technical details in each chapter.

Put together some of the ideas and models. Here, the idea of capital intensity and cost of capital. Next, growth rate, return on investment and multiples.

Use discussion of investments to mitigate or adapt to climate change to begin by thinking about very fundamental issues of what is an investment; what is profit maximization; what is rate of return;

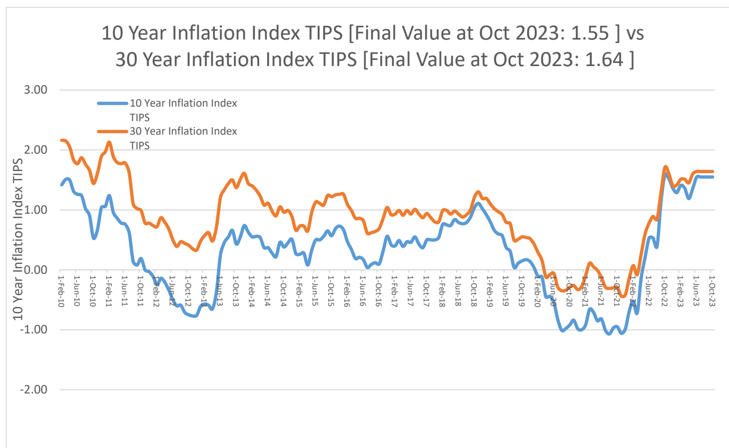
In the paragraphs below, demonstrate that carefully thinking about problems with finance theory does have concrete implications with respect to important investments made to resolve problems with climate change. I suggest that by delving into details of how finance is practiced for individual firms in a nuanced way you will see that the poor state of finance theory steers investments against those that combat releasing greenhouse gasses into the atmosphere. Through introducing project finance, corporate finance, and cost of capital in the paragraphs below I argue that we need to fundamentally re-think finance as part of combatting climate change.

John Sunu Senior and Discount Rates in NPV

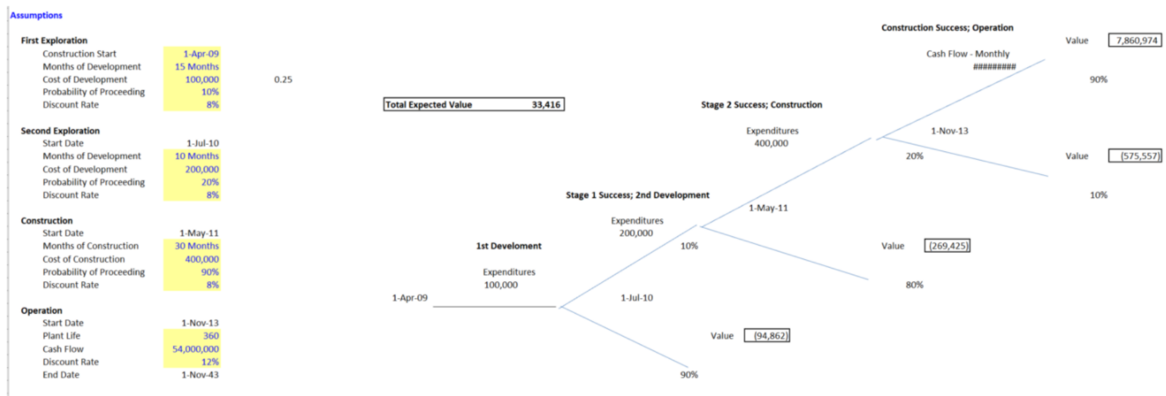
In working on energy and environmental issues many policy and valuation questions arise which can be used to illustrate different issues in finance. One example is issue raised by a man named Simon Clark makes videos on climate change included and discussion about the "lost decade" of the 1980's. He identifies a man who was the head of the U.S. environmental protection agency named John Sunu as the villain behind doing nothing at all over the decade. John Sunu and his staff concluded that costs of implementing policies to moderate climate change were not cost effective. This was in large part because when the future benefits of climate change moderation actions were discounted to the present value using a discount rate that presumably included a risk premium (that's the way we did things in the 1980'). Remember that any investment decision is a cost and benefit analysis and the uncertain benefits should be adjusted for risk. I hope this sort of analysis would make you feel queasy.

Now try to think about how you may do an alternative cost benefit analysis accounting for risk. Again, I am not arguing about policy, but the kind of analysis that is appropriate for an investment decision. First, with hindsight, the government discount rate in real terms (without inflation) has been close to zero as shown in the adjacent graph of yields on treasury bonds adjusted for inflation (these are called TIPS). Second, when incorporating risk into the analysis, wouldn't it be better to consider different future scenarios and the cost to the world of increases in temperature (droughts, Presumably the net present value analysis made in the 1980's involved some sort of cost of investing in technology to mitigate climate change and measured costs relative to lower costs of maintaining fossil fuel growth. Benefits must have involved potential costs of climate change if the investments were not made that you can now see) and could have been measured in different ways. But whatever the cost and the benefit, the benefits of investing in climate change mitigation would have occurred far out in the future and the investment costs would have been concentrated in the near term. In an analysis like this I imagine a relatively high discount rate (and by high discount rate I mean any real discount rate of above two percent) could have led to the costs of climate mitigation exceeding the benefits. But if you want to make an argument against using fundamental net present value analysis, it could be this case. The risks of climate change cannot be stuffed into a risk premium that is used in the CAPM. Instead, the time value of money could have been assessed with a real discount rate that is around zero as shown in the adjacent graph. The effects of climate could then be assessed with a probabilistic analysis that accounts for the magnitude of risks at different probabilities.

The kind of analysis made by Sununu and his associates is the same problem that companies face when investing in new energy technologies to mitigate climate change. Distortions in the calculation of IRR and NPV drive investment away from long-term capital-intensive investments (such as hydro projects, nuclear projects and solar projects) that are important in mitigation emissions of greenhouse gasses. In the 1980's and later, the real interest rate was often negative. This negative discount rate along with the costs in catastrophic climate scenarios and the probability of achieving the scenarios would in hindsight have been the appropriate way to evaluate mitigation measures.



Key point – the NPV formula and discount rates do not apply to many problems. Venture capital, it is probability of success and measuring the payoff.



Chapter 11 discusses measuring the value of a single investment from the inception and the development period through planning and construction, through beginning of operations without a track record and finally to a boring stage. This introduction hopefully makes you think about changing risk over the life of an investment.

German Feed-In Tariffs, Project Finance and Cost of Capital

Let's contrast the Chapter 11 discusses measuring the value of a single investment from the inception and the development period through planning and construction, through beginning of operations without a track record and finally to a boring stage. This introduction hopefully makes you think about changing risk over the life of an investment.

WACC – What Absolute Complete Crap

I now abbreviate WACC with What Absolute Complete Crap. Later could not bid on solar projects. 2382/782 or more than 3 per page including all of the pages with chapter headings. Only 619 WACC's and NOPLAT 1182.

As you now know the ROIC in the initial years is not constant over the life of a plant. This chapter uses project finance to correct the ROIC and derive a sensible performance ratio. To do this we compute the economic depreciation and illustrate how.

PART IV -- Project Finance: Lender Verification, Bidding to Achieve Low Cost of Capital, Structuring Incentives with Contracts and Evaluating Changing Risk

Chapter 16: Pillars and Essence of Project Finance

As with other parts of this book, I have had many attempts in writing things down about project finance and I have re-structured my thinking over the years. I began studying project finance a long time ago by reading presentations in academic texts where project finance is typically defined as just a special type of debt; by using case studies from business schools where details of debt finance are presented; or by analysing the debt structure in long and complex financial models. When I initially taught courses on project finance, I did not take a step backwards and have students begin by thinking about what makes project finance different from other ways of investing in capital intensive assets with a long life. I now insist that the real essence of project finance is that it can be an effective way to make large investments in essential infrastructure such as electricity plants, railways, bridges, and hospitals. This is accomplished through a unique way to assess risk; though creating incentives to efficiently construct and operate assets; through optimizing cost of capital and obtaining low prices; and, through encouraging investments that are good for society in general. These ways to think about project finance are a lot more that defining project finance as a special kind of debt. I now assert that thinking of project only in terms of debt provisions is a dangerous way to think about why project finance is used.

The more I work on actual projects; the more I teach classes in the foundations of project finance; the more I observe corporate finance in practice, the more I am convinced that from an academic perspective, project finance should be the starting point in assessing investments and not some kind of minor finance specialty. My idea is that only after measuring returns directly from long-term cash flow, assessing the performance and value of single stand-alone projects, and thinking about risk assessment from the standpoint of a lender should corporations (which are portfolios of projects) be studied. I suggest that project finance is a way to achieve low cost of capital through bidding; that risks can be effectively assessed with debt sizing and structuring; that evaluation of lifetime valuation with changing risk is assessed through sale of projects; and valuation is made using equity cash flow rather than operating cash flow. I am old enough and brave enough now to assert the manner in which contracts designed by governments purposely impose risks on private companies to encourage efficient investments; the manner by which bidding programs in project finance are used to discover the cost of capital; the manner by which bankers and other lenders verify the viability of projects; and the way governments can study the impacts externalities related to projects provides a unique and effective way to make crucial investments in an economy. This contract and financing structure can be better than alternatives without private investment i.e., government ownership or companies with cost plus regulation. It can also be a better way to structure long-term investments than to have no government involvement which will likely have a higher cost of crucial services to consumers.

Instead of beginning project finance discussion with classic terms related to debt features, I advocate thinking about the subject in a broader way that begins with basic principles of investment analysis using a few objectives of project finance that I call pillars. The different pillars include developing investments that (1) achieve a low price of essential services for society; (2) assets that are constructed and operated efficiently; (3) asset risks over a long time frame that are verified by independent entities who have a vested interest in assuring the projects work; and (4) assets that are determined to have long-term benefits to society above the benefits that accrue to private investors. To consider these objectives relative to other methods of finance, you can think of other ways to finance projects with long lives where the length of the asset lives implies that they could become obsolete and/or uneconomic. One alternative to financing long-term assets to project finance is government ownership or strict and guaranteed cost-plus regulation. With government ownership or guaranteed regulation there is arguably less incentive for efficient operation and less lender verification of the risks of the project. A second alternative for financing long-term investments is purely private investment without contracts and/or government involvement. In this case private investors must take obsolescence and market risks leading to higher cost of capital and resulting prices that will most probably be higher than the other alternatives. There will also be less lender analysis to justify the investment. In the purely private case, there will be no or less evaluation of whether the project makes sense for society when externalities are considered.

The way the four project finance pillars can be obtained is through using private entities in various aspects of the project along with signing contracts with government entities or companies that are heavily regulated by the government. With the contracts, projects can obtain high levels of debt financing because of stability in cash flow over long lives. Details of contracts, cash flow variability analysis, cost of capital, valuation and other subjects can become quite involved. Before you getting involved in the other complex items of debt sizing and structuring, evaluation of project upsides from risk reduction; interpreting IRR, DSCR, LLCR, and PLCR; interpreting large financial models; and evaluating credit enhancements like cash sweeps with mathematical analysis of volatility and mean reversion I think you should begin with the four pillars below:

1. Minimizing cost of capital for capital intensive long-term investments through use of competitive bidding which can result in low prices for in transport, water, electricity and other services.
2. Financing the project primarily with lenders (organizations with no direct stake in the ownership and development of the project) who will carefully and objectively

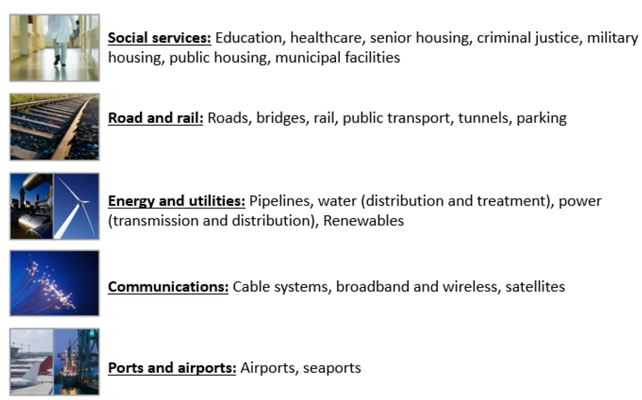
evaluate risks and assure the project and will assure the project makes sense from a technical and economic perspective.

3. Using of price, construction and operation contracts that are structured with private entities to provide incentives for efficient construction and operations while not imposing uncontrollable risks on the private companies and allowing for stable cash flow.
4. Government involvement in projects – structuring bids, limiting technologies, defining project parameters -- to encourage development of investments that incorporate positive externalities and betterment of society.

The fundamental problem resolved by project finance is raising money for an asset that will last a very long time. The pillars above cover key objectives to enable long-term financing, but not all aspects of project finance. Aspects of project not in the pillars are the use of IRR and DSCR to evaluate return and risk, changes in the value of a project over its life; upsides in project finance; the manner in which cash flows require mean reversion and/or contracts.

Pillar 1: Minimising the Difference between Cost of Capital and Rate of Return for Capital Intensive Projects

I have repeated many times that finance is about answering the question of whether investments should be made, and this question involves assessing investment costs relative to uncertain benefits. Investments for some typical industries where project finance is used are shown on the accompanying picture. These industries generally involve essential services to a society (I do not agree that the project finance for "criminal justice" with private entities is beneficial). The key differentiating factor of these investments is the long lifetime of the assets and the high level of capital expenditure relative to operating cost. These two characteristics mean that the investments are capital-intensive. I have previously introduced something that is pretty obvious, that if you have a bigger capital investment, the cost of capital and the return on capital matter more. In Chapter 12, titled "Cost of Capital and Distortion of Production Cost", the effects of capital intensity on the price of services were evaluated. This analysis demonstrated that when the real production cost is computed, that cost of capital has a dramatic cost on capital-intensive projects with a long life relative to less capital-intensive projects.



In modern project finance, revenues and prices are generally structured from a competitive bid process (this has not always been the case). While competitive bids can occur without project finance, the opposite is less true). The implied objective of competitive bidding is that the price to consumers and rate of return will be as low as possible – meaning the investor return is something close to its cost of capital. This idea is demonstrated by something I call the "night before" that I discuss when I meet people who have worked on projects involving bidding. This night before is when people who have been working on developing projects for many months have discussions with the chief financial officer about the acceptable IRR at the end of the process when the final bid is made. I imagine (I think correctly) a phone call between the developers and the CFO where the developer tells the CFO that unless you lower the IRR requirement, we will lose the bid. What this night before is doing is establishing the lowest acceptable rate of return in the context of the risk of the project which is the definition of cost of capital.

The pillar of project finance related to cost of capital versus rate of return is addressed at length in previous and subsequent chapters. For example, the MBA case studies mentioned in Chapter 2 demonstrate that when return earned is far above the cost of capital the cost to society can be very high and project financing often fails. One of the projects touted by Harvard is the Dabhol project. This project did not have competitive bidding, and investors were able to negotiate a contract that charged prices which resulted in high returns. The project ultimately failed because prices were unaffordable. Another project introduced in Chapter 2 is the Petrozuata project in Venezuela that was suggested to be "a case study in the effective use of project finance." In this case there was no flexible contract structure to provide more revenues to the country of Venezuela in the case of higher-than-expected oil prices. This resulted in a very high return and the ultimate nationalisation of the project.

Pillar 2: Using Lenders to Verify the Risk of Projects and Classic Definitions of Project Finance

Pillar number two involves the manner in which lenders are used to verify risk in project finance which contrasts with relying on more traditional measures such as CAPM. The manner in which risk is measured by lenders is introduced in this section and further elaborated in subsequent chapters that discuss the DSCR, mean reversion and debt structuring. If you are an investor applying project finance, you have somebody else verifying that the project will work (i.e. the bankers) through making a large monetary commitment to the investment. This is a luxury that is not available including corporate finance and government ownership. For example, if a large capital-intensive project is financed using general government funds, you cannot use the lender to assess whether the investment makes economic sense.

If you study project finance by reading texts, taking courses, or surveying the internet, the structuring of project finance debt seems to be the only thing that is important. This means that the idea of achieving low cost of capital through competitive bidding and/or contract structuring to provide risks and incentives for private parties does not appear to be a fundamental part of the project finance process. As the debt raised in project finance is a necessary pillar (in theory, project finance debt can be raised without competitive bidding and carefully structured contracts[49]), the discussion here is longer than discussion of the other pillars. I begin by reviewing various different definitions of project finance as the basis for discussion of some technical terms. After defining terms, the notion of using debt as the basis for risk measurement of the overall project and providing a stamp of approval of the project is addressed. Finally, the importance of having projects be evaluated on a standalone basis by banks without any support from parent corporations is considered.

The Danger of Defining Project Finance as a Form of Debt – Project Finance is Much More Than Just a Form of Debt

In rare cases when the subject of project finance is taught in business schools, it seems to be just classified as a kind of debt, maybe analogous to asset-backed securities (where debt is tied to an asset such as accounts receivable.) When project finance is defined as a form of debt, while other aspects of the investment are evaluated with standard corporate finance techniques, the investment benefits of the key pillars of project finance can be lost. These problems distort analysis by assuming the amount of debt raised is independent of risk; by mis-estimating the cost of capital through un-levering and re-levering betas; by assuming that WACC and risks remain constant; by believing that risks can be quantified with beta; by implicitly assuming that the distribution of equity cash flows is approximately normal; or applying volatility without mean reversion to cash flow will distort valuation and risk assessment.

The way project finance debt is structured is the basis for the idea that risks of a project are verified by external entities, i.e., banks. This aspect of project finance is not central to government ownership or highly regulated corporations where the debt is related to the overall viability of the government or regulated company financial statements. This pillar of project finance is how project finance is typically defined. While the idea that project finance is just a form of debt financing is wrong, working through classic definitions is a good way to work through technical terms that are used later in this part of the book.

In addition to introducing the debt verification pillar, the project finance definitions prompt the understanding some fundamental and important terms in project finance. I begin with a definition of project from a book written by J.D. Finnerty back in 2007. This first

[49] An example of this is Merchant Electric Power in the late 1990's and early 2000's which turned out to be massive failures.

definition is sometimes used in HBS case studies and includes a few terms that I further define after quoting the definition:

> *Definition One: … the raising of funds on a limited or* ***nonrecourse*** *basis to finance and economically* ***separable capital investment*** *project in which the providers of the funds look primarily to the* ***cash flow*** *from the project as the source of funds to* ***service their loans*** *and provide the return of and return on their equity invested in the project.*[50]

The first term in this first definition highlighted in the definition is the term **nonrecourse debt**. In the context of debt, the notion of nonrecourse is analogous to the lack of ability achieve guarantees from your parents where you cannot send an email to them and ask for money. Getting money from your parents is a parent guarantee is recourse, which is the opposite of nonrecourse. The second term highlighted in the definition is **separable capital investment**. The idea of a separable investment means that an asset has separate financial statements and can have different investors and can pay debt service and dividends to alternative investors. The separable investment can be called a special purpose vehicle, which is simply a corporation set-up to own the asset. This separability allows bank financing specifically associated with the project cash flow. The third term I highlighted are the two words **cash flow**. By including the notion of cash flow in the project finance definition (contrasted to earnings that are affected by depreciation, impairment charges other accounting adjustments), Finnerty's definition emphasizes the way cash flow drives valuation (with IRR) and credit analysis (with DSCR) in project finance. The fourth item highlighted is **servicing loans.** Servicing debt introduces the notion that in project finance, the debt service – the outflow for interest and repayment – is directly related to the total cash flow collected by the project.

I list a few additional project finance definitions below, each one of which emphasize the debt aspects of project finance. As with the above definition, I use these definitions to introduce a few more terms central to project finance. I note that all the definitions, including the definition above, miss the pillars of project finance related to encouraging efficient construction and operation using contracts; they miss the essential point of achieving low prices for consumers through bidding; and they miss the point of the ability of public policy to manage externalities.

> *Definition Two: Project financing is a loan structure that* ***relies primarily on the project's cash flow*** *for repayment, with the project's assets, rights, and interests held as* ***secondary collateral.***[51]

> *Definition Three: … financing of a particular economic unit in which a lender is satisfied to look initially to the cash flow and earnings of that project economic unit as the* ***source***

[50] Finnerty, J.D. Project Finance: Asset Based Financial Engineering. Wiley, 2007, Second Edition.
[51] Investopedia, definition of project finance

***of funds** from which a loan will be repaid and to the assets of the economic unit as collateral for the loan.*[52]

*Definition Four: Project finance involves the creation of a **legally independent project company** financed with nonrecourse debt (and equity from one or more corporate entities known as **sponsoring firms**) for the purpose of financing investment in a single purpose capital asset, usually with **a limited life**.*

*Definition Five: Project finance is used to refer to a non-recourse or **limited recourse** debt financing structure in which debt, equity and **credit enhancements** are combined for the construction and operation or **refinancing** of a particular facility in a capital-intensive industry.*

Terms of in these definitions that assist in better understanding project finance include:

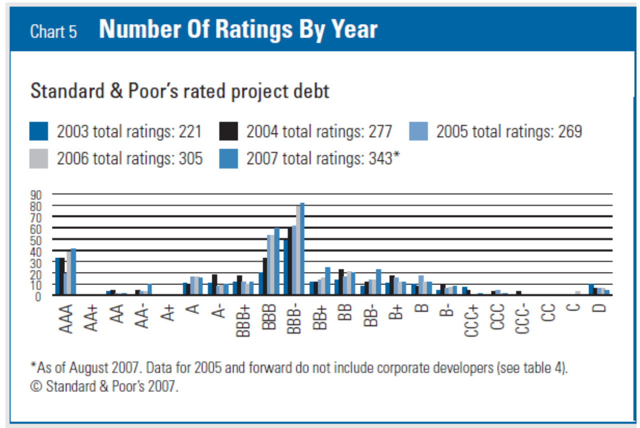
- The term **"loan structure that relies on cash flow"** implies a loan structure where the debt service mimics projected cash flow and implies something called debt sculpting which is a system of debt repayment where the total debt service is directly tied to the expected cash flow patterns of the project.
- The term **"secondary collateral"** in definition two and three is the value of a project that can potentially be realised through sale of the asset. I highlight this term because the concept is not important in project finance. It conflicts with the central idea that the value and the risk analysis of a project comes directly from cash flow.
- The term **"sources of funds**" points to the idea of cash flow and that the essence of evaluating project finance are two cash flow statements. The first is the sources of cash flow that are raised for constructing the assets before the project begins generating revenue. The second, often called a cash flow waterfall, is the cash flow returned to investors after operation starts.
- The term **"legally independent project company"** can also be called the special purpose company or the special purpose vehicle. This company can have different investors; it is the company that repays debt; and it is the company that signs contracts with other parties.
- The term "**sponsoring firms**" refers to stockholders or equity investors in a project. While there are often millions of investors in a public corporation; in project finance there are just a couple of partners who own the special purpose vehicle.
- The term "**limited life**" in project finance means what is says, but it is important in understanding project finance because cash flow analysis can be made over the entire life of a project. The amount of time between the end of the limited life and the end of debt term is called the tail.
- The term "**credit enhancements**" in the last definition refers to mechanisms that protect lenders through limiting dividends with various types of covenants. These

[52] Nevitt, P.K. and Fabozzi F, Euromoney, Project Financing, 7th Edition, London

credit enhancements include covenants that do not allow dividends when ratios fall below a certain level; covenants to repay debt early instead of paying dividends (cash flow sweeps); and cash held on the balance sheet to provide cash in emergency situations.

- The term “**refinancing**” refers to re-paying exiting debt (generally before the end of the term of the debt) and replacing the existing debt with new debt that has better terms.

While these definitions include important aspects of project finance debt, the more nuanced and important point about project finance debt is that cash flow risks evaluated by bankers define the risk of a project. In other financing structures such as corporate finance, the risk of a company is supposedly determined apart from the debt (unlevered beta and WACC), and the debt is adjusted to increase or decrease the risk of equity after enterprise value is computed. Similarly, the classic method for computing bond ratings is to begin with business risk and then, after the business risk is assessed, to interpose the amount of debt to evaluate a bond rating. In project finance the process is the opposite. You start with the size and structure of debt to roughly target BBB or BBB- bonds or equivalent bank scoring (barley investment grade). This means that the debt size is established from cash flow risk and that projects with less debt have more operating risk and projects with higher debt have less operating risk. Somebody asked me whether wind projects, battery projects or solar projects have move risk. I suggest that you can find out about the risks of projects as a function of which project has a more aggressive debt structure (higher debt to capital; lower DSCR; longer tenor).



Essence of Investing with a Project Finance Framework - Stamp of Approval by Lender Defines Whether the Investment will be Made

The pillar of project finance that involves having an independent institution – the bank – assess the risks and make the vast majority of investment in the project (for example 80% of the cost of the project). Rather than explain this pillar with technical definitions, I suggest an imaginary presentation on the costs and benefits of an investment with a long life. Consider an investment committee assessing the investment with one person makes a beautiful power point presentation to the board of directors on the construction of a large investment in a new battery giga factory. The presentation by this person includes very beautiful and professional slides. It includes discussion of the risks of the project, estimation of WACC, innovations in project efficiency and how the project will be built and operated. The adjacent picture represents this presentation, and it may be representative of an investment decision if there was no project finance.

I then ask people to imagine a second presentation of the same project. In this case there is no power point slide presentation. The presenter arrived late to the board meeting due to a prior meeting with a major bank that had funded similar projects and has experience in the risks of the type of project that are better than the equity investors. All she has is a piece of paper with a signature from the banker that the bank will finance the project and invest 80% of the capital expenditure of the project. The presenter also has other commitments with others such as a constructor regarding who will accept some of the risks of the project. The second picture is supposed to represent this rather silly and hypothetical example.

At the end of a course after we had worked through many nuanced, technical and legal issues associated with project finance, we sat around a table and pondered the benefits of project finance. Some insisted the big reason for using project finance is to keep debt off of the balance sheet of a corporation. I suggest that this is not very important compared to the fact that an entity that does not have upside in the project has done a lot of analysis with their own data and put an incredible stamp of approval on your project. This stamp of approval is particularly meaningful because it is not a consulting firm that does not experience big negative consequences for being wrong. This valuable stamp of approval comes about by putting in their own money into the investment.

Nonrecourse is A Whole Lot More than Just a Provision of Loan Agreements

I used to think about a nonrecourse loan as simply a kind of debt where the lender's risk is high, since repayment depends only on cash flow from one project and does not have added assurance from a parent guarantee that gives the bank many other sources of cash flow. Nonrecourse debt contrasts with normal corporate loans that can access cash flow and re-financing potential from an entire corporation, while a nonrecourse loan can only get money from the separately structured corporation (the SPV). You could go further and sound really sophisticated by discussing limited recourse debt which has some partial guarantees. As a side note, non-recourse can be an advantage when a company when the parent company implodes. The example of ENRON illustrates the point. ENRON could not pay its corporate debt, but SPV's could be working fine.

As with the definition of project finance which miss the essence of what it is all about, diagrams of nonrecourse debt can miss the essence of what project it is all about in terms of assessing an investment. When thinking about recourse as support from your parents, you can

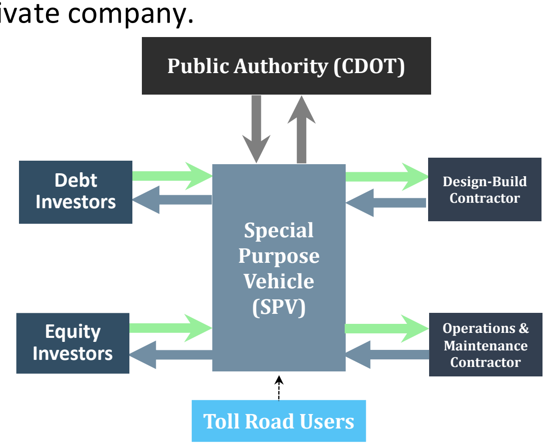
think about a scenario where your parents are rich and nice to you. On the other hand, you may have a parent who is absent from your life. If you have run out of money temporarily, the nice parent could respond to your WhatsApp message and send you money. This is recourse from parent support. If you are nonrecourse, you cannot send such a message, and your parents will not support you. The example of parental support (a term used in project finance) makes you understand that the real import of nonrecourse financing is that a project must be able to be viable on a standalone basis, as nonrecourse from your parents mean that you must be able to support yourself on an independent basis. Now think about how wonderful this is for investment assessment. Not only do you have a third party assessing the viability of a long-term investment; this assessment of is made on a pure basis where the risks and the economic viability are directly evaluated without the effect of other investments. Without the debt being nonrecourse, the imaginary example of two people making presentations above would not have the same outcome, where the second presentation with the note from the bank was so powerful. The investment would be back to the power point slides, with estimates of beta, WACC and classic corporate finance criteria.

Pillar 3: Use of Contracts that Include Incentives to Accept Controllable Risks to Allow Long-term Financing of Crucial Infrastructure Projects

Some kind of contract structure is almost universal in project finance, although project finance such as merchant electric power and resource project finance can be applied without revenue contracts (long-term investments in merchant power and resource are supported by assumed mean reversion in commodity prices). Contracts between the SPV and government agencies or other private companies create stable cash flow, mitigating the risk of technological obsolescence (if land lines become obsolete, a government contract can assure that cash flow continues). It is possible to structure an investment with a lot of contracts that impose targeted risks on investor without project finance debt, meaning that some kinds of contracts are necessary for project finance, but contracts do not mean investments will be project financed. Just as important as providing stable cash flow that is necessary for financing long-term investments, contracts with private parties can be used to explicitly impose targeted risks on companies to provide private companies with an incentive to construct and operate projects in efficient manner.

Putting all of the pillars together – bidding, financing and, finally, contract structuring -- is what makes project finance a unique and potentially effective tool of economic policy. The history of project finance (discussed in more detail in Chapter 26) was in large part due to coming up with a way to incentivise private investors by accepting construction cost risk, construction delay risk, plant performance risk, operating cost and other risks. Only by taking risk and incurring a downside will there be a desire to assure bad things should not happen (this is pillar number 3). In order to be able to provide these incentives, and at the same time encourage competitive bidding, many projects can be created from relatively small companies and with different kind of partnership structures. These companies with partnership structures and with the need to attract a lot of debt funding needed to be separable companies. The separable company, an SPV, has the ability to sign different contracts to further impose risks on parties that are qualified to take the risks such as Engineering, Procurement and Construction (EPC) companies. This separability the investment could in turn lead to financing of the projects.

As with other subjects, when you work on a project finance transaction you can get lost in various details and miss the big picture of what you are trying to accomplish. A prominent example of this is getting mired in the language and the details of the contracts. You can work carefully on a formula in the contracts or assure that the language of the contracts addresses details that are quite unlikely; but could potentially become an issue. My idea in this introductory chapter is that you understand the general objectives of contracts which is to provide incentives to private companies to be efficient as well as to assure stable cash flow. The contract provisions should not be structured where risks that cannot be controlled by the private companies. Such risks do nothing other than increase the cost of capital without encouraging efficient behaviour. Examples of such contract provisions that cannot be controlled and do nothing for prompting efficient management are imposing the risk of oil price changes; inflation rate variation; uncontrollable output such as traffic; and exchange rate fluctuations on the private investor. More nuanced case can impose some risk on a project where there is some control but a lot of factors out of the control of the private company.



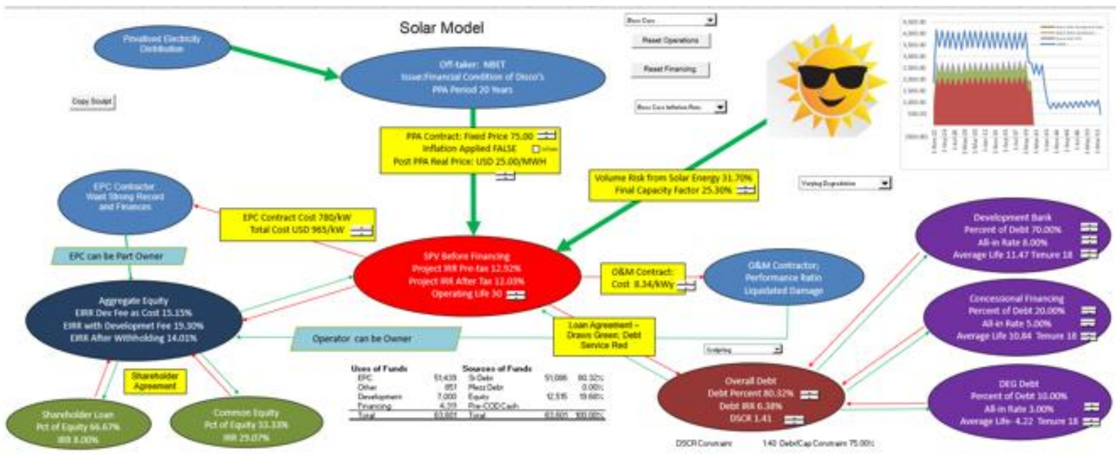
It is common in project finance to illustrate the relationship of different parties who sign contracts with the SPV using a diagram. My eyes used glaze over when I looked at project financing diagrams as I did not see what the diagrams added to the analysis of a project finance investment. An example of a useless diagram is shown in the adjacent picture[53]. This picture does not tell you anything other than that there is an SPV and a government agency named CDOT (the California Department of Transportation). We do not know if there is a minimum toll traffic, how the risks of re-surfacing expenditures will be dealt with, if there are penalties and bonuses from performing maintenance more efficiently, if there are increases in toll rates when

[53] This diagram comes from a presentation by Wall Street Prep.

the construction materials increase, who are the sponsors to the project, and what are some key aspects of the debt financing. Further the arrows do not represent money where you could follow the cash flow, but some undefined relationship between service provided and payment for the service. In this picture, you do not see the risks, you do not see the returns of different parties.

I now have a completely different (better) attitude to the diagrams. If the diagrams are effective, they can demonstrate the flow of cash, which should always start with how the project will generate revenues. If there is no revenue the project cannot exist; the risks of how revenue is received is often the most important risk. More often than not, if the revenue does not have some kind of security through the price with a reputable contractor, or if the revenue does not have a long-term history as a necessary commodity, it will be difficult to finance the project. As you move through the cash flow, the diagram can demonstrate how various risks can be mitigated with contracts. Contracts shown on the diagram can be designed with different risks and incentives for capital expenditures (EPC), operation and maintenance (O&M) contracts and other items that ultimately transfers risk away from lenders and equity investors. The diagram should demonstrate the contract itself (perhaps with comments) and the parties to the contract (again perhaps with comments), one of which is the SPV. The lack of ability of a contractor to fulfil the contract can become the most important risk in a project finance transaction.

The diagram below is illustration of a transaction that is part of a project finance model. The diagram shows the flow of cash (the green arrows) where the quantity produced comes from the sun with not contract. The price comes from a contract with a government agency in Nigeria (the contracts are in the yellow boxes) that in turn receives revenues from electricity distribution companies that have poor financial conditions. The EPC and O&M contracts and off-takers are illustrated in a similar way. The SPV oval shown with the project IRR can be used to evaluate the reasonableness of the price contract. Finally, the funding from debt and equity is illustrated with the key financial ratios – the equity IRR and the DSCR. The diagram also shows the expected cash flow relative to the debt service. This means the diagram should demonstrate the ability of the contractor to meet the terms of the contract. In the diagram below, the important contracts; how the contracts interact, what are the risks, who takes the risks.



While the contracts can provide incentives and reduce risk for the SPV and debt and equity investors (pillar number 3), the contracts can be expensive. Worse yet the transfer of risk can include country risk premia that do not make sense (if you are buying solar panels from China, and using local labour to install them, why do you need a big markup on an EPC contract). The diagram should also include comments (maybe written with a pen) of whether the contracts are sustainable (for example if the prices are reasonable) and whether the counterparties to the contracts will be around.

If you are old enough, think about twenty years ago when you would return phone calls after receiving voice mails on your land line phone and taking pictures using your Kodak camera. Going back in time would understandably make you feel queasy about investing in a single project that requires you to realize stable cash flow for three decades or more. With hindsight you should not have made investments in things that can become obsolete or do not have some kind of assurance that they will remain economically viable. The example is meant to make you think about what kind of projects can qualify for debt that has a tenure of more than twenty years and requires equity investors to wait a long time before receiving their cash returns. The kind of investments that are qualify for project finance are by definition low risk and boring (the term in project finance is more elegant and known as proven technology). At a fundamental level, project financed investments require some kind of way that long-term cash flow can be reasonably projected (collateral mentioned in the above definitions all comes from the value of the cash flow). Obtaining assurance that cash flow forecasts for long-term investments can be made may be derived from using contracts; locking in forward prices; or estimation of time series that do not depend on things like fashion, obsolescence risk or unstable prices.

Pillar 4: Consideration of Items in Project that Are Not Measured by Private Investor Return or Risk Assessment by Lender

In Chapter 3, two investments were considered where the impacts on society are minor compared to the effects on society as a whole, Christopher Columbus' voyage and NIVIDA. In the case of Christopher Columbus, the money earned by the Italian lenders for funding the project was tiny compared to the negative and positive influences of the voyage ranging from genocide of Indians to beginning the age of discovery and the Spanish Empire . For the investment in chips that allow very fast calculations by NVIDIA, the gains in value realized by some lucky investors are dwarfed by the potential positive and negative effects of artificial intelligence. When highways are constructed to allow easier transportation from city centres to outlying suburbs are built, the effect on the quality of life in different regions is probably a lot more than the cost of building the highway.

Encouragement of projects that have positive effects over and above the private investor return can be accomplished by regulations such as only allowing new electricity investments to be powered by renewable energy. Alternatively, the project can be assessed with something called an economic IRR ("EIRR"). Quantification of the external benefits that are not measured in the return to private investors (this return can be called the financial IRR or the FIRR). The economic IRR includes the externality effects of a project which are often related to the environment and other items such as the effect on the quality of employment or the promotion of related activity. Rather than thinking about really big investments, I think about externalities of things like going to the dentist, where if you do not allow your teeth to fall out may be not only nicer for you, but for your friends and family. In my apartment complex, the people who manage the area invested in a bunch of very loud leaf blowers that run on petrol. When making the investment in these horrible things, if they counted the value of disagreeable noise, I think the EIRR would be negative. Other examples of external benefits could be planting some trees to hide a parking lot.

When discussing the EIRR it is common that people will scoff at the statistic as there can be a lot of judgement in computing the number. In a way this use of judgement is a demonstration how lenders verify cash flow allowing objective return statistics. For example, in my case of the loud leaf blower, it would be difficult to quantify the cost to different people in an apartment complex of being irritated by the noise. Finally, if a project has positive externalities that pushes the IRR to 4% with a government grant, would have to come up with some basis how can you judge the adequacy of this return. If the real 4% return is above the expected growth rate of the economy and the 4% allows a better quality of life, it may be a perfectly adequate return.

I learned about computing the EIRR in an actual case. I was working on a project to bring electricity to villages in Mozambique through the use of solar power plus batteries. The project required funding by a quasi-governmental agency to support the capital expenditures because the financial IRR was below the required return of an investor. To quantify the environmental effects of the renewable energy, we measured the value of the reduced emissions in the EIRR and put a price on them. To measure the effects of having electricity to promote irrigation and other uses, we evaluated the price that people and businesses are willing to pay for electricity when the electricity is not available, called the shadow price. This price that people are willing to pay could be derived from the amount people in Nigeria pay for electricity outages by having a back-up generator and the associated fuel.

Aspects of Project Finance Other than the Four Pillars and the Essence of Project Finance

The list of pillars introduced in this chapter in no way covers all of the characteristics and the objectives of project finance. Subjects that are addressed in subsequent chapters include a detailed contrast between project finance and corporate finance; the use of IRR for evaluating value and the use of DSCR to quantify risk; assessing changes in the value of a project over its life; upsides in project finance from re-financing and selling a portion or all of a project; and, the manner in which cash flows require mean reversion and/or contracts. A particularly interesting subject is changes in risk and value over the life of a project. This involves going through stages where a project begins from something like a venture capital investment; then to a financeable investment with risks that can be handled by a lender; and finally, to a boring investment which looks more like debt than the equity of a typical corporation.

I have tried to come think about an alternative definition It is not easy to derive a nuanced definition of project financing that incorporates the key pillars, but here is my try:

> *… raising money from a bank and/or an investor for a capital investment where you can prove (through nonrecourse loans and equity cash flow evaluation) that the project is economic on a stand-alone basis and where debt and equity is structured corresponding to the risks, the timing and the pattern of cash flows from the project. Long-term financing is achieved through demonstrating mean reversion in cash flow and/or use of long-term contracts that allow cash flow to meet debt service, incentivise private entities to construct and operate the project efficiently; and provide a reasonable growth rate (IRR) in cash flow to investors and in a low cost for consumers.*

Chapter 17: Project Finance Resolves WACC and Terminal Value Problems in Corporate Finance

In the last chapter I argued that if project finance is done well, it is a lot more than a method of lending; it is a unique way to influence an investment decision to use private entities to encourage efficient investment, to limit risks that do not encourage efficiency to achieve a low cost of capital, to use lenders to carefully assess the technical viability of the investment; I suggest that project finance rather than classic corporate finance ideas should be the foundation for valuation, risk, return and cost of capital issues that are the centre of finance theory.

When I ask participants in my courses if they have made a discounted cash flow analysis, the answer is generally yes. When I ask if they have taken a project finance course in and MBA program, the answer is generally (but not always) no. People like to talk about billionaires who own corporations, the latest new trend in technology developed by a corporation or the dramatic increase in the stock price of a company. These issues may seem more interesting than how can we get a new train line developed or how can build more wind farms or whether an investment should be made in hospitals or prisons which can project financed. Given the general interest in corporate finance whether a reporter on television is discussing the stock market or whether an MBA student is evaluating and M&A transaction, I begin the discussion of project finance with a short overview of problems in the financial analysis of corporations (the problems are discussed elsewhere in the book). We will see that project finance resolves the most dicey problems in corporate finance. Ultimately project finance not only allows you the finance important investment like a new rail line or moving to renewable energy which are so crucial for people in a society, but it also allows investments to achieve a low cost of capital and result in reasonable price. This is even if projects are not as exciting as the latest variation of a social network.

After defining project finance the discussion typically turns to a comparison of project finance and corporate finance. A two-column table is often presented like t he adjacent table where

To be sure, corporate finance valuation and corporate finance lending are far bigger in volume and in general discussion than project finance. But I suggest that project finance can answer these cost and benefit questions better than corporate finance, its much bigger brother.

Ultimately, project finance is also a way to think about valuation, risk and cost of capital. Some of the ways include:

1. Considering a corporation as a portfolio of existing and potential projects which forces you to think about questions such as whether the value comes from existing projects that are earning a high return.
2. Measuring return with the IRR or the premium earned above the cost of capital and risks with the buffer in cash flow which will support volatility.
3. Understanding Acceptable Risks with Analysis of Contracts
4. Measuring Risk Premium and Bankability with Volatility and Mean Reversion

Project Finance versus Corporate Finance and Valuation of a Person versus Valuation of a Family

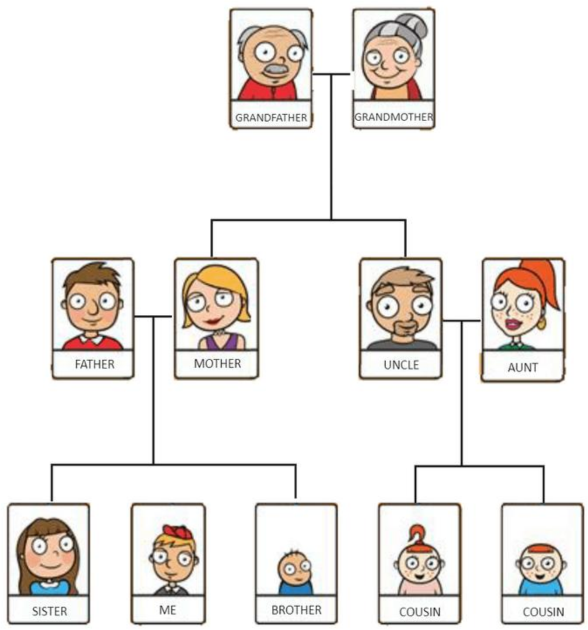
After defining project finance the discussion typically turns to a comparison of project finance and corporate finance. A two-column table is often presented like t he adjacent table where various features of project finance and corporate finance are compared. There is certainly nothing wrong with tables like this, but they don't tell you about the key that investments are valued and risk is analysed. I am not suggesting some kind of football match between analysis of investments with project finance and corporate finance, but I do argue that understanding how project finance is used to assess the value and the risk of an investment gives you insight about issues that should be at the centre of finance.

Project Finance vs. Corporate Finance

Features	Project Finance	Corporate Finance
Financing	• Look at cash flows of a **single asset** (the project) for repayment	• Look at strength of a **range of company assets**
Security	• **No/limited guarantees** of assets • Project contracts are main security for lenders	• **All assets can be used for security** • If project fails, lenders repaid via company cash flows
Duration	• Project has a **finite** life • Debt must be **repaid at end of life**	• Company has **indefinite** life • Losses can be **rolled over**
Control	• **Lenders exercise close control** over project activities	• **Company management runs business**

Instead of starting by considering project finance as a debt structure, I start with the notion that project finance is about valuing single investment (one Costa Coffee shop or one shoe factory or one solar power farm) whilst a corporation is the sum of a portfolio of projects. The relationship between project and corporate finance then involves the general manner in which a single investment can best be evaluated. The value of a single asset depends on the development, construction, early operation or mature operation stage of the investment. The deep difference between analysis of project finance and corporate finance is driven by how project finance analysis evaluates value and risk at various stages in detail versus how corporate finance is forced to apply crude methods without delving deeply into risks and reasonable cash flow forecasts associated with individual assets.

I some kind of idealized world the kind of risk and cash flow analysis that is used in project finance would be applied to all current and also all prospective investments made by a corporation. This aggregation of project finance analysis is impossible; but thinking about how it could be done can make you think about many financial issues in a better way. To see the difference in the thought process of project and corporate finance pretend for some crazy reason a grandmother in the adjacent family tree wants to know the value of her family (not including accumulated money that has been inherited). The value of the family in aggregate depends on the success of individuals in the family. Some of the family members are in the middle of their careers and earning stable income. One of the boys could be in the teenage development stage where his parents are worried about him getting into trouble. A girl in the family tree may show a lot of promise but she is just finishing his education and has not earned anything yet. Finally, the value also depends on future new family members who are not yet born. Each of the family members including those not yet born have different cash flow potential and different risk. I suggest that to understand issues of the value of the corporation you need to understand the underlying source of value as in a family.



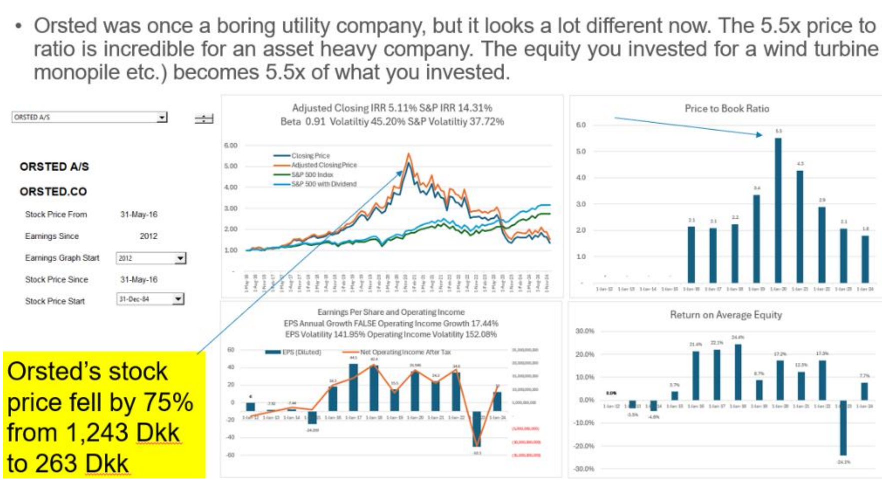
If you had tried to compute the value of this family by some kind of accounting statement that adds up the revenues earned, the costs incurred and the investments made in education and other personal development, the numbers would not be very useful in establishing the value that the grandmother asked for. When you look at some kind of aggregate financial statements, you do not get a reasonable story of what is really happening to all of the diverse assets of the organization. Each asset or each person must be valued, and the value must account for risk.

Start with what Project Finance is Not: Three Reasons why Corporate Finance is Messed Up and Is Not a Good Way to Finance and Value Important Investments with a Long Life

The more I have studied corporate finance the more the whole thing seems like a bunch of magic potions. This means that use of corporate finance to assess investment decisions may not result in effective cost and benefit analysis. I use an example of Orsted, a company that does not apply project finance. This company seemed to have a successful strategy until it invested in US project named Ocean Wind. Failure of this single project resulted in a loss of USD 5 billion which was about 40% of its equity capital. Investors lost trust in the company's ability to assess the risk of new investments and its stock price plummeted from 1,243 DKK to 263 DKK. The company had used classic methods of investment analysis by comparing expected returns to some kind of undefined WACC; by presenting near term EBITDA projections rather than returns over the lifetime of projects; and they touted their return on invested capital that increased after the Ocean Wind project was written off.

	DKK Billion	USD Billion
	0.14	
Ocean Wind 1	19.90	2.79
Ocean Wind 2	2.10	0.29
Revolution	2.70	0.38
Sub-total	24.70	3.46
Contract Cancellation	15.00	2.10
Total Loss	39.70	5.56
Sunrise 1	2.259	0.32
Orsted Equity Capital	103.55	14.50
Percent of Equity		38.34%

Three of the enormous problems that are highlighted by the Orsted case and any valuation in corporate finance are (1) the idea that you can value a corporation that supposedly has an indefinite life can be measured with a simple formula; (2) the notion that you can measure risk with WACC and beta which stuffs all of the risk of a corporation into a single statistic; and (3) the belief that you can use financial statements to compute ratios like EV/EBITDA or P/E which are used to compare valuations. When you seriously study these three issues, you quickly see that they do not really produce anything sensible for assessing big new infrastructure investments. In the next section that project finance can resolve these difficult issues. Without delving into details, consider the following with respect to these three issues:



Problem 1: Terminal value:

There are many problems that derive from the crazy belief that you can compute the value of something that has an indefinite life. (Say Jeff Bezos calls you to his office and asks you how long do you think Amazon will last. You probably should say that it will last forever or maybe more properly say that it is on-going.) The biggest item of value in a corporate DCF analysis is the terminal value. You typically make a forecast of cash flow for about five years and then take that fifth year cash flow to make a forever calculation. The absurdity of a calculation such as this is mind boggling. When you step back and think about things, for a corporation, consider:

- In the long-term future, all of the management will be replaced
- In the long-term future, all of the current products will be obsolete
- In the long-term, all existing assets (except land) will be retired
- Value in the long-term comes from the ability of management to do something special and charge high prices (allowing earning high returns above the cost of capital); isn't it arrogant to assume that future generations of management will have this same ability (or consumers will be forever addicted to products of the company such as an iPhone or a McDonalds hamburger).

Problem 2: Use of WACC Valuation:

The ultimate valuation of anything depends on projected cash flow (such as the terminal value) and placing a risk assessment on the forecast. These days, corporate finance is based on assuming that cash flow risk is incorporated in the weighted average cost of capital that includes an estimate of how much expected growth in cash flow is needed to compensate for the risk. Again, when you step back and think about whether risk can really be stuffed into a measure of WACC and then assume that this risk measure does not change over time. This notion has a similar level of absurdity as the idea that terminal value can be computed. WACC or that all risk can be stuffed into one beta statistic is absurd. Without delving to details of all of the problems, consider:

- In the real world, people including sophisticated investment bankers, academics and others have dramatically different opinions about what the equity risk premium and the beta are, leading to dramatic differences in WACC;
- It has never been proven that the beta statistic really measures risk when you get into the way the statistic is computed, you can obtain very different answers;
- The calculation of cost of capital generally requires an estimation of how much investors need to be compensated for taking risks in stocks compared to risk free bonds (there is no such in thing as risk free bond).
- There continue to be problems with valuing the tax shield from interest in WACC and debates about un-levering and re-levering beta or computing something called adjusted net present value

Problem 3: Use of Comparable Financial Ratios in Valuation:

A third essential problem in corporate finance is attempting to interpret ratios such as EPS, ROE and ROIC along with P/E, EV/EBITDA and Price to Book Ratios that come from financial statements to measure the value of corporations. The general idea of these ratios is that if we cannot measure the value of an investment from the terminal value and cost of capital problems, at least we can compare the value of one company to another to see if the value is reasonable. As with the above two problems, when you delve into the ratio analysis you find the approach close to being useless. Reasons that comparable analysis is so bad in corporate finance include:

- Financial statements distort the true growth rate in earnings when measuring returns because of straight line depreciation, impairment write-offs and other accounting adjustments.
- Multiples like the P/E ratio depend more on changes in return than levels of return meaning that companies with increasing prospects after a bad year cannot be compared to companies with decreasing prospects after a good year even if the companies are in the same industry and have similar risks.
- When companies are growing fast, the ROE and ROIC will be lower than the equity or project IRR while when companies are not investing the reverse will be true
- With straight line depreciation, earnings are distorted, and income is too low when companies grow and then too high when companies contract.

How Project Finance Resolves Big Problems with Corporate Finance

Some differences between valuing a project or a corporation using project finance include: (1) project finance risk measurement does not depend on arbitrary statistics such as beta, but third party verification from lenders; (2) project finance directly accounts for key risks through contracts and assessing mean reversion; (3) project finance directly uses debt capacity in valuation and risk assessment; (4) project finance valuation uses metrics of DSCR and IRR that are directly related to cash flow; (5) equity cash flows to project financed investments do not have symmetrical distributions but instead have upside from risk that declines over the life of the project.

Resolution of Problem 1: Terminal Value is Not Necessary

When assessing the value and the risk of project financed assets, there must be either contracts to secure the revenue from assets or alternatively documented mean reversion in the price of energy or resources. This allows you to make a valuation using discounted cash flow over the entire life of the assets and it allows you to compute the rate of return on the assets. In project finance analysis, you don’t compute terminal value; as you are measuring risk and cash flow for a single asset, you just need the discount rate.

Resolution of Problem 2: Computing the Cost of Capital from Bidding and Transactions Rather than from Absurd Statistics

Unlike all of the discussion in finance courses, books and presentations about the beta statistic, equity market risk premium and the process of un-levering and re-levering, the cost of capital, defined as the minimum acceptable return, can be obtained in a more objective manner. Many projects are selected from a from an auction where the project with the minimum price wins. When I think about this bidding process, I imagine the following discussion which arrives at the cost of capital:

- You bid on a project – the price in the PPA that is lowest will be used be the winner of the RFP.
- After you have prepared all of your analysis, found different contractors and even secured bank financing, you think that another company will accept a lower IRR than what the CFO demands.
- You work late into the night of the day before the bid is due, and you have many calls with your CFO. You tell him that he must either allow a lower IRR, or you will not win the bid.
- You keep pushing down the IRR until the CFO really sweats and tells you that he can absolutely not go any lower. This is the cost of equity capital, and you have an objective number.

Resolution of Problem 3: Ratios Computed from Pure Cash Flow

A principal reason that the P/E ratio, the market to book ratio and the EV/EBITDA ratio are so difficult to interpret is related to distortions in accounting and the treatment of capital expenditures. Project finance solves problems with financial ratios by focusing on alternative measures that separately evaluate risk and return. These measures are the equity internal rate of return (IRR) and the debt service coverage ratio (DSCR). In the chapter after next, I explain in detail why these two measures can be used to understand the value of projects and compare the risks of different investments.

Throughout this book I contrast corporate finance and project finance. As with the family example above, the corporation has a history which individual people do not. As the family has an indefinite life (it can die out but also become very big), the terminal value that is supposed to be founded of a corporation is a big deal. In corporate finance, valuation depends on the weighted average cost of capital that may be computed by un-levering and then re-levering beta. Some of the difference between corporate finance analysis and project finance analysis are shown on the table below.

Corporate Finance

1. Analysis is founded on historic financial statements and companies will evolve relative to the past.
2. Financing is important but not necessarily the primary part of the valuation.
3. Successful companies expected to continue growing and refinance. Terminal value is a big factor.
4. Focus on earnings, ROIC, P/E ratios, EV/EBITDA ratios and Debt/EBITDA.

Project Finance

1. Since there is no history a series of consulting and engineering studies must be evaluated.
2. The bank assesses whether the project works (engineering report). Without debt financing, the project is not viable.
3. Successful projects will pay of all debt from cash flow and end their life.
4. Focus on cash flow rather than earnings. Equity IRR and DSCR.

This table makes it seem as there are some ways in which measuring value with corporate finance are better and some ways that project finance is better. But don't be deceived, corporate finance does not give you a better foundation for valuation, even if you have a lot of financial statements. Take point number one where you do not have history for a new project financed investment, but you can compute the historic returns for a corporation. As so much of valuation is about forecasting returns, the history from the corporate finance side of the ledger seems to be invaluable.

In fact, because you cannot measure return accurately from financial statements due to depreciation, write-offs and other accounting distortions. In terms of the financing of a corporation, the debt is much less structured and ultimately involves trust that the company will have enough reputation to assure re-financing. When you get to terminal value, there is no way really compute the number. Terminal value is philosophy and cannot be boiled down to a simple formula. The ideal way to value a corporation would be to have a set of information on individual projects demonstrating the returns on the projects in terms of IRR, the risks of the projects in terms of the same kind of cash flow analysis that lenders perform and assessment of the potential to develop new projects where returns exceed the cost of capital or at least that the project IRR exceeds the interest rate.

Imagine a lot of investments. Could compute the value of each one then add them up and get

This chapter describes project finance theory and how project finance can achieve a low cost of capital for investments that combat climate change.

Chapter 18: Two Key Ratios to Define Value and Risk in Project Finance – IRR and DSCR

When you are thrown into your first project finance transaction, you will see that any model, any investor memorandum, any sale and purchase transaction will emphasize two different financial ratios. These statistics are not the kind of ratios you may have seen in corporate transactions such as the P/E ratio, the EV/EBITDA ratio, the WACC or the terminal value. The first statistic you will see is the IRR and the second is the DSCR. The IRR referred to in all of the models and presentations is the return realized by equity investors called the equity IRR and other measures such as the project IRR. If you studied finance, you probably learned that you should evaluate investments using free cash flow and the weighted average cost of capital (ideas directly derived from Merton Miller, whose picture I show). You may have heard about adjusted net present value; you could have learned the basic function of business is to make investments when the return on invested capital exceeds the cost of capital and you may remember that you are supposed to focus on overall cash flow and not equity cash flow. None of these classic investment approaches have much to do with the two ratios in project finance. The objective of this chapter is to explain why.

Understanding Why the IRR is so Important in Project Finance

Over the years I have gained much more knowledge from general discussions with people who have endured the torture of attending my classes than by reading finance books and articles. Many times, the questions the students ask really make me think hard. A Malaysian lawyer once asked me, "What's IRR all about?" She seemed to be wondering why the management of her company was so focused on this number. I often ask my course participants why executives focus on this statistic for investment decisions. The typical answer I receive is something like the IRR is the rate of return. This is like saying a pilot announcing that the airplane is arriving late because of the delay in the flight landing at the airport – there is no information. But my answer to the question at the time was even worse. From some university class many decades ago, I learned that the IRR is the discount rate number that makes the NPV equal to zero and that was my response to the lawyer, and which disgusted her. Not only does the answer not mean anything; it puts focus back on the cost of capital. My answer and vague statements about the IRR being a return do not address the underlying idea of what IRR really measures and why CEOs of companies care so much about the number. For me the best answer is that IRR is the growth rate in your money from making an investment. When you see that everything comes down to compound growth rates, returns and IRR's and that capitalism is driven by growth, you have a big foundation in valuation and many other issues (I am not saying that this is good for humanity). But this growth rate has some complications.

The nice thing about the stock price graphs presented earlier that use the Yahoo adjusted close is that evaluate results of an investment in a stock can be evaluated with the IRR after the fact and this growth rate is the same as the IRR.[54] The yahoo finance adjusted close assumes that dividends received are re-invested in the same stock, meaning the growth rate in the adjusted closing price can be used to compute the IRR and we don't have to worry about the re-investment rate. In a leveraged buyout transaction, the equity investment is made at the transaction followed by a period where zero or little dividends are received. Then, once the debt is repaid, the equity can be received in a lump sum when the company is re-sold. This means that we do not have to worry about re-investment and the IRR is the same as the growth rate with no ambiguity.[55]

The classic definition, which is correct, is that the IRR is the discount rate that makes the NPV zero. Probably comes from the teaching of NPV and the fact that you could not compute with your HP calculator. Now has taken over. When discuss return probably talking about the equity IRR. IRR can be defined as the growth rate in cash flows with a very big asterisk. This asterisk is that it is assumed that any dividends received are assumed to be re-invested in a similar asset with earns exactly the same return. So the next fundamental concept is that the IRR and the growth rate are the same.

In the last chapter I presented the growth rates (which is the same as the IRR) for various stocks which was computed from the amount of the investment, re-investing dividends in the stock and then selling the stock. Wouldn't it be good to make the same kind of evaluation for any other investment that pays off in the future where the growth rate in our money is established. Couldn't we just replace the historic cash flow that is computed by yahoo finance with future projected cash flow from our investment in anything else ranging from spending money on advertising to buying a company and then determining the growth rate. The answer is no. In evaluating any investment from buying a stock to acquiring a company to investing in a hydrogen project to investing in advertising, to paying for your own education to buying a lottery ticket, we are evaluating the investment relative to uncertain future cash flow, and the success of the investments depends on some kind of explicit or implicit cash flow projections. These projections include some intermediate cash flow before the end of the project. Unlike the stock price, this cash flow cannot automatically be re-invested in the same investment, and some assumption must be made with respect to what happens to this cash flow.

Computing the IRR by Hand as the Growth Rate in Cash

[54] You can work with the stock price and beta file at https://edbodmer.com/comprehensive-stock-price-analysis/ where the IRR is computed with the XIRR function and the compound annual growth rate is shown to produce the same value.

[55] You can work through exercises in the IRR file at https://edbodmer.com/project-finance-theory-and-contracts/.

In this chapter I address issues related to the IRR including the real meaning and a good definition of the IRR; why the equity IRR has become so pervasive; well-known problems with the IRR; bigger problems with alternatives to the IRR; interpretation of high or low IRR's; Oxford Professor stated that IRR is BS. Maybe he was advocating to use NPV which in the end is no different from IRR, but which implicitly suggests that you should not evaluate risk with alternative scenarios. Maybe he is thinking about the well-known problems of re-investment or multiple IRR's, the fact that with fairly high IRR's, the IRR gives no value to cash flow far in the future or that the IRR does not directly measure the effect on returns from changing risk. The real issue is coming up with a good alternative and understanding why IRR is computed.

		0	1	2	3
Free Cash Flow					
Cap Exp		1,000.00			
EBITDA			400.00	400.00	400.00
Cash Flow		(1,000.00)	400.00	400.00	400.00
Discount Rate	6.00%				
NPV	65.29				
IRR	9.70%				
Cash Balance					
Opening Balance			-	400.00	838.80
Add: Re-investment	9.70%		-	38.80	81.37
Add: Cash Received			400.00	400.00	400.00
Closing Balance			400.00	838.80	1,320.18
Final Cash	1,320.18				
Initial Cash	1,000.00				
Multiple	1.32				
CAGR	9.70%				

This fact that cash flow between when we first take money out of our pocket and then have many periods when we receive or pay money creates what I call the re-investment headache. The problem with the IRR statistic is that the intermediate cash flow assumes that we can invest the money at the same rate as the IRR itself. You can prove that the IRR is the growth rate with reinvestment at the IRR itself by setting up a simple little example with an up-front investment, some cash flow received and an assumed lifetime for the investment. When cash is received, you set up an investment account with an opening and closing balance and then allow the cash in the investment account to grow by investing in other projects that receive the same IRR. At the end of the life of the project, you can tabulate the accumulated cash. When you divide the ending money by the beginning money and raise it to the power of one divided by the life of the project, you get the compound growth rate which is exactly the same as the IRR.[56] This just proves something that most will now, namely that the IRR is the growth rate with a big footnote. The asterisk is that to achieve the growth, the money must be invested at the IRR itself.

Risk Quantification in Your Daily Life

I have written most of this book whilst in airports, trains or busses in the process of travelling to different classes (I have a very good life). I have been writing this chapter after travelling to a city that I had not visited before, Krakow Poland (a wonderful place). As I had not been to Krakow, before I had to decide how to assess the risk of making mistakes in getting to the airport; in being able to have my passport checked by Ryanair and waiting in the line for security. This all made me a bit nervous, and I even may have lost a little sleep about it. So even though the flight was at 11:40, I left the hotel at 8:30. I made the decision to leave early

[56] You can write IRR = (Ending/Starting)^(1/life)-1, where Ending in the formula is the accumulated cash with re-investment at the IRR itself (no circular references here).

because I was worried about getting on the wrong train to the airport, waiting in long lines for Ryanair and so forth. My sister thinks I have big psychological problems and maybe you agree.

I am sorry if I wasted your time about this story, but the reason I did was to make you think about how risk can be evaluated in the real world. In determining how much extra time to leave I could have tried to research some kind of statistic like beta (I have no idea how I could have even thought about this), but instead I used a downside risk process. I implicitly used something just like the DSCR there you could write the formula as:

DSCR = Total Time for Getting to Airport/Minimum Time Before Default

This measure of risk allows me to assess how much buffer I have before something bad happens. I suggest it is a very reasonable way to measure risk relative to more fancy statistical measures. If I go back to Krakow, I will know how the train to the airport works and use my experience at the airport to think about how much buffer I need next time. This way that risks diminish over time is very much like the way the DSCR's decline after a bank gains more experience in an industry (the solar industry is a good example of this where DSCR's now seem to be consistent around the world).

What is the Risk of a Solar versus Wind versus a Battery Project

A very nice man who was attending a virtual class of mine asked me which is riskier, a solar project, a wind project, or a battery project. My normal response may have been a bunch of gobbledegook about the variability of wind compared to solar, whether batteries are proven technology over their lifetime; uncertainty in battery parameters of degradation, round-trip efficiency and state of charge …

Somebody who just completed an MBA program would try to find companies that only develop solar projects; companies that only own wind projects and companies that are only involved in the ownership of batteries. Then I suppose one could try to find betas for these companies –(all of this would not be possible). After you somehow found some kind of comparable company, you would have to un-lever the beta and re-lever the beta. You could get into arguments about whether the beta should be computed from daily, weekly or monthly stock price data and whether the beta should be mean reverted with the arbitrary two-third and one-third adjustment made in an academic article by Professor Bloom in the 1970's.

I think we can agree that this would be utterly ridiculous. Instead, if you follow the project finance industry you could ask lenders what DSCR's they use for the different projects. You would receive some fancy banker talk but, ultimately they would probably tell you that solar projects have a DSCR of 1.20 (based on a downside scenario) and wind projects may have a DSCR of 1.35 to 1.40. As to batteries, this is a new industry and they may not yet have easy numbers. Can you think of anything better. The idea of this introduction is to have you see how bankers and more specifically bankers using the DSCR give you an objective definition of the risk of a project – a better definition than you can get just about anywhere else.

DSCR, Downside Buffer and Risk Assessment

For people who are not bankers or have never been bankers, the importance of developing a reasonable downside case may not seem like a big deal. But when you think about a bank and how it structures debt around a pessimistic case, this single issue of a downside case becomes essential. If a bank makes a downside case that is too optimistic, then a lot of loans will go bad. If a bank makes a downside case that is too pessimistic, it will get no business.

In structuring debt and developing downside cases, the DSCR statistic becomes the central measure of risk. Furthermore, as the debt size drives the value of the project, the DSCR is instrumental in the economics of project. The DSCR is measured by cash flow that is available to pay debt service (CFADS) divided by the amount of money that you pay to the bank – the interest and principal which is the debt service. The division of CFADS by Debt service provides a measure of how much cash flow can decline before it will not be enough to pay off the debt service. For example, if the DSCR is 2.0 from Cash flow of 200 and debt service of 100, then the percentage by which the cash flow can fall before not being able to pay debt service is 50% [(200-100)/100]. If the DSCR is 1.2, the percent by which the cash flow can be reduced is 16.67% (.2/1.2). The break-even amount of buffer in cash flow can be expressed as (DSCR – 1)/DSCR.

DSCR = CFADS/Debt Service

Percent Cash Flow Reduction Before Not Paying Debt = (DSCR – 1)/DSCR

In addition to the DSCR, there are two cousins of the ratio that reflect the ability of cash flow to repay debt over the life of the loan or the life of the project. These ratios are the LLCR and PLCR which in a sense reflect the loss given default and the potential of the debt to be restructured and still meet all of the required debt service. These two ratios involve computing the present value of the cash flow and debt service rather than computing the ratio on a periodic basis which is the case for the DSCR. The ratios also reflect a key fact that the present value of debt service at the interest rate on debt is the same as the value of the loan. Equations for the ratios are:

PLCR = Present Value of CFADS over Life at Interest Rate/Present Value of Debt Service

PLCR = Present Value of CFADS over Life at Interest Rate/Debt Outstanding at COD

LLCR = Present Value of CFADS over Debt Life at Interest Rate/PV of Debt Service

LLCR = Present Value of CFADS over Debt Life at Interest Rate/Debt Outstanding at COD

As with the DSCR, the PLCR and the LLCR can be used to measure probability of loss on a loan. If the LLCR is below 1.0, the cash flow is insufficient to pay off the loan at the maturity of the debt. If the PLCR is below 1.0, there is not enough cash flow to repay the debt by the end of the life of the project.

Chapter 19: The History of Project Finance and Contracting

If you begin working for a company working on project development or working for a bank on evaluating transactions, you will have no idea where the project finance comes from. I worked on transactions in the 1980's when projects were in their infancy. At that time we did not think much about why the project financing was good for society.

When you are thrown into your first project finance transaction, you will see that any model, any investor memorandum, any sale and purchase transaction will emphasize two different financial ratios. The first is the IRR and the second is the DSCR. The IRR referred to in all of th

Les Trente Glorieouses and MAGA or MUBA – 1945 to 1973

To think about project finance, I use the energy industry as an example. I begin with by going backward to a time when project finance was not much of a subject. Some people long for these old days and perhaps the movement make America great in is referring to this period. In France, the period is referred to as Les Trente Glorieouses, or about 30 years after the second world war before the dramatic oil shock of 1973. It may be difficult for a young person to think about life before refrigerators, washing machines, television sets, vacuum cleaners, electric/gas stoves, dishwashers and other electric appliances. These appliances grew exponentially and were powered by electricity plants that used fossil fuels including oil. Demand growth and economies of scale implied that government ownership or a system of regulated prices was not controversial. Prices of electricity were falling, and GE was the one of the most valuable companies in the world.

From a financial perspective, government ownership or cost plus regulatory systems supported making long-term investments. If investments in electricity generation and other infrastructure were subject to oblesence risk, competition from new entrants, demand risk and other risks that had to be incurred by regular companies, the ultimate cost to society (electric bills) would have been much higher than it was. In the US, the system of cost plus regulation to support long-term investment was advocated by Samuel Insull. In this system, Electric Ultility companies earned stable returns (which were probably somewhat but not dramatically above the cost of capital.

Samuel Insull	
 Insull in 1920	
Born	November 11, 1859 London, England, United Kingdom
Died	July 16, 1938 (aged 78) Paris, France
Resting place	Putney Vale Cemetery, London
Occupation	Business executive
Known for	Chicago utilities empire
Spouse	Gladys Wallis (m. 1899)

After World War II, one of the most dramatic events was the oil crisis of 1973 and 1979 which

, parf you begin working for a company working on project development or working for a bank on evaluating transactions, you will have no idea where the project finance comes from. I worked

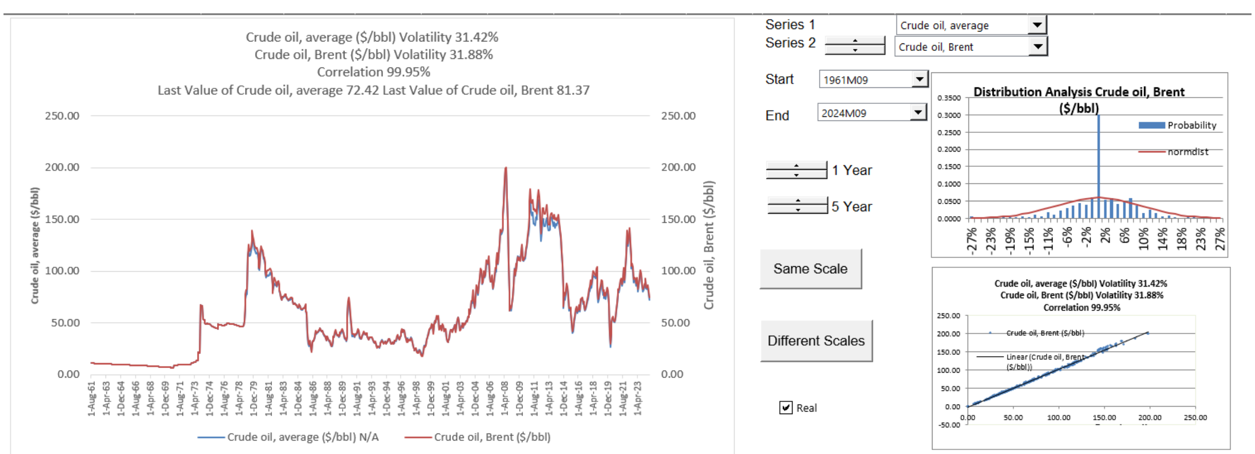


TABLE 1

PSNH SEABROOK STATION -
UNITS 1 AND 2

DATE OF ESTIMATE	COMMERCIAL OPERATION DATE UNIT 1	COMMERCIAL OPERATION DATE UNIT 2	UE&C AMOUNT (MILLIONS)	TOTAL (MILLIONS)
7/73	11/79	09/81	$ 710	$ 1,175
5/74	11/79	09/81	798	1,300
10/75	11/80	11/82	895	1,545
10/76	11/81	11/83	1,150	2,015
7/77	07/82	07/84	1,150	2,150
12/77	12/82	12/84	1,335	2,355
12/78	04/83	02/85	1,448	2,610
12/79	04/83	02/85	1,672	3,162
4/81	02/84	05/86	1,950	3,560
11/82	12/84	03/87	2,846	5,120

Allocate the risk between the investor and private contractor and the off-taker.

Risk to Be Allocated

1. Generation Level from Changes in Demand
2. Generation Level from Changes in Plant Availability
3. Cost Over-Run
4. Construction Delay
5. Plant Efficiency (Heat Rate)
6. Change in Fuel Price
7. Change in Real O&M Cost
8. Change in Inflation Rate
9. Change in Interest Rates and Cost of Capital

Chapter 20: Balancing Benefits to Parties in Project Finance with Case Study

Foundation of risk and return

What really drives risk – how can beta really differentiate between mean reverting and non-mean reverting cash flow

Importance of debt and Miller and Modigliani

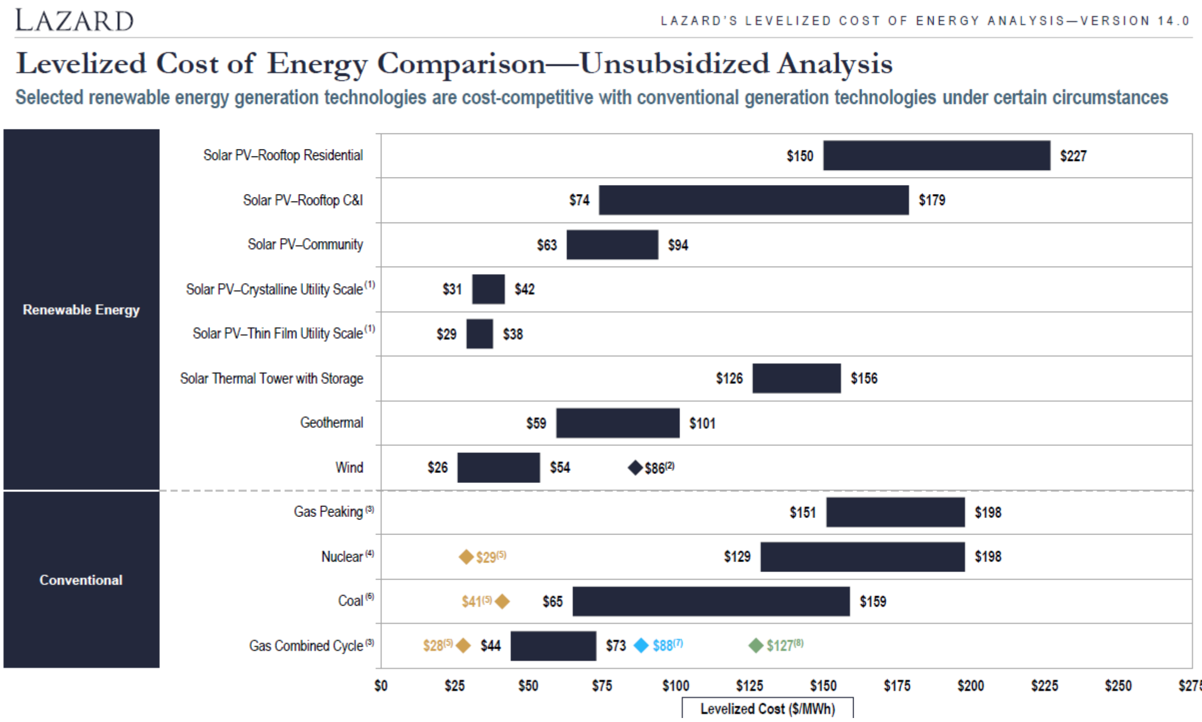
Upside and cost of capital

Project Finance and Correctly Measuring the Economic Cost of Long-term Investments

In assessing the cost of different alternatives for meeting addressing climate change, the overall cost to people or institutions who pay for the product is paramount. Note that I may argue with engineers who may focus only on efficiency in things like converting energy from one form to another instead of the overall cost. For example, if a green hydrogen project that loses a lot of energy in converting water molecules to energy (i.e., it is inefficient) can be done with a very low capital and operating cost, it may be economic in producing ammonia, steel, airline fuel or even fuel for automobiles (maybe not short-term storage). To measure the total cost of different electricity alternatives, the levelised cost can be computed (which can be called the total operating cost in transport or the break-even cost in commodity price analysis). For electricity, this calculation attempts to boil down the cost of a project over its entire lifespan to the cost of producing electricity in a single hour – the cost per kWh which is called the levelised cost of electricity. Please do not jump up and down and complaining about inappropriate calculations for something that you can control like a car or a dispatchable plant with something that is controlled by somebody or something above like the amount of clouds that diminish the sunlight hitting a panel.

The levelised cost of electricity can be used to demonstrate cost of capital issues and the essence of why project finance is so important in making investments that can combat climate change. To illustrate the way levelised cost can be distorted from bad finance theory and practice, I use the levelised cost of electricity published by an investment bank named Lazard.

Lazard is a large investment bank in New York and the levelised cost calculations made by the company are often used as a reference for evaluating different energy alternatives. I remember the Secretary of energy in the U.S. using a report published by Lazard to argue for expansion of solar power. The excerpt below shows one of the reports – a football field diagram – that was published by Lazard.[57] The Lazard report demonstrates the kind of distortions that are made by large financial institutions. These problems are illustrated by the number $129/MWH in the football field diagram which can be written as 12.5 cents per kWh and compares to the low cost of solar power of 2.9 cents per kWh.



To understand how the numbers are computed (and how easy they are to compute), you can begin with the operating assumptions (capital expenditures and operating expenditures and the life of the project) documented in the Lazard report and repeated in the excerpt below. If you look around carefully, you can find the financing assumptions as well. The report I used was from 2020 when the yield on U.S. long-term treasury bills was around 1.75%. It is common for project financed investments to fund investments with 75-80% debt to capital and a credit spread of around 1.5% leading to an interest rate of 3.25%. Equity returns at the time could be

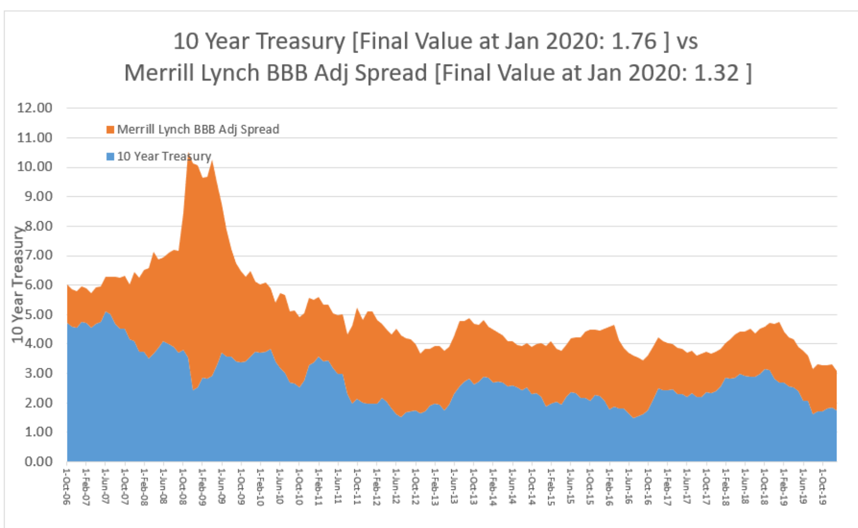
Key Assumptions (4)	
Capacity (MW)	175
Capacity Factor	38%
Fuel Cost ($/MMBtu)	$0.00
Heat Rate (Btu/kWh)	0
Fixed O&M ($/kW-year)	$39.5
Variable O&M ($/MWh)	$0.0
O&M Escalation Rate	2.25%
Capital Structure	
Debt	60.0%
Cost of Debt	8.0%
Equity	40.0%
Cost of Equity	12.0%

57 Lazard Report on Levelized cost of electricity, published in 2020 at the website.

below 6%. Yet Lazard used an interest rate of 8%, a debt to capital ratio of 60% and an equity IRR of 12% as shown in the adjacent insert.

In addition to using high cost of capital that does not reflect project finance, the Lazard calculations hold the levelized costs constant in nominal terms over the lifetime of the projects. When evaluating the cost of capital, operating costs, or cash flows in finance, it is essential to keep inflation assumptions consistent. In the case of levelized cost, a flat nominal levelized cost is equivalent to a real cost that dramatically declines over the lifetime of the project. In the adjacent table I have re-computed the Lazard levelised cost for a nuclear plant and correctly accounted for inflation. The number at the bottom right of .127 USD/kWh conforms to the Lazard number shown in the football field table above (the calculations can be made in a simple way using a couple of formulas).[58] When adjusting the levelised cost, this number of .127/kWh is 218% above the real economic cost of .058/kWh computed with the same operating assumptions, but a longer life, the real cost and cost of capital that reflects project financing.

		Real	Short Life	Lazard WACC Real	Lazard WACC Nominal
Capital Cost	USD/kW	7,675	7,675	7,675	7,675
Life	Year	65	40	40	40
Project IRR	%	4.90%	4.90%	9.60%	9.60%
Inflation	%	2.25%	2.25%	2.25%	2.25%
Real	%	2.59%	2.59%	7.19%	7.19%
Capital Cost	USD/kWy	245.43	310.48	588.32	756.13
O&M Factor	Factor	1.00	1.00	1.00	1.29
O&M Cost	USD/kWy	149.22	149.22	149.22	191.78
Total Fixed Cost	USD/kWy	394.65	459.70	737.54	947.91
Capacity Factor	%	92%	92%	92%	92%
Real Capital Cost	USD/kWh	0.049	0.057	0.092	0.118
Fuel Cost	USD/kWh	0.009	0.009	0.009	0.009
Total Cost	USD/kWh	0.058	0.066	0.100	0.127
Versus Real			113.95%	173.54%	218.66%



58 You can find the spreadsheet that is used for this example with the formulas at www.edbodmer.com

Chapter 21: Quantifying Risks and Cost of Capital Using Volatility and Mean Reversion

Force you to think about different kinds of risks. Reviewed Moody's and Standard and Poor's risk discussion that drives ratings which is vague. Put example.

Mean Reversion and the Mathematics of Deriving an Appropriate DSCR

Thought about introducing Monte Carlo simulation in classes. The simulation is used to illustrate the importance of mean reversion in evaluating risk and to demonstrate how the level of volatility in theory drives the DSCR that is required by the bank which in turn ultimately drives the economics of the project. Before working through the formulas for volatility, mean reversion and the structure of the debt it is helpful to think about mean reversion concepts as well as volatility. Volatility is founded in standard deviation and specifically measures the standard deviation in the percent change of a variable on an annual basis. Mean reversion measures the tendency of a variable to move back to its average level after a period of time. The classic example of a non-mean reverting series is a stock price while the classic example of mean reverting series would be weather (except for changes caused by global warming). The table below lists some things that are mean reverting and things that are not.

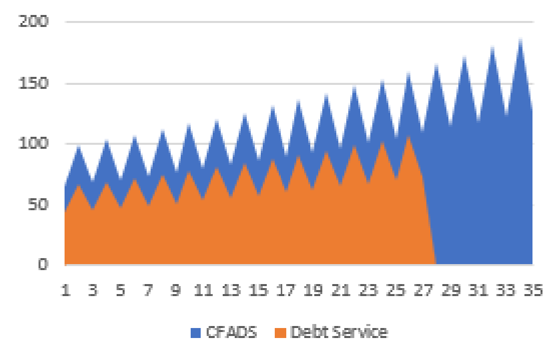
Mean Reverting

- Solar and Wind Variation
- Commodity Prices moving to marginal cost of production
- Movement in Traffic from year to year after initial traffic has been established
- Maintenance cost variation from year to year
- Refinery Margins
- Electricity Merchant Prices in Markets with Little Renewable Capacity

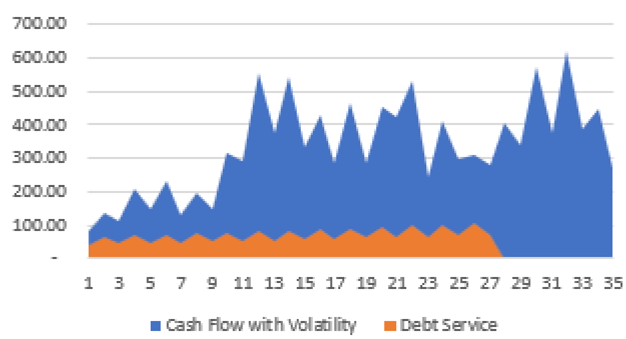
Non-Mean Reverting

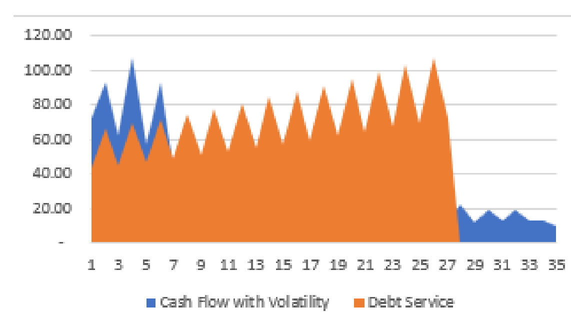
- Stock Prices
- Items that go out of fashion such as handbags
- Items that become obsolete like Kodak Cameras and Blackberry
- Sudden Political Decisions to Nationalize Industries
- Errors in Modelling Solar, Wind or Toll Road Traffic

The reason I delve into this mathematics is the project finance and risk analysis in general make an important distinction between things that are mean reverting ant things that are not. Mean reverting series have a lot less risk and can be financed over the long term. Things that are not mean reverting can generally not be financed over long period. To illustrate the importance of mean reversion in risk analysis and ultimately obtaining a low cost of capital for capital intensive climate combatting projects, scenarios with different volatility and mean reversion are presented in below.



In the example, begin with structuring the debt where the size of the debt or the present value of the debt service depends on a target DSCR. The cash flows are assumed to be seasonal and growing that could reflect a renewable energy project. The key graph for a banker demonstrates the cash flow and the debt service to illustrate the DSCR, the Debt Size and the buffer that the end of the project life (the debt size is the present value of the brown area). As in real projects, the actual cash flow will not be the cash flow modelled at the date that contracts are signed (the financial close date) and different projects will have different levels of volatility which could result in the blue line being below the brown line (a DSCR of below 1.0) and even that the present value of the blue area being below the present value of the brown area (a PLCR of below 1). In banking parlance this is credit analysis rather than structuring. With a volatility of 20% and no mean reversion, potential actual scenarios are illustrated below.





Monte Carlo simulation involves running thousands of cases with structured random number drivers to measure the probability of the minimum DSCR, the LLCR and the PLCR being below 1.0. Using the probabilities, different levels of DSCR targets can be used to manage the cash flow risk of the project. Scenarios with different volatilities, mean reversion factors and target DSCR's are shown in the table below.

Volatility	20.00%		
Mean Reversion	0.00%		
Target DSCR	1.5		
	DSCR	PLCR	LLCR
Count	1000	1000	1000
Count < 1	756	280	306
Probability	75.60%	28.00%	30.60%
Average	0.68	1.70	1.52

Volatility	20.00%		
Mean Reversion	50.00%		
Target DSCR	1.5		
	DSCR	PLCR	LLCR
Count	1000	1000	1000
Count < 1	773	0	0
Probability	77.30%	0.00%	0.00%
Average	0.90	1.76	1.50

Volatility	10.00%		
Mean Reversion	0.00%		
Target DSCR	1.2		
	DSCR	PLCR	LLCR
Count	1000	1000	1000
Count < 1	466	36	92
Probability	46.60%	3.60%	9.20%
Average	1.03	1.77	1.50

Volatility	10.00%		
Mean Reversion	50.00%		
Target DSCR	1.2		
	DSCR	PLCR	LLCR
Count	1000	1000	1000
Count < 1	13	0	0
Probability	1.30%	0.00%	0.00%
Average	1.20	1.77	1.50

Monte Carlo to Illustrate Risk, Not to Measure Risk

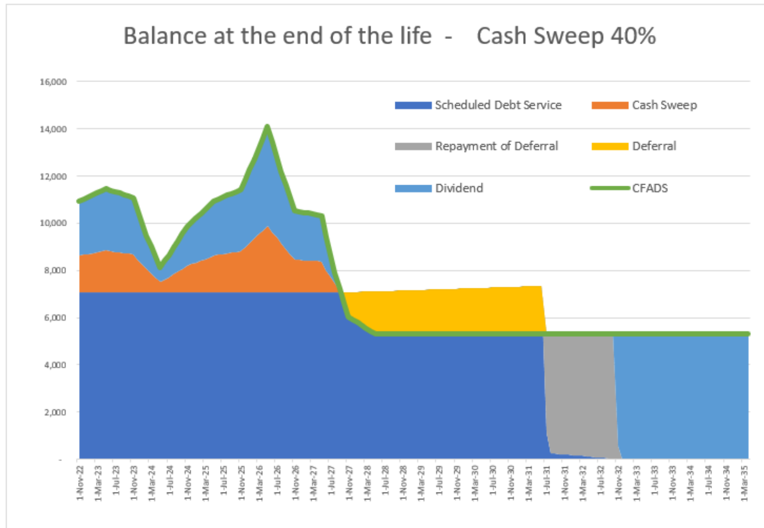
Equity has upside and downside. Use simple Monte Carlo simulation to illustrate risks. Do not suggest that about volatility in a very simplistic faces let's assumption that Equity cash flow Equity cash flow has more risk with more debt. In other words, if two projects have the exact same dial are which means they have the same return on invested capital economic depreciation then if these projects have the same risk to different projects Jack with the higher level of debt higher variability in equity cash flow and the graph below uses a very simple example to give us breaks babe given that the equity cash flow is and if you want to that's okay that you can say if that slowly economy and therefore the overall Market then at the end tell her that she should have today if you want to go there and you could even put together the Forum either of the asset Equity the capital equity the capital times debate of the Dead if there is more that there's more risk associated with it.

If we have two projects exactly the same if we have two projects that have exactly the same return on invested capital the project with higher level of debt has a higher required Equity irr because of the higher Beta. And so long no turn if the two projects has this at the same required return on Equity or equity IRR then the if the bankers adjust the debt structure to meet the same triple B credit requirements they even out equity risk the lower amount of debts or the shorter debt tenor or other debt terms associated with the riskier project Lower the equity IRR on a project being equal at the same Equity I are

For different rates of return or required rates of return on invested capital all of this means that the debt providers the debt structuring a way to come up with the required rate of return or overall return on invested capital and overall return on invested capital is the overall cost of capital for the project. That is essentially a weighted average cost of capital because of tax issues and we can't say weighted average cost of capital because structure over the life of a project might not be we will not be in the same across time.

Debt not paid	-
Debt balance Input	700,000
Volatility	24%
Mean Reversion	0.00%
Cash Sweep	40%
Start Row	21
Total Simulations	1000
Probability of Default	0.00%

Reset



Why Project Finance is a Good Starting Point for Risk Analysis and Valuation

Objective of discussing some nuanced issues in project finance analysis. Work through different issues. See that can get real understanding of risk and contrast to corporate finance that has crude methods and not real understanding.

So that's the way it's a different way of backing in cost of capital. Now to think and come up with real world answers to acquired rate of return is. In the next section/chapter we're going to talk about the more nuances of project financing Finance. We will work through some risk issues with project Finance in Finance literature add and come up with some very general chance of risk of business risk it might be called these things a categorize the wrist evaluate and when you we need how credit rating agencies example come up with the credit rating on a on a bonds or how bankers evaluate the credit rating of a loan you might see a score for the business risk of a company which covers things like competitive risk covers things like maybe they even tried to measure the volatility and cash flows from the trough of a business cycle to the peak of a business cycle maybe it has a category called illogical risk all of these things which almost meaning when I try to think about risk. I will try to have some sort of way to quantify risk I'll mention two ideas hopefully they'll not take me way off track one idea is issue of mean reverting and cyclical kinds of risks for example risks that the oil price go up and for even a more extreme case risks that will have a cold winter or a warm winters.

Mean Reverting and Non-Mean Reverting Cash Flow – Does Beta Really Distinguish Between Risks

Project finance delves into individual risks and studies them. Never any discussion about diversifying risks. Contrast with beta, CAPM, DCF where through everything into crude concoction and magically come up with a measure of risk. I am not advocating that project finance is somehow better. But hopefully making you think. The second type of risk of things going out of fashion risks of the first case with mean reverting patterns. One should be paid very differently for risks that are mean reverting from risks that suddenly and dramatically change. Think of your life. A mean reverting risk may be if you have education and skills, but you have some bad periods. A non-mean reverting risk may be that your skill becomes worthless. Maybe a finance professor can say that non-mean reverting risks can be diversified away and that beta can capture these risks. The finance professors may also say that the lower risks with mean reversion can also be incorporated in beta and when the overall market moves up or down, the company with mean reverting risks will have a lower beta.

In the first things are cyclical where the sun comes up and down where are Commodities move up and down where they called mean reverting. In those sorts of circumstances that risks are mean reverted we might have to have a lot of patience we have some we know that there's going to be volatility associated with a mean reverting cash flow. But that is really different from volatility of a non-mean reverting cash flow. A mean reverting cash flow are things like fashion and how do you know when something will go out of fashion. Victoria Secret would be a good example of a non-mean reverting Cashflow. When we go back to examples of Amazon and mean reverting item covid pandemic there certainly experienced some positive effects pandemic doesn't last forever. General Electric makes more money on conventional power plants like power plants. When there's a move out of fashion conventional technologies this is a non-mean reverting Cash Flow. Risks are very different. And when lenders Stay will evaluate the risks of they should evaluate these risks very different. You would have to be a real believer to suggest that beta can incorporate all of these different risks.

Now think about betas and the CAPM. Do you really believe the beta and arbitrage pricing model will correctly account for risks that are mean reverting and non-mean reverting cash flows. I don't. Much better to Evaluate the risks and give us an assessment structuring their debt around quantifying those risks setting the structure of the debt. Around those risks and using data risk analysis back in to the cost of copper. That's enough for free now. Discuss how to measure risks with mean reverting cash flow and estimate mean reversion parameters.

Graph with mean reversion and non-mean reversion

Lender Analysis, Downside Risks and Mean Reversion

In terms of investments for addressing climate change that have long lives and are capital intensive, project finance can be used to demonstrate the low cost of capital associated with investments. Some of the investments such as renewable energy has prices that are fixed with long-term contracts but volumes that depend on the amount of sunlight, wind, or water flow. The volatility associated with seasonal and annual cash flows are cyclical of these projects can be effectively managed unlike industries that are subject to changes in fashion. Even projects that are subject to commodity price fluctuations can be managed through hedging and evaluation of historic volatility. One could argue about the risk allocation and suggest that contract structures may transfer risks to the government, but one could just as well argue the deregulation of energy markets has done nothing other than increasing volatility to consumers.

Does Anybody Really Believe that Beta Really Captures All Risk

This chapter continues my obsession with the idea that studying the nuances of project finance can tell you a lot about evaluation of all sorts of financial issues. Here, I move from using project finance to measuring the rate of return to the difficult issue of evaluating risk. If you are a true believer in the stuff taught in finance, you should believe that every risk in an investment that is not related to the overall market can be diversified away and all of the risk that you should care about is stuffed into the beta statistic. I am not disputing the mathematical fact that when independent time series have a reduced variance when combined and a portfolio of investments reduces risk. But I do think it is dangerous to somehow believe a statistic derived from historic data can accurately be used to evaluate different types of risks and nuances that happen with actual projects.

In making an investment decision ranging from buying a stock to choosing a career to recommending an investment for your company, you need to assess risks in a more practical way than applying a beta statistic from historic data. There will be ups and downs in the cash flow or happiness from your investments. There also may be permanent changes in the future benefits that will never reverse. There is certainly not easy alternative to translating risk into value and one of the problems with beta is the presumption that this translation can be made. As an alternative, I will try to work through the issue of risk and value by studying how people whose entire job it is to assess risks of a particular investment – bankers and other lenders – implicitly measure the risks of individual projects. Maybe my real motive is to write about the essence of project finance which is to structure financing around the risks of a project. The idea of this chapter is that you can evaluate risk using project finance ideas. In project finance the debt is carefully structured around the risk of project. What I do not do in this chapter is to work through the mechanics of project and contract structure.

But we can be quite confident in one thing. That is, that no lender would use beta and the CAPM to assess the risk of investing in a new venture like an IT project; a boring project like a solar project with a lot of history; a project subject to commodity price fluctuations like an oil exploration project; a venture that depends on women liking a particular fashion of lingerie. I will try to do something that is very difficult – to derive the returns implicit that derive from different types of risks from use project finance as a base.

If you are asked about the risk associated with a forecast of cash flow for Amazon or GE, I cannot imagine that your assessment of risk would really be based the betas of the company. Perhaps if you're making some kind of big portfolio me about are you comes from how to practically get an assessment of the volatility. My objective is to prompt thinking of investment risks in a different way. When structuring the debt of a project financed investors, lenders come up with a I hope you think about mean reversion and cyclicality. I hope you think about the ultimate question of return and the dispersion of returns – even if you do not make a fancy financial model. Do you really evaluate risk with beta. Examples of new investments. Example of stable investments. Examples of investments with upsides.

Project Finance and Debt Capacity

Here is something I have observed about project finance and cost of capital. I ask people about required returns to see if I can find secrets about their required returns (I am not really that impressed with their secrets, but more curious). I ask this question knowing that different there are kinds of projects with very different kind of cash flow patterns and certainly different kind of risk. I don't even ask whether they are talking about project IRR or equity IRR. What I often find is that investors (developers of the projects) are almost exclusively talking about return on equity capital (the equity IRR). Further, and more interestingly, they generally have similar required rate of return on equity capital for different types of projects. The projects may be a toll road could be a conventional electricity plant such as a natural gas plant or other projects like a hospital or a factory.

the required return vastly different projects on equity is it is very is often very similar let me put it that way find that return you can say well I found the cost of equity capital because the cost of equity capital is

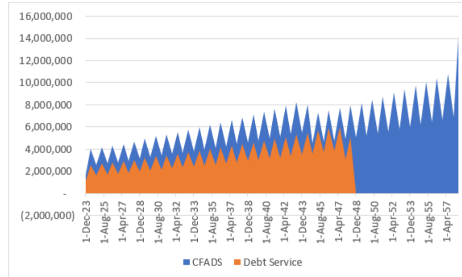
Key Dates	Start	
Financial Close Date	1-Jan-23	
Commercial Operation	1-Dec-23	
Operations Period End	1-Dec-58	

Key Metrics - Tariff & Financial Score		
PPA Rate (USD/MWH)	33.00	
PPA Inflation	200.00%	
Capacity (MWp)	132	
	kWh/kWp	Cap Fac
Annual Yield - P50	1,980	22.60%
Annual Yield - P90	1,726	19.71%
	USD	USD/kW
EPC Cost	118,800,000	900.00
Total Plant Cost	122,400,000	962.41

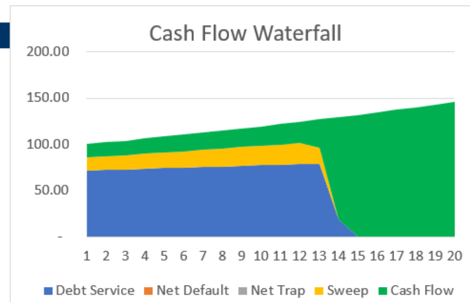
Uses of Funds	
Total EPC Cost Incl. Contingency	118,800,000
Interest During Construction - Senior	3,600,000
Up-Front Fee	2,537,583
Commitment Fee	842,937
Interest During Construction - SHL	192,179
DSRA	1,065,999
Total	127,038,698

Return Metrics	
Equity IRR -- All Equity	8.70%
Post-Tax Project IRR	7.72%
Pre-Tax Project IRR	7.46%

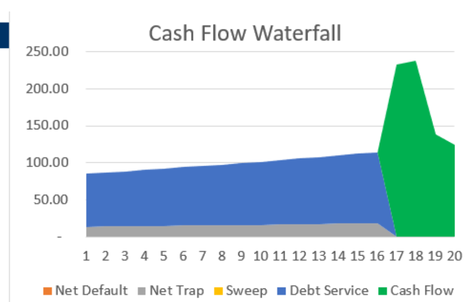
Debt Metrics	
DSCR Output from Sculpting	1.23
LLCR	1.53
PLCR	1.91
Average Debt Life	18.25
Model OK	TRUE
Debt Size	84,293,745
Resource Standard Deviation	10.00%
Yield	1,980
Debt Tenor	25
Apply Minimum Debt Amount ☑ Minimum	TRUE
Structuring Case	P90 Debt Size Case
Debt Fixed from Other Structuring Case	TRUE
Circular Resolved	TRUE
Degradation Scenario	Base Degradat
Construction Period	11



Inputs				
Cashflow	100.00		Ending Default	-
Volatility	0%		PLCR	1.65
Mean Reversion	50%			
DSCR for Sculpting	1.40			
Debt Tenure	16.00			
Interest Rate	5.25%			
Cash Trap Covenant	1.20			
Cash Sweep Percent	50%			
Growth Rate	2%			
Adjusted Starting Index	1.00	100		



Inputs				
Cashflow	100.00		Ending Default	-
Volatility	0%		PLCR	1.41
Mean Reversion	50%			
DSCR for Sculpting	1.40			
Debt Tenure	16.00			
Interest Rate	5.25%			
Cash Trap Covenant	1.20			
Cash Sweep Percent	50%			
Growth Rate	2%			
Adjusted Starting Index	0.85	85		



Risk and Return Analysis from Project Finance

Some of the things that may be a little new in this chapter come from incorporating project finance ideas into corporate finance and valuation. As with other chapters, I do not suggest some kind of formula which can solve the problems. Ideas like the fallacy of assuming a constant cost of capital over the life of a project, understanding why straight-line depreciation distorts, impairment write-offs and development risks distort rate of return statistics and using debt capacity to measure risk. These ideas will be the basis for a lot of analysis in subsequent chapters.

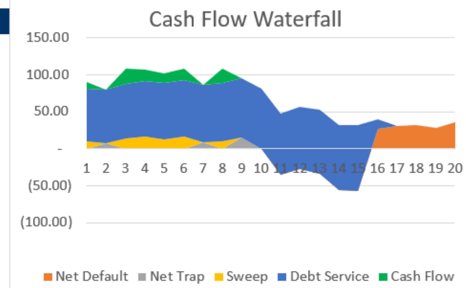
Different types of risks and mean reverting risks versus permanent risks. Victoria Secret example.

1. Start with development risk and understand that development and research are very different – can allocate development risk to a project and it is done in project finance.
2. Development risk demonstrates the difficulties in valuing companies that have a lot of start-up projects where the probability of failure should be allocated to the cost of a project and can measure the ultimate return by accounting for the development risk. When sell all or a part of the project based on the investment, should account for the development risk.
3. How the development risk is relevant for corporate valuation. Corporate valuation includes as operating expense, but if change the growth rate should change the capital expenditures. Does not work as a percent of revenues. Example of no real growth.
4. How changing risk over the life of projects affects the measured IRR and valuation over the life of a project and results in capital gains
5. How start-up risk and development risk can be incorporated into IRR, ROIC and valuation analysis through asset value write-ups and probability rather adjusting target IRR
6. Why debt capacity and debt structure are part of the fundamental analysis in project analysis and why risk is not measured with anything like beta in real world project analysis
7. How equity IRR is used instead of project IRR and why WACC is irrelevant in project analysis

The Beauty of Project Finance – Lenders Structure Financing Around the Economics and the Risks of a Project

Need discount rate or minimum required IRR to compute the value. The practice is to have required equity discount rate. With discount rate can compute the equity value that depends on the risk of the project. Risk evaluated by debt structure. Use debt to compute the project IRR or the required ROIC. Show table with different DSCR and the same equity IRR.

Inputs			
Cashflow	100.00	Ending Default	128.72
Volatility	20%	PLCR	1.05
Mean Reversion	0%		
DSCR for Sculpting	1.40		
Debt Tenure	16.00		
Interest Rate	5.25%		
Cash Trap Covenant	1.20		
Cash Sweep Percent	50%		
Growth Rate	2%		
Adjusted Starting Index	1.00	100	



To introduce problems with measurement of return use project finance analysis. Modigliani and Miller and Project Finance Theory. Fundamental idea that project return should be higher than cost of debt (not ROIC and WACC but analogous). Then use Equity IRR to evaluate different investments. This is theory. No Beta. Really good to compare. This is the real world.

The most essential and beautiful part of project finance is that a lender – somebody who is not in the management of your company and who does not have vested interests in a project or who does not manipulate numbers to make a project look good – drives the investment decision. This may seem abhorrent to people who worship Merton Miller (like me), but it is not. The lender gets access to massive information about the project; the lender hires engineers and consultants to evaluate technical aspects of the project; the

So let's take a trip across time the life of a project finance transaction and while we are taking this trip we can think about valuation implications for corporate corporations that own different portfolios of assets.

The Magic of Letting Somebody Outside of Your Company (who puts a lot of money in your investment) Tell You About Risks

Earlier I defined the cost of capital using a hypothetical bidding situation and I wrote that the cost of capital is the lowest rate of return that managers will accept to win the bid. so how does this idea in project finance defining risk well in establishing the minimum rate of return -- the definition of the cost of capital work.

In project finance the debt financers will make an assessment of the risks of the project will carefully structure the debt and the risks of the project and around structure of the cash flow. You as the developer would like when we focus on the rate of return. If the risk is higher the debt terms will be negative is that the amount of debt will be less meaning that the tenor of the debt will be shorter and even the premium on the interest rate spread may be higher.

I am careful with the discussion of credit spread because a typical rule in Project Finance is that you push the debt up and push it up and push it up until you achieve a something like a BBB or Baa rating. Or in other words and investment-grade rating. In fact project finance loans often are or not rated. You can ask Bankers what kind of rating is typical internal rating is typical on Project Finance. They will give you some kind of numbering system or a letter system that is analogous to S&P and Moody's. Generally they will tell you that the project finance debt has typically has a rating in their system which is very much like a triple B or Triple B minus equivalent.

The key from this discussion of the bond rating is that if one project is riskier than another project, the structure of the debt will change. Through structuring the debt, the project finance lender has told you about the risk. If a project is considered to have more risk, the banker will put less debt into the project, the tenure will probably be shorter and there may be restrictions on the and the dividends from a cash flow sweep. We don't need to go through all of this stuff on the details of lending agreements. But we do need to see that, all else equal, the expected equity IRR with a lower amount of debt will be lower than equity IRR if there was more debt. This is why they say leverage in the U.S. and gearing in the U.K. As long as the overall return (for now you could either call it the return on invested capital or the project IRR) is more than the cost of debt, the equity IRR will be more than the project IRR.

Later on I complain about measuring the risk of debt that has limited downside risks and the cost of equity which can have a lot of upside potential – an aspect of cost of capital that is not implicitly or explicitly recognized in the CAPM. For now, we can assume that there is more variability in the risk to equity cash flow if a project has more debt. The idea is that debt is carefully structured from the risks and the structure of the project. Change the idea of return being greater than the cost of capital to Project IRR begin greater than the overall cost of debt. The cost of debt can include fees and changing credit spreads. The most fundamental idea is that project IRR should be higher than the debt IRR to achieve this Equity rate of return.

Figure xxx – Demonstration of Different Risks, Pushing Up and Down Debt and Leveling Volatility of Equity Problems of Considering Risk. Looking for definition. Looking for categories. Looking for pricing risks. Looking for ways to simulate risks. Sticking it all into beta does not get you anywhere.

Chapter 22: Cost of Capital in Project Finance - Absurdity of Un-Levering and Re-Levering

Cost of Capital in Project Finance

One of the characteristics of project finance is that it allows evaluation of the cost of capital for long investments such as renewable energy with revenue contracts to be resolved with project finance where the careful assessment of risk made by bankers drives the cost of capital. In project finance the overwhelming amount of capital is provided by a lender (often more than 80%). This level of debt means that much of the cost of capital estimate is the cost of debt. Even if the cost of equity is relatively high, the overall cost of capital will often be lower than the cost of capital resulting from standard techniques that rely on Beta, EMRP and terminal value. Some of characteristics include: (1) that risks of the investment can be managed and assessed over the long-term (even if revenues are somewhat volatile, as long as they are mean reverting); (2) risks are assessed using the debt service coverage ratio which evaluates potential percent reduction in cash flow and not a more theoretical notion of beta or value at risk; (3) the debt structure (debt size, repayment patterns and covenant protections) is carefully tailored to the cash flow risk and expected cash flow level; (4) as debt structuring adjusts risks of the project, the remaining equity cash flows have reasonably similar risk to debt where equity valuation is made using residual cash flow and IRR rather than DCF and WACC;

Project finance removes the distortions from accounting and the entire basis of maximizing debt leverage in project finance involves having an independent institution – the bank – assess the risks and make the vast majority of investment. The structuring of debt size and repayment to correspond to the specific risk of projects has a corollary with the remaining cash flow to equity. Even if project cash flows have very different risks and patterns, the cash flow after paying the debt service has a reasonably similar risk. In terms of the overall cost of capital that drives the economics of investments in projects such as those which could allow us to adapt to climate change, the size of the debt and the manner in which the debt allows equity holders to receive dividends Even if the equity IRR earned is above the cost of capital, the effect of debt leverage reduces the transfer.

In project finance transactions as the example shown in the above diagram there is some volatility from the solar volume. If a transaction has just about all cash flow locked in place, the volatility in cash flow can be just about zero. In other resource transactions (minerals, natural gas production or oil) there can be more cash flow volatility. When a lender structures the debt through determining the size of the debt, the length and pattern of repayment and added protections such as a cash sweep where debt is paid off early in high cash flow periods, the volatility is accounted for in the debt structure which is what project finance is all about. In a sense by changing the size and structure of the debt, the lender adjusts the risk and leaves equity holders with about the same risk. For projects with very little cash flow volatility sometimes called tight projects, an old project financing saying is that small risks can become very large (because of the high leverage). For projects with more cash flow volatility, the small risks are not a big deal. This idea that equity risk is magnified for tight projects demonstrates that equity risk for very different projects is evened out by the debt structuring and that the equity IRR requirements tend to be very similar for completely different projects.

Trying to Find the Beta of Project Finance Investments

To illustrate the benefits of using project finance I recount a discussion I had with employees from Shell Oil. When I was teaching a few years ago a person from Shell Oil attended the class and did not accept that project financing of renewable energy is driven by debt capacity and equity returns that can have a relatively small premium relative to bond yields. I unsuccessfully tried to explain how project finance and that the observed target equity IRR is just about independent of the capital structure and is not very high. If you target a high IRR you will have a staff of people who make bids and lose (which seemed to happen). But the person didn't pay attention and was frustrated that he could not find betas and then un-lever and re-lever the beta. If you used this technique and came up with equity IRR requirements above 10% you can be pretty sure that you may have a lot of people working on bids, but you will not win any of them (explaining why Shell's return on its renewable investment was so low).

Downloaded Equity Beta	0.60				Ba = Bd x D + Be x E							
Debt/Captital Book	55.00%				Be x E = Ba - Bd x D							
Market/Book	2.00				Be = (Ba - Bd x D)/E							
Debt/Capital Market	37.93%											
Debt Beta	0											
EMRP (Damodaran)	5.94%											
Rf	3.80%											
Asset Beta	0.37	Debt/Cap	37.93%	x	Debt Beta	0	+	Equity/Cap	62.07%	x	Equity Beta	0.60
Re-levered Equity Beta	1.86	Asset Beta	0.37	-	Debt Beta	0	x	Debt/Cap	80.00%	/	Equity/Cap	20.00%
CAPM Cost of Equity	14.86%	Rf	3.80%	+	Beta	1.86	x	EMRP	5.94%			

If you apply standard corporate finance principles, you would un-lever and re-lever betas for projects with high levels of debt in project finance and you will end up with a very high cost of equity and you ultimately remove many of the benefits of project finance. You would then measure the costs and benefits using an overall project IRR (analogous to the ROIC) instead of the equity IRR. This is counter to the way that IRR targets really work. It does not reflect the equity IRR's that are used by actual investors in project finance and leads to a much higher cost of capital. If companies such as Shell apply high target IRR's without considering financing, they will end up making high bids and end up with a lot of bureaucracy without many projects. When reviewing market to book ratios of renewable energy companies with high leverage, you can see that the cost of capital does not increase with the high gearing ratios. The next tables show that the equity returns are stable even though the debt ratios are high.

WACC with Un-Levering and Re-Levering

	Percent	Cost	WACC
Credit Spread	1.50%		
Debt	80%	5.30%	4.24%
Equity	20%	14.86%	2.97%
			7.21%
Inflation			2.50%
Real Cost of Capital			4.60%

Cost of Capital with Target IRR

	Percent	Cost	WACC
Credit Spread	1.50%		
Debt	80%	5.30%	4.24%
Equity	20%	7.00%	1.40%
			5.64%
			2.50%
			3.06%

Return on Ending Equity	2018	2019	2020	2021	2022	2023
Nextera	19.43%	10.17%	8.00%	9.59%	10.55%	0.00%
Ibederola	8.30%	9.20%	10.18%	9.55%	10.54%	0.00%
EDP Renovaveis S/A	4.82%	6.76%	7.60%	7.46%	6.81%	0.00%
ORSTED A/S	26.03%	8.90%	18.57%	15.95%	20.28%	FALSE
Shell Oil	11.20%	8.82%	-14.90%	11.49%	21.68%	0.00%
Total Energy	9.60%	9.67%	-7.48%	13.78%	18.61%	0.00%
BP Oil	8.95%	4.37%	-30.27%	9.76%	-3.72%	0.00%
Exxon Mobil	10.86%	7.49%	-14.27%	13.68%	28.62%	0.00%
Cheveron	9.60%	2.02%	-4.20%	11.27%	22.26%	0.00%
Saudi Aramco	40.81%	31.88%	18.55%	35.52%	41.21%	0.00%

Chapter 23: Changing Risk in Project Finance – From Venture Capital to Boring Annuity

Changing Risk and Upside Potential Meaning that WACC is Irrelevant

Classic finance and in particular cost of capital theory is centred around the CAPM which in turn assumes that returns are independently distributed over time, that there is no mean reversion and that the returns follow a normal distribution. Because of the changing risk of projects over time, the distribution of project finance returns can have a skewed distribution to the upside. This means that initially developing a project with a seemingly low return (maybe 200 to 300 basis points above the risk-free rate) can ultimately produce a much higher IRR. This negates any measurement of the cost of equity using levered and un-levered betas and/or applying the CAPM in project finance to estimate equity returns.

To demonstrate the manner in which risk changes for a project over time (and not for a corporation) I present the example of a romantic relationship below. We begin with the first date in the dating stage. For project finance this is the development stage. The probability of this first stage resulting in a project with low risk or a boring life with grandchildren is very small. If you make it through the dating/development stage, you may reach financial close where you make implicit or explicit contracts (in the romantic scenario, you promise to love the other person forever). Once you have made the commitment to get married the risk changes. Now you have to make it to the wedding date or in project finance to the financial close. After the wedding date you still do not know if things will work out. Risk is not really reduced until you have some history. The risk is declining at each stage. As the risk changes, so does the cost of capital. It would be crazy to apply the same WACC to the project at different stages the different stages.

Adjusting Debt Capacity for Two Projects with Different Risk

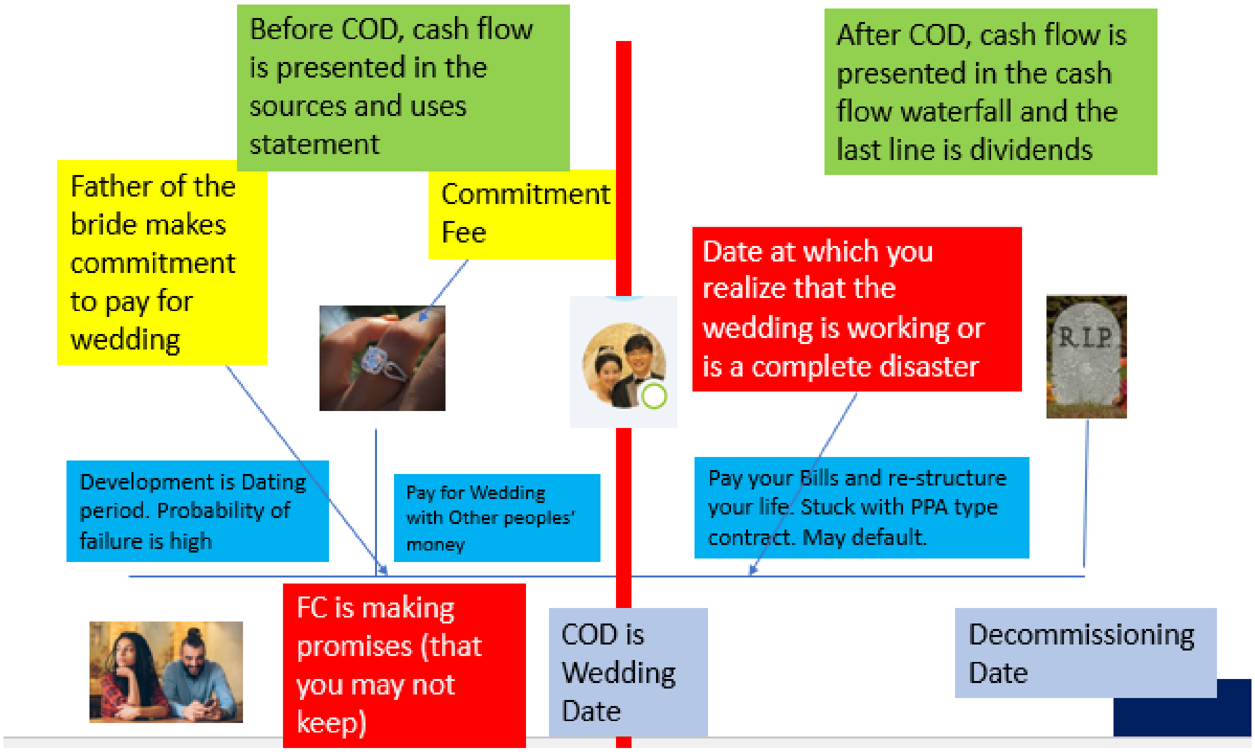
General theme is that you can let financers tell you about risk and return. Let them tell you as a check on your assessment rather than trying to measure risk yourself. Many implications. If you are beginning a project and evaluating a new venture. If you have a really boring project what is the cost of capital. If you have a mixture of new ventures and boring assets how should you make an evaluation.

Let's take an example let's say we have a relatively risky project with new technology, and we have another project that has very conventional technology and safer cash flow. The debt structure includes the amount, the length of debt repayment and the manner in which debt is repaid. If the risk of the debt default is similar for the two projects, the amount of the debt could be more, the length of the debt could be longer and the pattern of debt repayment could be more aggressive for the project with less operating risk.

If you look up how Standard and Poor's makes credit assessments and comes up with their credit ratings (AAA, AA, A, BBB etc.) you cannot find all that much and there seems to be a whole lot of mystery. But you will see how the ratings depend on both operating risk and financial risk. I could add credit rating agencies to my complaint list, but I my list is already long enough. With different structures, you could look at this from equity perspective and imagine that for the first project, increased operating risk is offset by lower financing risk (from less debt, shorter debt, and a structure of repayments that is more front-end structured). The project with safer operating cash flow would have the opposite structure with more debt, a longer tenure and a back-ended payment structure. The diagram below illustrates the leveling out effect of debt to the risk of equity.

Continuing with our hypothetical case, you could imagine that safter project has a lower rate of return if no debt were used to finance the project. But when more debt is added to the project, the equity return is increased. This is just leverage. See below. For the risky project – with the lower debt, the equity return does not increase much above the expected overall project return. We could go further and make an assumption that when you combine the operating risk and the financing risk, the equity risk is about the same. With this assumption, the banker has made the risk assessment for you and after they do their risk analysis job, the required return for the equity risk is about the same, meaning that the cost of equity for the projects should be about the same. I realize that there are a lot of assumptions in this hypothetical example, but the point that the lender has in some sense equalized the risk for different projects remains. Turns Miller Modigliani on its head.

If you could find the general minimum requirement in terms of equity returns, you would have the cost of equity capital. This general equity return requirement would not depend on any beta calculations or other problems. You have an alternative way to assess risk. For project finance this is very real. There are many entities that buy and sell projects and there are general return criteria that are used. How much premium should add to debt. This depends on the premium to debt if any for taking equity risk. Suggest that because of upsides, that this premium may not be very much.



Deciding on a University Degree versus Deciding on a Job Offer

An irritating aspect of applied and finance and financing teaching is that the models and analysis attempt to put all problems into the same tired framework of net present value and cash flow. I am afraid I have fallen into this trap so far in this book. Just about all of my suggestions implicitly or explicitly applied the same risk, discount rate or rate of return to a company or an investment over its life. The earlier chapters also did not consider the possibility that the distribution of cash flow can be different than a similar upside and downside. My methods of analysis for terminal value, multiples, computing returns and evaluating costs and benefits applied the same model over the life of an investment. When you think about all sorts of valuation decisions, the implicit idea that risk and the evaluation process can be the same over time is crazy.

To illustrate how risk and valuation models change, consider the life of person who wants to become a doctor. The first valuation decision is whether to go to university and take up medicine. In the U.S. there is apparently a low probability of making it to the end: “Only about 17% of US Freshman pre-meds earn admission to med school. About 140,000 start out. Half drop the program before completion. Of those who “stick it out” and take the MCAT (~70,000), half do not do well enough on the MCAT even to apply. Of the ~ 35,000 who apply, a little under half get in."[59] Presumably, when you make this difficult decision, you must have the self-confidence to be able to make it. You would also have to consider the possibility that your life will not be very interesting as a doctor and there will be a big chance that you are wasting a whole lot of time and money. Now fast forward to your life as a doctor and you are deciding whether to accept a new job offer. Your decision-making process concerning whether or not to select the new job will be very different than you decision making with respect to entering university. The new decision will be a lot more boring where you may implicitly or explicitly write down the pros and cons of the different alternatives (maybe you will do something a silly as putting the alternatives with different salaries, risks and quality of life in a spreadsheet). It may be possible that one alternative would have a lower salary but more possibility for upsides.

Avec Macron, cinq ans de plus pour la "Start-up Nation"

Par Maxence Fabrion (@max_fabrion) | Publié le 05/05/22 à 07h00

Partager :

COMMENTER (2)

© Getty / Jean Catuffe - Emmanuel Macron

Avec un soutien sans faille affiché en faveur de l'écosystème numérique de l'Hexagone, Emmanuel Macron, qui entame un second quinquennat à l'Élysée, a su entretenir la flamme auprès des entrepreneurs tricolores. De grands défis l'attendent pourtant...

Corporations as Collections of Assets in Different Stages of Development

Extreme examples are Amazon and Tesla but very many other companies are trying the same kind of thing. Applying financial modelling ideas built from evaluating stable companies to start-up or fast growth companies is one of the failures of finance. Whether a company has projects in a start-up stage or whether all of its projects are mature, a corporation is made up of a portfolio of projects. To understand a corporation, I posit that it is best to understand first the underlying value of the projects that make up a corporation.

Consider new locations for McDonalds and the valuation of a new place. Wouldn't think of this as a start-up company, but it goes through stages. Do not really know how it will work until have some experience. Venture capital has to use probability. But applies in building solar plants. Sun Edison example.

Absurd Suggestion to Apply Concepts of Diversifiable Cash Flow, Beta, Constant IRR to Investments with Changing Risk

[59] I admit I just found this on the internet

The contrast between the start-up decision to attempt to gain a medical degree and the decision to select a new job is analogous to very many investment decisions ranging from start-up ventures to exploration projects to infrastructure investments to new product development. In this chapter I will discuss some valuation approaches for different valuation over the lifetime of an investment. I suggest that many if not most investment projects go through different phases beginning with a start-up or development phase and ending with the keep calm and carry-on phase. It certainly should not be a radical proposition to suggest that the framework for evaluating investments must be very different and cannot fit into the net present value model.

As any corporation is an amalgamation of projects, if the tired old model is not appropriate for a single investment, it is also not very good for assessing different corporations, some with a lot of projects in the development stage and other corporations with assets that are earning stable cash flows. If the risks are different for the corporations, how can we suggest that the beta statistic can really capture the risk.

Time Travelling Through the Life of an Investment Project

When you think about the value of a person or an investment, the first basic point is that the value diminishes as you get old. This is simply because you have less time left. We have already implicitly dealt with this issue in all of the discussions about economic depreciation, asset replacement in terminal value and age of assets in multiples. In Figure XXX I have taken two minutes and made an example with 2% growth in cash flow and different discount rates. Then the value is simply the present value of those cash flows. The first graph discounts the cash flow at a rate of 5% and the second graph discounts the cash flow at a very high rate of 10%. The pattern of the graph is affected by the simple mathematics of discounting (if the discount rate were zero the line would be straight down and if the discount rate was really high, the line would be much flatter). In thinking about a corporation as a collection of assets, you could imagine a whole lot of these graphs on top of one another. If the corporation has older assets, those assets must be replaced sooner and the value of the corporation should be less. This is counter to the return on invested capital that would be increasing because of accounting with straight line depreciation.

Imagine old or new portfolio. Old will have to replace. New will have long life. But old will be confusion because of high IRR. Will add together different ages. This is not intended to represent a company. If a company continually replaces assets and grows, then the value can gradually increase without the extreme swings. But if capital expenditures are reduced, then the value.

A second notion about the value of an asset is that the risk of most projects change over their life. This change in risk can be represented by a decline in the discount rate as the project moves though its life until it reaches the keep calm and carry-on phase. The example with one project demonstrates how you can use the projected cash flow to derive discount rates. Examples of industries where projects are often bought and sold include real estate investments, oil projects and renewable energy projects. I would argue with quite a bit of emotion that if you have a reasonable idea about the projected cash flow, it is much better to derive the discount rate from evaluating projected cash flow than to make some sort of CAPM estimate. All you have to do is use a goal seek with the value and the cash flow (after accounting for taxes).

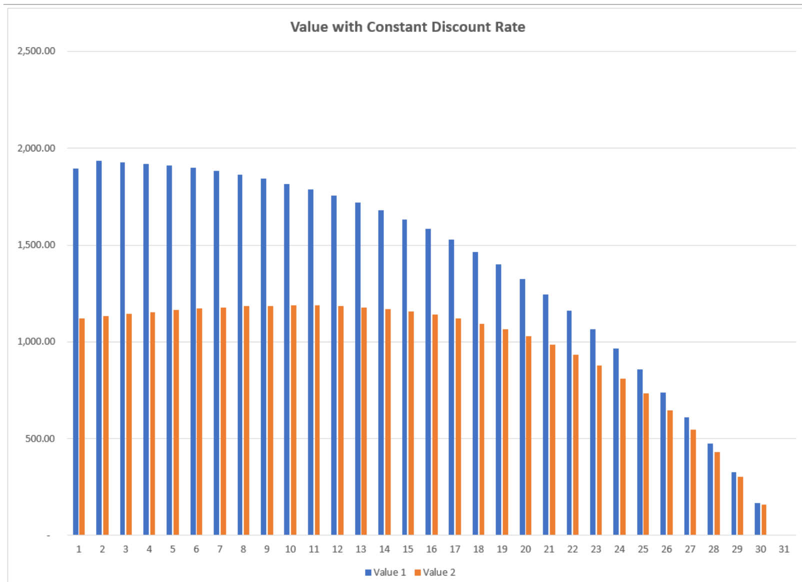


Figure xxx illustrates the effect of changing value on the value of a project over time. In this case the discount rate starts at the level in the previous case and then moves. In the top case it moves down from 5% to 3%. In the second case it moves down from 10% down to 6%.

In this case But because of accounting with straight line depreciation, the observed return on investment goes up. Value is the NPV of future cash flows as illustrate in the simple example below.

Discuss how IRR can account for changing risk. In this case compute a holding period that consists of negative cash flow when the project is constructed. This demonstrates that an IRR is distorted. Your friend Warren Buffet in implying that private equity people are bad says that his holding period is forever. The fact that he is not a very bad person who dismantles corporations and squeezes out money by treating employees badly. But this idea of risk reduction and this increase in value happens whether you hold the assets or sell them. In Think of a person or a person's brain. You will depreciate away and become worthless. Allocation of value is depreciation and change in value can be computed different ways. One way is straight line which is absurd. Best is to compute value and then the change in value.

The next sections we'll address that there the changes in the risk over time and some more nuanced issues with projections. The final issue will address cash flow pattern ultimately realized by equity investors again at every section that the corporation that a corporation the portfolio relation of project and to understand the risks faced by a corporation you need to understand the risks of the project. It bears repeating that even if that the ideas of project finance in terms of deriving risks both downside risks and upside risks should one day hopefully be an integral part or reports.

Try to go one step further and compute the NPV over the construction period and the development period.

Development and start-up risk and proof of concept

Value is driven by cash flow for a project as well as capital gains from changes in the returns required by investors. You can see this by using a simple perpetuity formula – Value = Cash Flow/Discount Rate. When cash flow changes, value obviously changes. But value changes also when the denominator changes. The denominator represents risk. When the discount rate goes down because of risk declines, the value goes up. We can call this value increase a capital gain. Here I will suggest that value should consider capital gains as well as the cash flow forecasts.

I am thinking about a wind farm, but you may be thinking about development of a hydrogen truck; an initial project in Madagascar; a port in Pakistan;

Get paid a development premium or a development fee and be taken out by other investors.

Fund capital expenditures with debt and may or may not be compensated by the lenders for the development fee and maybe achieve really low cost financing.

This is a lot like valuing a start-up company by a venture capital fund. At the initial stage the value is driven by the probability of achieving success. This continues as you make some kind of estimate of the value that can be realized if you do achieve success. Eventually, if you achieve a proof of concept through selling products, you have a better idea of the potential cash flow and the probability of success increases. This is a capital gain. The risks of an investment continue to decline as risks are resolved – the risk of construction problems, the risks of not achieving expected results after the project is finished with construction.

What is the General Process for Valuing Start-up or Development Investment

Start with valuation once achieved some sort of milestone. Maybe proof of concept where your project is really being sold. Maybe financial close in project finance investment. Raises many issues. First is how to make valuation after you clear the early hurdles and change method to standard cash flow. A second issue is whether you should make some kind of explicit cost and benefit valuation. Third, is if you make a valuation, whether you are a venture capital investor or whether you are an entrepreneur how can you assess the explicit or implicit probability. Fourth, how do you assess the changing probability and the risks of different stages and options to exit the investment. Fifth, should you back into the risk premium or development premium and use this premium in analysis or should you back into it from the final valuation. Sixth, should the measured return on a successful project consider the opportunity cost of failed projects in measuring returns.

I go a bit crazy with all of this. I argue that you should be able to come up with some kind of cost benefit analysis. I argue that you cannot perform this cost and benefit analysis with some kind of adjustment to the discount rates. I suggest that you should explicitly or implicitly consider probability so you can present the costs to investors and bankers. I suggest that you should put the risk of failure into the analysis.

I try to develop a couple of examples. One example which is real is to imagine a competitive bidding for a Solar project in Dubai. There are multiple bidders and each has about the same chance of success. Each bidder has to get bank financing. Each bidder has to do a lot of engineering. Each bidder has to pay staff and for trips to Dubai. Each bidder has to pay for lawyers to go through the documents. All of this has a significant cost and I assume there are bidders. This is a simple example where the probability is and costs are clear. How do you recover the costs of losing. While the costs are big, they are only two percent of the overall project cost.

Total Cost	1,000		Cost Spent	20.00		Cost Spent	FALSE	☐ Cost Spent
Dev Cost	2%					Econ Cost	TRUE	
Cost of Capital	5%		Total	10				
Probability	10%		Losses	9		Derive CF		
CF	62.49		Econ Cost	200.00				
Growth	2%							

		-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
Dev Cost	FALSE	(200.00)														
Construction			(1,000.00)													
Cash Flow				62.49	63.74	65.01	66.32	67.64	68.99	70.37	71.78	73.22	74.68	76.18	77.70	79.25
Net Cash Flow		(200.00)	(1,000.00)	62.49	63.74	65.01	66.32	67.64	68.99	70.37	71.78	73.22	74.68	76.18	77.70	79.25
Value	(0.00)	200.00	1,210.00	1,208.01	1,204.67	1,199.89	1,193.57	1,185.61	1,175.89	1,164.31	1,150.75	1,135.07	1,117.14	1,096.82	1,073.96	1,048.41
Difference			210.00	With Econ Cost			52.73									
				With Direct Cost			62.49									
IRR	5.00%	($0.00)		Percent Difference			18.51%									
IRR at COD	6.57%															

A second example could be an oil project or a merchant electricity project. Could use something called risk neutral valuation. This idea is that you can verify value using forward markets and something close to a risk-free rate. You can establish value but you have to assess the explicit probability of making a successful exploration or a successful geothermal analysis. How do you assess the costs of the exploration against the known value at the end.

A third example is a start-up venture with unknown value and attempts to achieve a proof of concept. Clear that Private equity class – gave multiples. No discussion of achievable return.

Can forecast value if become doctor (would have to account for the boring nature of the profession). The investment depends on the probability of success and the cost of the development.

Diagram of Risk of Boring Company and Ten Projects with Diversifiable Risk

I have often discussed this in terms of a marriage and relationship and I apologize if this is becoming too trite. You begin with a dating or development phase and you want to end with a boring cash cow or, similarly, a boring marriage where you grow old together. The first questions is how can you make any investment, in a dinner for example, where the expected payoff is so low. The first valuation issue is how do we value a development investment. Please note that this could be a new company, it could be investment in developing a vaccine or other drug, it could be investment in software. Ysou can try to value this investment with some kind of IRR or NPV, but without accounting for probabilities, this gets you very little.

How to make valuation after you clear the early hurdles and change method to standard cash flow.

Do need some kind of valuation when successful. Many projects this would be some kind of business plan. Unfortunately, may be valuation from EV/EBITDA ratio with high growth or net present value at unknown discount rate. Could use a high growth period with some kind of interpolation. For most start-up or development projects this would be speculative and something like the terminal value discussion. The drivers are a realistic assessment of growth and a reasonable assessment of short-term and long-run returns.

In Dubai example assume that somehow know the required return. If do not recover the return on failed projects would be out of business. Development companies are real. Solar is not too hard. Development companies will be out of business unless they recover the unsuccessful projects. Key point is that make some kind of valuation and critically evaluate the prospects for earning a return on investment and thinking about competitive pressure in Box 1.

Should you make some kind of explicit cost and benefit valuation or just evaluate the difference between the ultimate value and the initial cost

If you make a cost and benefit analysis, you need to have some kind of cost. This cost is irrelevant if it does not include probability. Should you even bother or should you just use the final value compared to the pure cost. The difference can be called the premium. You could make some kind of vague judgmental assessment of the probability of success.

The alternative is to make an explicit assessment of probability. This can be presented to bankers. It can be shown to venture capital investors. It can even be used by accountants (not very relevant). For example, when making a project finance loan the lender can agree to put development fees into the calculation. Development fee is controversial but can be a big deal in financing. You can understand a banker not wanting to lend to a round-trip fee. Discuss the general issue of development premiums and alternative models. Multiple of cost.

Diagram of Round-Trip with Developer and Sponsor and SPV. Also the Bank. You can find the total value. Either the lower cost of capital for the Dubai project or the risk neutral valuation.

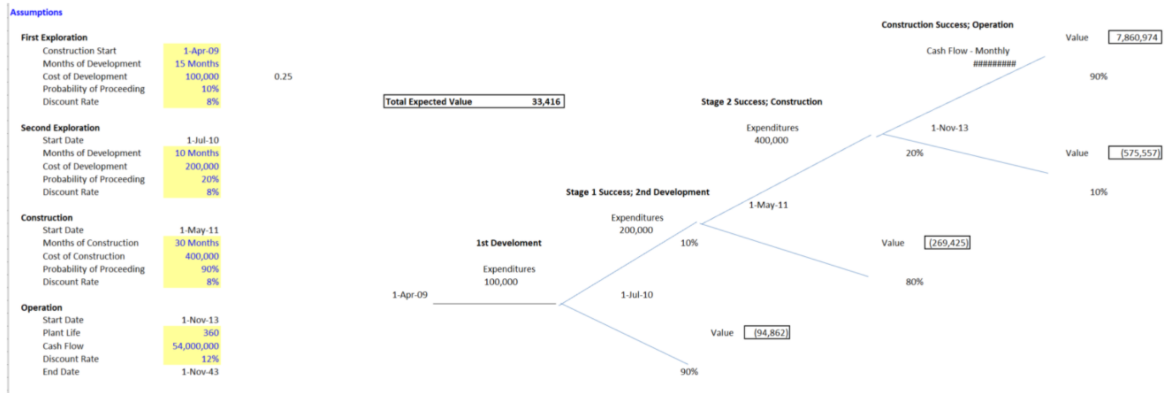
My point is to make some kind of cost and benefit analysis and understand if the business activities. The cost is not the profit. Dubai example where have the final return.

How can you Assess the Explicit or Implicit Probability.

It would be fraud to claim that you know the probability. But how could you do this any other way. Could compute the break-even probability. Could compute a series of different probabilities and get a distribution of cost and benefits. If do not make some kind of probability, would not have an objective cost. Show graph of profit.

How do you assess the changing probability and the risks of different stages and options to exit the investment.

So many options are the options to get out of something or options to cancel. The distribution of options is not anything like some kind of normal distribution of cash flow. Show the distribution with stages compared to a normal distribution.



Should you back into the development premium and use this premium in analysis or should you back into it from the final valuation.

Should the measured return on a successful project consider the opportunity cost of failed projects in measuring returns.

Risk Analysis for Start-up Ventures – Attempting to Put Risk of Failed Start-ups into the Cost of Capital

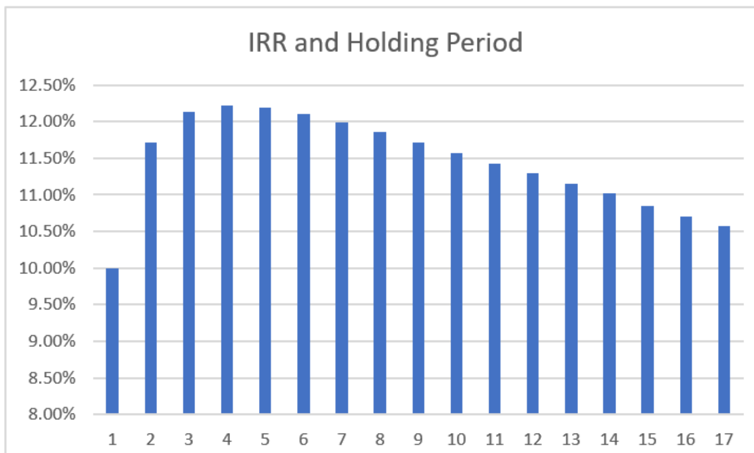
The start-up phase. Should explicitly consider risk and adjust the return for the probability of failure. Contrast traditional finance again and show how crude it is. Need to earn a return that compensates for the probability of failure. When assessing returns, go back to the graph of returns and risks. Is there a competitive advantage that is sustainable Let's go back the risks of an investment also set a risk related to start-up ventures. These are extremely often at least extremely risky proposition where the chance of failure is high.

Imagine we have two corporations. One Corporation has a number of new projects that do not yet have a proof of concept. Another corporation has boring old assets operating for a long time. Finance professors would say that the market in some kind of Wizard of Oz like knowledge can drill down to the individual assets and somehow dissect a company to find the risks of start-up ventures that are buried in the asset base. Then, even if a company has a whole lot of very risky ventures, the management will be so smart as to make careful probability estimates of success. So, in the end, the risk of failure of the assets does not have to be understood because it can be diversified away. This is illustrated in the diagram below.

Chapter 24: Deriving the Cost of Capital from Project Finance Transactions

Risk and Value over Lifetime of Investment, Changing Risk

One of the key aspects of your life and just about any asset is that the risk of the asset and the value of the asset changes over time. If the risk of a can diminishes over time in a dramatic fashion. A project starts with some research and then something very different which is development. Note that the words development and research mean something very different and as usual accountants and people who waste time on financial statement analysis do not think about the difference. Development implies expenditures for a specific project. It could be investments in contracting, permits, start-up marketing, product development. Development risk is analogous to the risk that a start-up company succeeds and can demonstrate a proof of concept. Once the project makes it through development, the risks have declined a lot and the company constructs the project. There are lot of risks involved in constructing the project including whether the technical aspects of the project will be met; whether there will be cost over-runs; whether there will be delays and so forth. After the project is constructed, the risks are less, but there are still supply and demand risks that can be important. For example, if you were told that the wind level will be at a certain level by consultants, this may not turn out to be the case. Similarly oil project.



Graph: Value change from decline in cost of capital with titles. Graph: Just use post development as will be explained below

Second accounting problem is that do not account for economic costs of start-up projects and businesses. As with economic depreciation and economic ROI, this can be evaluated. As discussed at the beginning of this chapter, companies are a collection of different investments. Some investments are mature and have been operating for a long time. These investments can have fairly certain cash flow like a McDonalds drive through that has been around for 15 years, a beer company like Carlsberg selling in a country for a long time, a wind project that has been operating for five years, an oil field with proven reserves that has fixed forward prices, or a youtuber with millions of viewers who has proven her concept. But other investments can be speculative, like trying a new McDonalds in Barbados (there one of the companies without any McDonalds), exploration for a new oil field, a wind project that has not yet tested local wind speeds, or a youtuber with a seemingly good idea, but few subscribers. Project finance ideas can be used to demonstrate that valuation of development projects with do not have a specific proof of concept or have not yet been able to secure contracts. The projects with development risk cannot be valued with traditional net present value of cash flow.

General Inputs				
Development Period	Months	15	IRR - Cash Basis	8.11%
Construction Period	Months	12		
Development Cost (actual)	EUR	20,000	IRR with Dev Fee as Cost	7.49%
EPC Cost	EUR	400,000		
EBITDA p.a.	EUR	30,000	IRR to Partner	7.51%
EBITDA Growth	%	2.50%		
			IRR to Developer - Cash	8.64%
Development Inputs			IRR to Developer - Econ	7.47%
Probability of Success	%	10.00%		
Target Development Profit	%	15.00%		
Loss Scenarios	Number	9		
Costs of Loss from Failures	EUR	180,000		
Total Cost Including Success	EUR	200,000		
Target Profit = Development Fee	EUR	30,000		
Developer/Sponsor Investment	%	55.00%		
Partner Investment	%	45.00%		

Separation of Value with Probability

In fact, there are many valuations that depend on probability. Loans, new ventures … Loans – probability of default x loss given default. Loans do not use beta and equity market risk premium. Instead, you compute the probability of default by the loss given default. New ventures is the probability of making it to the IPO times the expected IPO proceeds. Here I assert that valuation of many if not most assets and ventures goes through different phases; one with probability and a second with standard IRR/NPV. For mature investments, the standard IRR and NPV can be applied from the last chapter, but during the development phase probability should be applied.

- Use both methods for valuing a single asset
- Cannot apply CAPM
- Probability generally does not have diversification in CAPM

- The cost of failures during the development stage should be included as a costs
- Stages in development periods and real option to exit
- Understand risk change

Expected value supposed to be used in boring companies. Supposedly have some kind of variance and the variance in your cash flow forecast corresponds to stock price volatility. Maybe the variance is such that the distribution around the expected value is normal. Very much of the theory of finance comes from boring companies that have been around a long time and have many years of history for their financial statements and stock prices. For example, the McKinsey Book uses examples like UPS, Heineken and ____. But so much of valuation is about start-up companies or companies that are growing very fast.

An alternative valuation method is for start-up companies. The second is use of probability where the value is determined by an outcome multiplied by probability. This is like venture capital. There must be a big payoff to overcome the high probability of failure. Using some kind of IRR or cost of capital in this case is crazy.

The case of Sun Edison. It went bankrupt. This company was a manufacturer and a developer of solar project. It tried to acquire a wind company as well which directly led to the bankruptcy the company. I had sold its operating assets to a its own related subsidiary. It kept development assets that those assets that were riskier of course had a would come along with a higher cost of capital and those riskier asset would have been financed very differently than the safe assets. I should say the riskier assets are financed very differently than the development assets. Again, we can look to the financing to understand and the implicit cost of capital. I'm not saying that you can find precise answers. This is just like when I discussed the implied cost of capital from the debt amount and the debt structuring. That doesn't give you any exact number required return, but it gives you a way to think about things. I argue a much better way to relate risks to required returns to compensate for those risks is to directly think about probability. Compare to the asset pricing model that now is the middle of just about every case study.

Changing Risk over the Life of a Project – Corporate Finance Pretends that Somehow Diversified Away

What is the continuing theme – really understand risks from project finance. Contrast with corporate finance. Beta is constant or simplistically adjusted. Terminal value does not have different discount rate. Again, not providing answers, but if any notion that can accurately get down to the value of assets and the potential for making future money, it is crazy.

In the end argued way to measure risk so now back to our example of a development venture. We can move to a project that has development risk before proof or concept or signed contracts and then to construction risk before a project becomes operational and then to different stages in the operational period. For a typical project construction risks after we have our proof of concept have very different characteristics from development risks. During the development period there is a big probability of failure and methods for recouping the high risk of failure must be dealt with. After the development (or after we have a solid proof of concept) we want to make sure the technology is going to work; we want to deal with the potential for delay risk and we better make sure technical aspects of the project will work.

After construction operations for the project begin and we want to see how it really will perform. Now you start to have real data instead of feasibility studies and consultant reports. The data on actual production, actual revenues and actual operating cost start to mean a lot more than estimates which were made when the project was initially developed. The risk of variability in future cash flows is reduced. After we gained some history the risks go down dramatically changing risk. Of course not every project has the same characteristics of declining risk from the development period to the mature operating period. We start with high risk lower some projects may have minimal development and construction risk. Some projects may experience even higher risk over time because they are subject to changes in fashion or obsolescence. Take me to technology change so idea is how do we apply a method of valuation for the real world for risks for items that don't have the same risk over time.

Upside Potential in Projects and Valuation – Standard Finance Does Not Recognize Distribution of Cash Flow

I'm repeating that a corporation is a portfolio of projects. The same sort of upside potential will apply to a corporation to understand the upside associated with the change in the risk over time. The value comes from the change in the risk over time. Equity with individual projects has a very different structure typical equity return assumption that's the foundation of the capital asset pricing model. I don't know how the CAPM is taught in business school. I need to admit and that learning the capital asset pricing model I remembered that there was something called independent and identically distributed and follow a normal distribution. The assumptions the capital asset pricing model the computation of beta other academic discussions there was always a assumption about return daily rates of return weekly monthly rates of return being identically distributed and normal and having a normal distribution this normal distribution is nothing like what happened for returns on a project. Again, a theoretical project an actual project and the equity returns have an upside potential that does not match the downside risk.

Upside potential from to resources that I will discuss. The first upside return, from the risk declining and the evidence of the risk declining is to sell an asset at a profit. The second issue is the ability to change the financing structure. Because of the issues discussed the cost of capital declining in the cost of capital. Just like the evidence what is the sales sell the assets we know this upside outside from selling an asset and receiving a capital gain. We emphasize in the next two sections it doesn't matter if the asset is really sold. The answer matter that we refinance we can refinance or so means is that if we have a corporate. Corporation with a portfolio of a whole lot of different asset the value of that Corporation should go up as the risk declines. The graph shows the value changes in a base case.

I'm not saying that this corporate value adjusts to changes in the risk of individual projects because the last thing I'm saying is that markets are tremendously efficient, and they can understand the risk profile of every single asset in a portfolio. But if we want to dig deeper into really what drives the value of an asset drive to value of a corporation, we need to understand how the risk profile of different assets in the portfolio changes. The value of the asset comes about this ability to sell the asset depends on the resolution let's start with some relatively simple financial modeling have to get really sophisticated. In the simple case let's assume we have three scenarios a low case a base case and an upside case.

We could construct the volatility and perhaps in the downside case barely gets repaid. The debt holders in theory going to create a model and become comfortable that even in a low case they can be repaid. The low case may even be after some restructuring. In a base case, things work out well and rate of return on equity that was targeted should be achieved. A high case now if we three different cases we don't have to sell the asset. In the downside case we can't get much for our asset and we probably won't sell it. In a base case as the risk has come down and the plant has operated as we expected the plant can be sold at a capital gain. We will be able to realize an implicit capital gain when actually when we sell whether we sell the asset or not because the risk has come down. In the third case -- the high case willing we will receive a very high value from selling the asset.

So now if we begin with our three cases a base case with a downside case and a high case. We maybe even attached probabilities to those cases can be very crude and we'll just say for now there's a 25% chance of realizing 50% of the base case and a 25% probability of the upside case. If we don't recognizing that we don't incorporate the capital gain because the example is developed so that the turn the overall rate of return is approximately the same as in the base. Then e have a downside case and a downside case and leave yeah there are three different cash flows with probability on those cash flows. I get about the same rate of return now if we incorporate the upside. But if we incorporate the upside from ability to sell the asset, the rate of return increase because of the capital gain associated with the reduction in the risk of the project for evaluation and analysis. The issue is making an assessment of this project which is the right rate of return to you are expected case that recognizes the upside.

Project Finance as a Convertible Bond

I argue in case the recognize the upside the end of the day the cash flows look something like a convertible Bond. With a convertible bond we might have a very low basic interest rate, but we get an upside if the entity paying the bond interest does very well. This is the similar to the equity cash flow for the value distribution.

Upside from Re-financing

To consider the upside from refinancing way back first section of this when we discussed the debt structuring when it's being constructed and that that structuring was driven by construction Risk by faded construction risk bye operating risks where we didn't have any history and by technology after project achieve an operating history the Risco. And the financing structure should follow them we follow the logic the initial section that would just that this increasing in that capacity has led to a lower cost of capital the same sort of lower cost of capital achieve by being able to sell the asset where the fire is accepting a lower because the fire the buyer has a lower risk accepting a lower risk now in the graph below made some assumptions about refinancing and use the three cases before when we look at the three different cases we add refinancing into the cases in the downside case just as before we wouldn't refinance the asset but and the hot case we would refinance DSS do Equity return free from the three cases is buffer without refinancing I think we get the upside let's have a new section is Dakshin again and on this introduction we need to do we want to say dad typical project Finance his talk with some diagrams talk with understanding some financial ratios like the DSCR, LLCR, PLCR and working through some technical aspects of project Finance I've read these books make it there very good but this chapter is going to look at project Finance in a very different way it's going to use project Finance to draw implications took a Valium corporations and it's going to.

And it's going to make you hopefully think about project Finance in a different way at the end chapter I hope you will see that project Finance can provide some foundational ways to think about finance. You can see that project finance for equity investors can be thought of as a convertible bonds or have the cash flow patterns with the upside case potential of a of a convertible bond. I also you see that the way in which you can stop the development with something like a strike price that with Investments and how probability assessment and capitalizing cause

Real Options in Project Finance and Corporate Finance

During the dot com bubble real options were a big top and people were looking for real options in anything and claiming that value could magically be increased from real options. Somehow you could find a stock and believe that the market had not valued real options correctly. You could buy a stock with negative cash flow and say that the company has the option to stop its cash outflow.

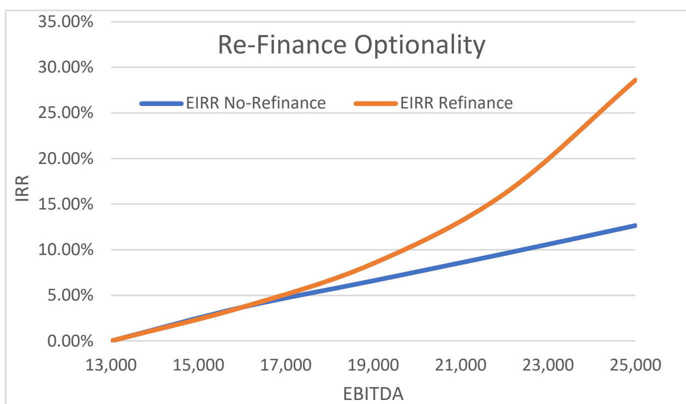
Capital Gains and Project Finance as Convertible Bond

Capital gain is change in value that is not driven by cash flow. Your house value goes up because interest rates go down. In project finance, if the risk declines while the prospective cashflow does not change, value increases. Absurd to suggest that anybody knows what will happen to future discount rate.

Illustration of capital gain in positive case and negative case

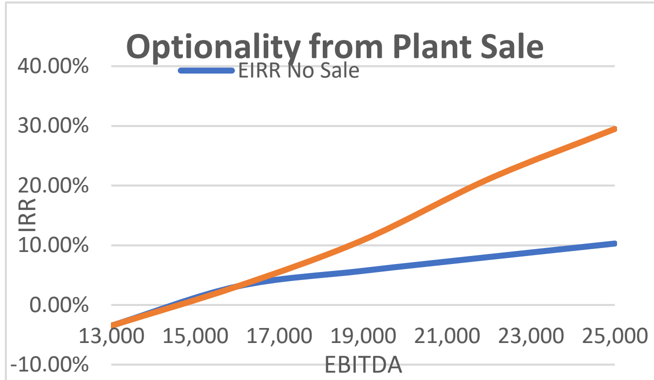
Re-finance the project once you can demonstrate to bankers that the risk has been reduced. Sell your project to an insurance company. Compute the IRR with and without cost of development. Compute the cost of development with probability analysis and stages

Imagine if you could see Amazon projects in data centres, in transport, in retail, in other activities. Imagine if there are no distortions. Imagine if banks would tell you about the risk of each project by virtue of the amount of money they lend. When I discuss project finance, I use the analogy of analogy of a relationship. This time, the relationship is a very quick engagement without much testing of the market. After a quick ___ period, a marriage contract along with a pre-nuptial agreement is signed. This time, unfortunately, one party is not happy with the contract and arguments make the whole project difficult for all parties. Transparency in Project Finance and Financial Statement Analysis. One of the advantages of project finance for a bank is that you can see the cash flow.



Debt Structure Around the Economics and Risk of a Project

Transparency of value in project finance that cannot find in corporate finance. But can use project finance ideas to see what you would really like. Set the debt capacity to earn an equity return and evaluate the project with equity cash flow rather than overall cash flow (no Miller and Modigliani). Practical, IRR with changing risk, IRR and ROIC with economic depreciation Changing Risk, DSCR versus Debt to EBITDA Debt Sizing



EBITDA	EIRR No Sale	EIRR Sale	PIRR	Probabilkty
13,000	-3.48%	-3.48%	2.01%	15.00%
16,000	3.10%	3.10%	3.40%	20.00%
19,000	5.72%	10.87%	4.64%	30.00%
22,000	8.03%	21.11%	5.78%	20.00%
25,000	10.28%	29.48%	6.84%	15.00%
Expected	4.96%	12.00%	4.56%	

Parked Project finance

Aspects of Project Finance not in Pillars – Acceptable Risks; Changing Risks; Use of IRR and DSCR

Cases of where the returns to private investors are much higher than the cost of capital because bidding has not been applied or not been structured well.

Spanish Feed-in Tariffs, Petrozuata Case, U.S. Renewables, Dahbol Case, African Solar Cases

Cases where contracts were not structured to provide good incentives to operate efficiently.

Eurotunnel and toll-roads with traffic risk, Dabhol out of order dispatch, battery contracts without adjustments for number of cycles, Philippines and Ghana single buyer, private prisons; merchant plants and no nuclear projects, prison controversy

Cases where debt verification were not performed well and projects defaulted

Merchant electricity plant cases, Errors in traffic risk evaluation,

Cases where externalities not considered

Train traffic versus air traffic, promotion of roads, Electricity Infrastructure in Nigeria, Coal Plants in Malysia and Vietnam, oversupply of natural gas

PART V – Corporate Finance, Multiples, Terminal Value, and WACC Distortions

Chapter 25: Deciphering P/E, EV/EBITDA and Debt/EBITA Multiples

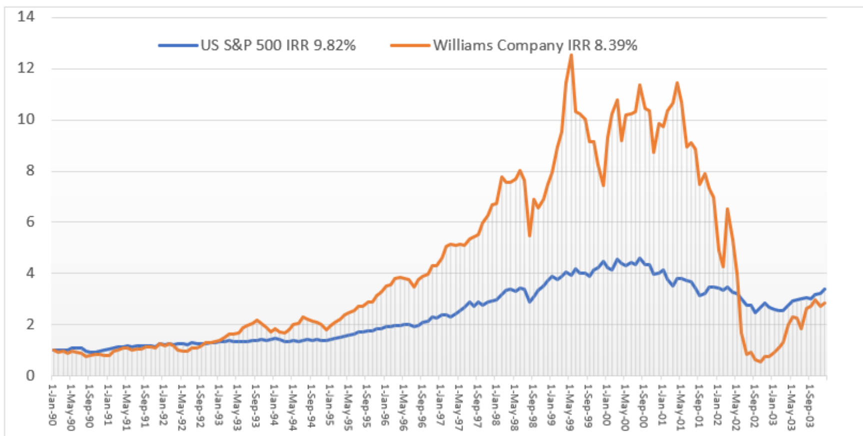
No Rate of Return on Invested Capital in MBA Cases and Project Finance

I have reviewed the kind of case studies that are taught in prominent MBA programs (finance courses, private equity courses, investment courses), and I was surprised. First, none of the cases suggest directly or indirectly for students to compute the return on investment much less the project IRR in understanding the foundation of valuation analysis and its connection to corporate strategy. Second, in the valuation cases, students seem to be taught that the only way to compute cost of capital is using the CAPM (or maybe the arbitrage pricing model) and they are given an equity market risk premium number that is much higher than the real growth in the economy (they are never asked to question the number, nor the absurdity of high cost of capital numbers). Third, any analysis of terminal value in the case studies -- the elephant in the room of valuation -- are either based on simple (and very flawed) constant growth models or unadjusted comparative multiples. Fourth, the MBA programs continue to teach financial statement analysis without emphasizing the search for the true ROIC or IRR which is the number you want as the starting point of your valuation. These were topics that I was taught many decades ago and the lack of progress is remarkable.

For example, there was an old case study about a telecommunication venture before the dot com bubble of 2000-2001. The dot com bubble is now ancient history, but at the time the internet was a relatively new thing and anything thing that had anything to do with investing in the internet received a high valuation. I remember a natural gas pipeline company named Williams that put fibre optic cables next to its pipes and called itself a Williams Telecom company. As shown in the graph below, the company experienced a very high stock price and then experienced a dramatic decline after it was clear that there was a dramatic overcapacity – anybody could do something like Williams and there was no special competitive advantage. It was a classic example of moving from the power-house square – box 1 -- to the throwing money away square – box 2. Now back to the case study. There was no discussion of the true competitive advantage or the potential for making a high return in this case study. Instead, students were instructed to waste time on the CAPM, the terminal value, comparative companies and the prospects for and IPO.

The company As discussed in Chapter 2, the ROIC statistic is essential for many reasons. Some of the reasons include: (1) calculating value using value driver formula – Value = E1 x (1-g/ROIC)/(WACC-g); (2) evaluating the current performance of management relative to, competitors and other potential business lines as part of competitive strategy; (3) Understanding trends in ROIC and potential risks from increased competition and supply from around the world (China); and (4) considering whether the level of ROIC is adequate relative to the risk that is taken. A central idea of the discussion in this chapter is the idea that the true return on investment is the project IRR which is the starting point of project finance analysis. Furthermore, the project IRR can be established over time by use of economic depreciation rather than traditional accounting depreciation.

If you waste your time watching boring financial television programs or take a basic course in finance, you will hear a lot about the P/E ratio, the EV/EBITDA ratio, and the Price to Book Ratio. These statistics that are called multiples are the centre of evaluation of leveraged buyouts; they are used in assessing benchmarking stock prices of companies; they are used as inputs for computing terminal value; and some can be used to assess the performance of management. Alternative multiples are used measure the risk and value of debt including Debt to Capital, Debt to EBITDA, and Debt Service Coverage. The debt ratios directly or indirectly are used to measure the risk of default on debt through establishing credit ratings.



Bankers can wave their magic wand and suggest the correct multiples to use. You can pay a lot for an advisor.

I begin using a Harvard case study of an acquisition a proposed acquisition the railway industry. The table below shows the PE ratio and the EV/EBITDA ratio for all companies in the industry. One would think that companies in this industry are very stable and very similar with similar multiples. But when we look at the and the EV to EBITDA ratios there is a wide range. note that the PE ratio varies between X and why. Note that the EV to EBITDA ratio is between y and z.

It would be ridiculous to simply take the average ratio or the median ratio without understanding why these ratios are different. Differences in value

Exhibit 18: Comparable Public Companies
Source: https://www.sec.gov/Archives/edgar/data/724606/000119312

Company	EV / EBITDA 2017E	EV / EBITDA 2018E	P / E 2017E	P / E 2018E
Fast Casual				
Chipotle	25.9x	18.8x	54.8x	37.1x
Shake Shack	14.8x	11.7x	66.8x	53.0x
Wingstop Inc.	24.7x	21.2x	44.2x	36.3x
Potbelly	7.7x	7.0x	30.2x	26.2x
Zoe's Kitchen	16.0x	12.8x	NM	NM
Habit Restaurants	10.2x	8.6x	60.0x	54.5x
Freshii	26.5x	18.5x	42.0x	28.8x
Noodles & Company	8.1x	7.2x	NM	NM
Multinational QSR				
Domino's	20.2x	17.7x	35.4x	29.7x
McDonald's	13.6x	13.3x	21.0x	19.6x
Starbucks	14.8x	13.0x	26.4x	23.3x
Yum! Brands	15.5x	15.0x	23.4x	20.3x
Restaurant Brands[1]	13.5x	12.5x	29.7x	22.9x

theoretically come from resources the rate of return on investment the growth rate and cost of capital. When we dig a little deeper we may explain why these ratios are different. First, note the lower ratio for the company that has a higher return. Other possible reasons for the difference is in the ratios maybe the upcoming required Capital expenditures, the growth rates , of the businesses. If we have a good idea about the return on investment including Trends in the rate of return we should be able work through differences in the ancient in the in the multiples . We will see that there are important differences between the interpretation of an EV/EBITDA multiple and a PE multiple.

Bidding for Hertz: Leveraged Buyout

Comparable Company Analysis
($ millions)

				LTM Financials			Price Earnings		Enterprise Value/LTM	
Company[1]	Stock Price (8/15/05)	Equity Value	Enterprise Value (EV)[2]	Revenue	EBITDA	EBITDA Margin	2005E	2006E	Revenue	EBITDA
Car Rental										
Amerco	$58.01	$1,236	$1,929	$2,047	$298	14.60%	19.1	15.7	0.94	6.47
Cendant	$20.54	$22,117	$26,417	$20,454	$3,119	15.20%	14.6	12.3	1.29	8.47
Dollar-Thrifty	$32.30	$846	$661	$1,481	$107	7.20%	15	13.7	0.45	6.18
Equipment Rental										
United Rentals	$18.49	$1,440	$4,212	$3,013	$785	26.10%	10.8	8.7	1.4	5.37
Ashtead Group	$2.04	$675	$1,567	$1,144	$246	21.50%	16.9	11.8	1.37	6.37
Atlas Copco	$18.02	$10,942	$11,823	$6,270	$1,495	23.80%	16.8	15.2	1.89	7.91

(1) Cendant held Avis and other travel-related businesses. RSC Equipment Rentals was a division of Atlas Copco.

(2) Enterprise Value for car and truck rental represents the value of the operating company, such that the associated multiples represent the multiples for the operating company. Similarly, EBITDA for car rental represents adjusted EBITDA. Dollar Thrifty Automotive Group, Inc.'s enterprise value is less than equity value because all of its debt is fleet-based (there is no operating company debt) and because Dollar Thrifty has $185 million in excess cash.

Source: Consortium internal documentation on LBO.

Another example is shown below. In this case the multiples should be very similar as the industry is stable.[60]

Explaining Multiples to your mother (who is not interested in finance)

Explain to your mother and usefulness when multiples are really low.

The multiples and ratios are easy to criticize, but most of the complaints you hear simply suggest that the multiples are simplistic, and the companies are not directly comparable. In real world if you have some multiples for comparable companies, the real world is to blindly use the

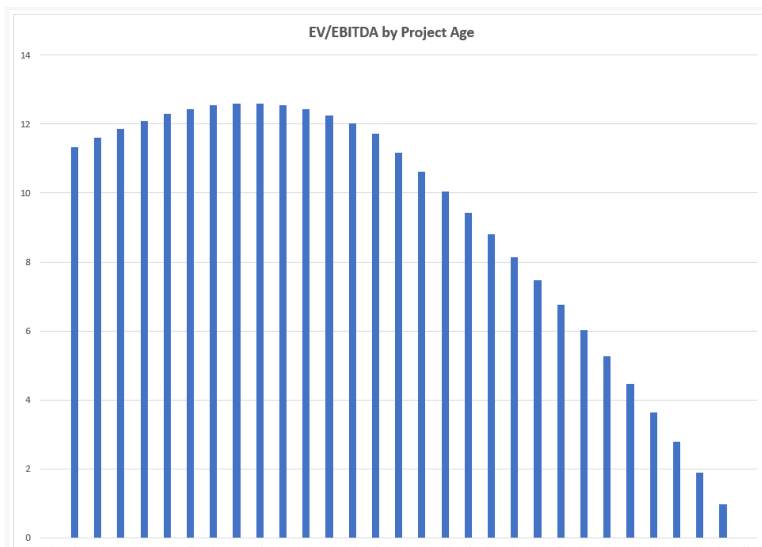
[60] 216-057 Canadian Pacific's Bid for Norfolk Southern

multiples. But the multiples are not studied in the context of implied changes in returns and growth, or the distortions created by accounting. The comparative multiples also do not account for the effect of the age of assets on the return and the requirement for new investment.

In this chapter I hope to provide methods of thinking about how you can adjust multiples to receive to remove distortions. For example, if you have two companies in an industry -- one is the company you were valuing company. The other two are comparison companies. If one of the companies earning a higher rate of return and the company being valued while the second comparable company is earning a similar rate of return. Then you could see a … the company earning the high rate of return and derive and adjusted multiple assuming that company would earn a similar rate of return. This may sound a little complicated but unless adjustments are made, the whole idea of you suppose cat give you.

Multiples are Distorted even if Returns and Growth were Stable

If things worked. Simple case. Could find the cost of capital. If had the return on capital (remember the last discussion). If different returns and different growth for different companies. Could derive the multiple for the company in question. Could derive the cost of capital for each company.



Multiples and Project Finance

Kind of things that are obvious once you make a very simple analysis. Demonstrates something that also should be obvious, namely that companies with older assets should have lower EV/EBITDA.

Constant Return and Different Growth – Multiples Affected by Different Growth Prospects

When young investment bankers put their value presentations together an analysis of comparative multiples, they do not show the return and growth prospects next to each comparative company. To compare one company that may have different growth prospects than other companies, the multiples will be different because of the different growth. For example, if the company being valued has a relatively low growth potential while the comparative companies have higher growth prospective, using the comparative sample with higher growth will overstate the value of the company being valued. It can be argued that this is the typical problem with terminal value where multiples are used in comparative analysis. Table xxx illustrates comparative multiples for a case study developed by Kellogg business school. Note the extremely wide variation in both the P/E and the EV/EBITDA multiples. Maybe you could throw out some extreme companies; compute the median; select a couple of the companies with a little discussion. But in the end, we all know it will be rubbish.

Illustration of Using Multiples – GE Case Study

No fancy new things here. History presented – and long-term history. Return and growth the central parts of Comparison

All comes down to two variables – ROE and P/E ratio. Alternatively ROE and growth.

My father got this and used to spend time sorting it out.

IRR connected which is called annual return

GENERAL ELECTRIC NYSE-GE	RECENT PRICE 27.48 G	P/E RATIO 16.1 (Trailing: 15.1 Median: 15.0)	RELATIVE P/E RATIO 0.83	DIV'D YLD 3.5%	VALUE LINE

TIMELINESS 3 Lowered 4/18/14

SAFETY 3 Lowered 3/13/09

TECHNICAL 3 Lowered 2/21/14

BETA 1.15 (1.00 = Market)

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
High:	37.8	37.3	38.5	42.2	38.5	17.5	19.7	21.7	23.2	28.1	27.9	26.3
Low:	28.9	32.7	32.1	33.9	12.6	5.7	13.8	14.0	18.0	20.7	23.7	23.4

Target Price Range 2018 | 2019 | 2020

2018-20 PROJECTIONS

	Price	Gain	Ann'l Total Return
High	45	(+65%)	16%
Low	30	(+10%)	6%

Insider Decisions

	M	J	J	A	S	O	N	D	J
to Buy	0	0	1	0	0	0	0	0	0
Options	0	0	0	0	0	0	2	0	0
to Sell	0	0	0	0	0	0	1	0	0

Institutional Decisions

	2Q2014	3Q2014	4Q2014
to Buy	866	848	925
to Sell	818	838	846
Hld's(000)	5353860	5407658	5496474

% TOT. RETURN 3/15	THIS STOCK	VL ARITH.* INDEX
1 yr.	-0.8	7.7
3 yr.	35.7	57.2
5 yr.	59.4	94.5

1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	© VALUE LINE PUB. LLC	18-20
11.33	13.07	12.69	13.21	13.33	14.44	14.28	15.90	17.30	17.32	14.70	14.15	13.93	14.16	14.52	14.76	**15.15**	**15.35**	Revenues per sh	**18.10**
1.77	2.06	2.14	2.12	2.24	2.38	2.56	2.90	3.28	2.81	2.07	2.13	2.28	2.44	2.65	**2.60**	**2.65**	**2.75**	"Cash Flow" per sh	**3.65**
1.07	1.29	1.41	1.51	1.55	1.61	1.72	1.99	2.20	1.78	1.03	1.15	1.31	1.52	1.64	1.65	**1.70**	**1.80**	Earnings per sh B	**2.60**
.49	.57	.64	.73	.77	.82	.91	1.03	1.15	1.24	.61	.46	.61	.70	.79	.88	**.92**	**1.00**	Div'ds Decl'd per sh C■	**1.40**
.21	.26	.29	.24	.97	1.24	1.38	1.62	1.79	1.52	.81	.92	1.20	1.45	1.34	**1.35**	**1.40**	**1.45**	Cap'l Spending per sh	**1.60**
4.32	5.08	5.52	6.39	7.87	10.47	10.43	10.93	11.57	9.93	11.00	11.20	11.01	11.82	12.98	12.73	**13.75**	**14.75**	Book Value per sh D	**17.70**
9854.5	9932.0	9925.9	9969.9	10063	10586	10484	10277	9987.6	10537	10663	10615	10573	10406	10061	10064	**10050**	**10050**	Common Shs Outst'g E	**10000**
35.9	40.1	30.8	20.7	18.1	20.5	20.5	17.3	17.2	15.7	13.0	14.4	13.9	13.3	14.7	15.7	*Bold figures are Value Line estimates*		Avg Ann'l P/E Ratio	**15.0**
2.05	2.61	1.58	1.13	1.03	1.08	1.09	.93	.91	.94	.87	.92	.87	.85	.83	.82			Relative P/E Ratio	**.94**
1.3%	1.1%	1.5%	2.3%	2.7%	2.5%	2.6%	3.0%	3.0%	4.4%	4.6%	2.8%	3.4%	3.5%	3.3%	3.4%			Avg Ann'l Div'd Yield	**3.7%**

CAPITAL STRUCTURE as of 12/31/14
Total Debt $272.2 bill. **Due in 5 Yrs** $170.0 bill.
LT Debt $200.4 bill. **LT Interest** $11.0 bill.
(61% of Cap'l)

Leases, Uncapitalized $900 mill.
Pension Assets-12/14 $60.7 bill.
Obligation $86.3 bill.

Pfd. Stock None

Pfd. Div'd None

Common Stock 10,064,909,484 shares
MARKET CAP: $277 billion (Large Cap)

CURRENT POSITION 2012 2013 12/31/14
($MILL.)

2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016		18-20
149702	163391	172738	182515	156783	150211	147300	147359	146045	148589	**152400**	**154200**	Revenues ($mill)	**181000**
30.6%	32.5%	35.1%	31.1%	25.4%	26.8%	30.3%	27.7%	26.5%	**26.7%**	**27.0%**	**27.3%**	Operating Margin A	**30.0%**
8538.0	9158.0	10278	11492	10636	10013	9185.0	9346.0	9762.0	9283.0	**9300**	**9600**	Depreciation ($mill)	**10500**
18275	20666	22468	18089	11434	12623	14880	16065	16882	**16600**	**17085**	**18090**	Net Profit ($mill)	**26000**
17.4%	16.1%	15.5%	5.5%	- -	7.4%	27.4%	14.4%	8.5%	**13.0%**	**25.0%**	**25.0%**	Income Tax Rate	**25.0%**
12.2%	12.6%	13.0%	9.9%	7.3%	8.4%	10.1%	10.9%	11.6%	**11.2%**	**11.2%**	**11.7%**	Net Profit Margin	**14.4%**
184959	235281	244405	254715	316579	314972	272131	283910	245855	297289	**303000**	**317000**	Working Cap'l ($mill)	**330000**
212281	260804	319015	330067	338215	360681	315832	312668	251789	200400	**205000**	**210000**	Long-Term Debt ($mill)	**220000**
109354	112314	115559	104665	117291	118936	116438	123026	130566	128159	**138000**	**148000**	Shr. Equity ($mill) D	**177000**
7.1%	6.7%	6.4%	5.6%	4.6%	3.9%	4.8%	4.8%	5.6%	**5.5%**	**6.5%**	**6.5%**	Return on Total Cap'l	**8.0%**
16.7%	18.4%	19.4%	17.3%	9.7%	10.6%	12.8%	13.1%	12.9%	**13.0%**	**12.5%**	**12.0%**	Return on Shr. Equity	**14.5%**
8.2%	9.1%	9.5%	5.4%	2.1%	6.6%	7.2%	7.2%	6.9%	**6.0%**	**6.0%**	**5.5%**	Retained to Com Eq	**7.0%**
51%	50%	51%	69%	79%	38%	43%	45%	46%	53%	**54%**	**56%**	All Div'ds to Net Prof	**54%**

Understanding the ratio of capital expenditures to depreciation

Capital expenditures and depreciation are part of the computation of invested capital that, together with the assumed return, drives income. The income in turn drives cash flow that determine value. The ratio of capital expenditures relative to depreciation is important in projecting cash flows that result from assumed return on investment. For example, as the capital expenditures to depreciation ratio is driven by growth and the lifetime of investment, if you change the assumed growth you can use the capital expenditure ratio to compute normalised cash flow.

I have been naïve by thinking people at investment banks must have some sophisticated way to compute stable ratios of capital expenditure to depreciation and the depreciation ratio on net plant. With this calculation, instead of applying some kind of arbitrary and simple valuation approach like the growth model or multiples or even the value driver formula.

Eyes will probably glaze over, but if you do not know to make a table of growth and depreciation and capital expenditure you will go wrong. In the NS/CP case the Harvard Professor Ben Esty (a very nice man), suggested that the terminal capital expenditure to depreciation should be ____.

Need a round of stabilization – move until work through the life of the plant. You must compute the retirements and the replacement of retirements. Unfortunately this means the future ratio depends on historic growth as well as future growth.

Need to make an explicit or implicit forecast of capital expenditures. Any cash flow subtracts capital expenditures. If you do not have a reasonable estimate of capital expenditures everything will fall apart.

Effect of Projected Growth Rates that are Different from Historic Growth Rates

Assume that you start your multiple analysis or terminal value in year 20, after the life has stabilized. In case 1 assume that the historical growth rate was high. In case 2 assume that it was low. You get different ratios of capital expenditure to depreciation.

		Growth			
	1.32	2.00%	3.00%	4.00%	5.00%
	5	1.06	1.09	1.12	1.15
	10	1.12	1.18	1.23	1.28
	15	1.19	1.27	1.34	1.41
Life	20	1.27	1.36	1.45	1.54
	25	1.36	1.46	1.57	1.68
	30	1.45	1.57	1.69	1.82
	40	1.67	1.82	1.97	2.12

EV/EBITDA calculation and Stable Capital Expenditures

They won't even do it for P/E ratios where you use income after depreciation. EV/EBITDA is more complicated because you have to come up depreciation yourself.

		Growth				
		5.50%	6.00%	6.50%	7.00%	7.50%
	5	7.66	8.43	9.18	9.91	10.62
	10	10.87	11.88	12.85	13.78	14.67
	15	13.44	14.60	15.70	16.74	17.72
Life	20	15.56	16.82	18.00	19.10	20.12
	25	17.34	18.68	19.90	21.03	22.09
	30	18.88	20.25	21.51	22.66	23.73
	35	20.21	21.62	22.89	24.06	25.13
	40	21.38	22.81	24.10	25.28	26.35

What Drives Differences in the EV/EBITDA Ratio

All agree that multiples affected by cost of capital and growth. I wonder if you asked the following questions to investment bankers what their response would be. To answer the questions, start with a basic case.

Start with a simple one – taxes. If higher tax rate will EV/EBITDA be higher or lower. The answer is that it will be higher. Need more cash flow EBITDA for the same level of income. So the EV is lower from the payment of taxes, but the EBITDA does not change because it does not have taxes in it.

WACC 5.50%

ROIC

		Growth				
		5.50%	6.00%	6.50%	7.00%	7.50%
	5	4.14	4.67	5.19	5.69	6.18
	10	5.86	6.60	7.31	8.00	8.66
	15	7.29	8.19	9.04	9.86	10.63
Life	20	8.51	9.53	10.49	11.39	12.23
	25	9.57	10.68	11.72	12.68	13.58
	30	10.48	11.67	12.77	13.78	14.72
	35	11.29	12.54	13.69	14.74	15.71
	40	12.00	13.31	14.50	15.58	16.58

EV/EBITDA is also driven by the life of the plant as shorter life means that you have to replace sooner and will have a higher level of investment for the same EBITDA. A dramatic Effect of Plant Life on EV/EBITDA. Big problem is the EBITDA ratios. Understand why they are used because no distortion from depreciation. Both EV/EBITDA and Debt/EBITDA distorted. Second issue is trends in ROI and growth (already introduced). Age of assets. Depreciation life of assets. Use current income that is affected by depreciation.

Effect of working capital – receive higher return for the same level of EBITDA (the EBITDA is not affected by the working capital change). Changed days revenues from 10 to 90.

WACC 5.50%

ROIC

Growth

		5.50%	6.00%	6.50%	7.00%	7.50%
	5	19.74	21.63	23.52	25.41	27.31
	10	22.26	24.30	26.31	28.31	30.29
	15	24.34	26.47	28.55	30.59	32.62
Life	20	26.09	28.28	30.40	32.48	34.51
	25	27.61	29.83	31.98	34.07	36.11
	30	28.94	31.19	33.35	35.45	37.50
	35	30.11	32.39	34.56	36.66	38.71
	40	31.17	33.46	35.65	37.75	39.80

Use project finance valuation again to demonstrate problems. EV/EBITDA with

Computing Adjusted Multiples Like Re-Levered Betas

This is not as easy as un-levering and re-levering betas.

The process of using multiples generally involves finding a few comparable companies and then throwing out values that seem out of line. But the multiples are not adjusted for companies that have different return or growth nor for the relationship between return and growth. Some of the new stuff in this chapter for you to think about includes:

1. The value driver formula: Value/Earnings = (1-g/Return)/(Cost of Capital – g) is not useful in assessing the P/E multiple because of changes in the return.
2. Use of project finance for a single asset demonstrates problems with multiples for corporations where the assets are aging, and investment is not re-invested.
3. Dividing the value driver formula into existing and future return does not solve the problem and there is no magic convergence of existing return to the future return.
4. To understand the EV/EBITDA ratio stable ratios of depreciation to capital expenditures, net plant depreciation rate should be established.

5. How can you compute imputed multiples that adjust for changes in return; different growth rates; different returns; age of plants and other things that drive the different multiples.
6. When comparing the valuation multiples, provision should be made for the age of the assets and distortions created by straight line depreciation.
7. The EV/EBITDA and Debt to EBITDA ratio depend to a large extent on lifetime of assets which drives capital expenditure requirements and ignoring the age of assets in using EV/EBITDA leads to distortions
8. The price to book ratio or EV/Invested capital ratio can be used to evaluate performance and cost of capital in an effective manner.
9. The DSCR gives you an evaluation of risk that is more effective than other measures of risk measurement.
10. **Example of Risk and Probability – The Risk and Valuation of Projected Synergies in a Merger**
11. When teach M&A, use the basic formula that after-tax value of synergies must be more than premium. I note that claims to measure synergies is utter nonsense. Highlights the application of different risk to different cash flow.
12. Consider a Beer Company. When I went to Denmark the students suggested I use called now Carlsberg had kind of a nice boring return on investment and think about people buying beer during a recession. Maybe even more beer effective these continuing let's say and let's give you an example that's a Carlsberg has some nice boring old Investments and now engaged in an acquisition another company alternatively they could be engaged they want to develop some new business strategy moving to another kind of beverage.
13. If Carlsberg pays a premium in a merger for another company and expect some kind of synergy (a word that I hate) you cannot say the risks remained the same. The risks of a creating synergies has anything like the general risks of a beer company. If you believe in beta and the beta of the stock doesn't change suggesting that there is not a change in the risk structure. However, the synergies the have a very different probability distribution. The synergies achieving the synergies achieving is like a new business venture where there is a limited probability of success. In evaluating the synergy, you can go back to the way the risk is capitalized into a development fee. The premium is the development cost and you could compute the return on this premium from making synergies.
14. Nobody would do this analysis of a premium. But again I am making suggestions about different ways to think about finance. You could add the probability of failure in computing the return on invested capital for the merger. We can now return to our Amazon and GE cases. if Amazon is entering into a new growth business as the business. When the business becomes mature and as the business is demonstrated to be a reasonable strategy the risk changes. We could use grocery store business. Even if the cash flow stays the same, the value of the company or has increased just like selling

assets in the project finance analysis. For people studying valuation and studying finance these ideas have relevance.

15. Continue discussion of project finance. Note that different because do not have a terminal value. Instead make a long-term forecast as much as 60 years. This may be crazy, but remember that when making a corporate forecast you are making an even longer forecast. Often in project finance you have some contracts or economic principles that allow you to make a reasonable forecast.

Chapter 26: McKinsey's Value Driver Formula Does Not Help in Valuation

By using the basic valuation formula – Value/Income = (1-g/ROI)/(CoC – g) you can see why different companies have different multiples. If the cost of capital is held constant across comparative companies and the return is greater than the cost of capital, then companies that are expected to grow faster will have a higher multiple. Alternatively, if the ROI is below the cost of capital, then lower growth increases the multiple. Therefore, instead of simply listing multiples as in the table xxx, you should put the returns, the expected returns and the expected returns next to the multiples. You could in theory make adjustments for different returns and different growth rates to the multiples to attempt to resolve the differences.

To illustrate issues with comparative multiples and use of multiples to evaluate potential differences in value I have constructed a simple model. I have made some different scenarios with different returns and growth rates (in this case I hold returns and growth rates constant over time) that are shown in Table xxx. If the returns change over time because of expected profits or changes in the age of assets or large capital expenditures or write-offs, this assumption of a constant return cannot be made and the analysis. As discussed in the last chapter, you are searching for the true return and if you cannot find it you cannot really evaluate multiples. The non-replacement of capital expenditures and write-offs is at least one reason why, if you look at the Dow 30, many of the companies have extremely high returns that cannot be assumed to continue indefinitely. For these Dow 30 companies, the earned return is nowhere near the economic return.

In this case with constant returns and cost of capital, you can apply formula Value = Income x (1-g/Return)/(CoC – g) and it works. Figure xxx shows the earnings multiple with different growth rates using the base assumptions in Table xxx. When the return is above the cost of capital, you want to reduce the growth. Importance of the case where the return = cost of capital. If you knew this and if the return and cost of capital are constant, then

Constant Return Cases

		Base	High Return	Low Return	Return =COC	Return below COC
ROIC		7.00%	8.00%	6.50%	6.00%	3.00%
Growth	7	2.00%	2.00%	2.00%	2.00%	2.00%
Cost of Capital	6	6.00%	6.00%	6.00%	6.00%	6.00%
Current Return		5.50%	7.00%	4.50%	6.00%	3.00%
Future Return		5.50%	7.00%	4.50%	6.00%	3.00%
Book Value		1,000.00	1,000.00	1,000.00	1,000.00	1,000.00
Initial Income		55.00	70.00	45.00	60.00	30.00
Value formula		982.14	1,312.50	778.85	1,000.00	250.00
Value/Earnings		17.86	18.75	17.31	16.67	8.33

P/E = 1/Cost of Capital or Cost of Capital = 1/PE. Note also that if there is no growth the Cost of capital = 1/P/E. This has big implications. If you can find companies with no growth, you can get an approximation of the cost of capital. If you are working on M&A cases and believe you can increase growth for a company earning a high rate of return, this is the value of the synergies.

Note that income can be expressed as book value x current return.

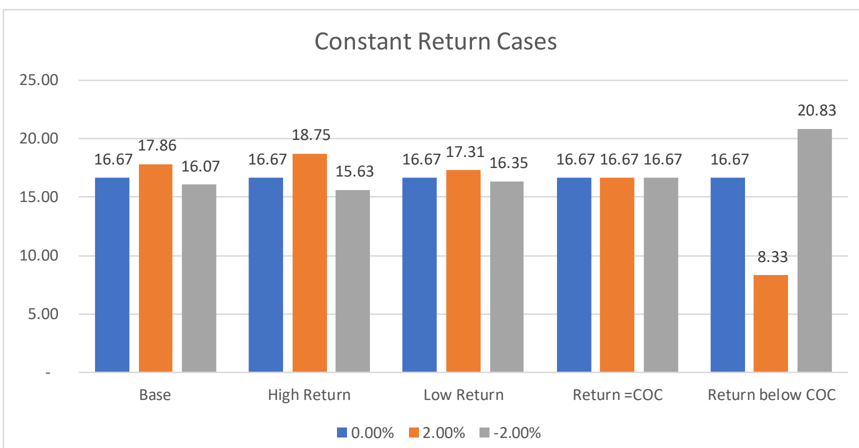
Therefore, Value = Book Value x Current ROE x (1-growth/ROE)/(Cost of Capital-growth)

If the future ROE = Current ROE, the Value = Book Value x (ROE-Growth)/(COC – Growth)

In theory the multiples such as the P/E ratio could be adjusted for differences in growth. This could be presented in an analogous manner un-levering and re-levering betas. One could imagine a table with a list of the return on investment and sales growth. Then there could be a column that would show the adjusted P/E multiple. I have not bothered to try this, but one wonders why fancy investment bankers who make presentations of un-levering and re-levering betas could not develop something similar.

Changing Return and Growth – the Value Driver Formula Falls Apart

If companies stayed completely stable earning constant returns, and we knew that would occur, then valuation and financial analysis would be boring. We could then back out the cost of capital from multiples and the value of a company could be defined precisely using growth rate estimates and the value driver formula. But when the rate of return and growth changes, the value driver formula does not give you an accurate number. Further, there is no magic way the ROE converges from the existing level to the new level. When you put a changing ROI into the formula, the growth rate in income that results is not the growth rate that is input. You can think of the growth rate as the growth rate in investment or capital expenditures. The resulting growth rate will be higher if the return-on-investment increases. McKinsey does not mention this in their book.



We can look to Amazon and GE again to see how changes in value are driven by changes in the return and growth. Given the dramatic changes in stock prices of both companies, it is clear that the changes and growth were not easy to forecast. The growth and the return are shown on the figure xxx below. Indeed, the real essence of people who make valuations is to make forecasts of these items.

The effect of changing returns are show in Table xxx and Figure xxxx. The calculated multiple in the table is computed from making a model of cash flow with an interpolated rate of return that is shown in table xxx. Table xxx shows that when the returns decline the value driver formula over-states the valuation of multiple. On the other hand, when the return is increasing the, true multiple is higher than the multiple computed from the simple value driver formula. In Figure xxx, the computed value is shown in blue while the simple value driver formula that falls apart in orange.

	A B C	D	E	F	G	H	I	J	K	L	M	N	O
1													
2		Scenario	Increasing Return 4.50% to 7.00%										
3													
4		Inputs	0	5									
5		Return	4.50%	7.00%									
6		Growth	1.00%	1.00%									
7		Payout	77.78%	85.71%	=(1-E6/E5)								
8		Cost of Capital	6.00%										
9													
10		Model	0	1	2	3	4	5	6	7	8	9	10
11		Return	4.50%	4.92%	5.37%	5.87%	6.41%	7.00%	7.00%	7.00%	7.00%	7.00%	7.00%
12		Payout	77.78%	79.66%	81.38%	82.95%	84.39%	85.71%	85.71%	85.71%	85.71%	85.71%	85.71%
13													
14		Opening Book Value		1,000.00	1,010.00	1,020.10	1,030.30	1,040.60	1,051.01	1,061.52	1,072.14	1,082.86	1,093.69
15		Add: Income		49.16	54.24	59.84	66.02	72.84	73.57	74.31	75.05	75.80	76.56
16		Less: Dividend		39.16	44.14	49.64	55.72	62.44	63.06	63.69	64.33	64.97	65.62
17		Closing Book Value	1,000.00	1,010.00	1,020.10	1,030.30	1,040.60	1,051.01	1,061.52	1,072.14	1,082.86	1,093.69	1,104.62
18		Terminal Value											
19		Total Cash		39.16	44.14	49.64	55.72	62.44	63.06	63.69	64.33	64.97	65.62
20		Growth Rate			10.33%	10.33%	10.33%	10.33%	1.00%	1.00%	1.00%	1.00%	1.00%
21													
22		Value	1,151.14		=NPV(E8,F19:$K19)								
23		Formula Value	771.43										
24													
25		PE Ratio - Correct	23.42		=E22/F15								
26		PE Ratio - Formula	15.69		=E23/F15								
27													

	Reducing Return 7.00% to 6.50%	Reducing Return 8.00% to 7.00%	Increasing Return 4.50% to 7.00%	Return =COC	Increasing Return 3.00% to 7.00%
ROIC	6.50%	7.00%	7.00%	6.00%	7.00%
Growth	1.00%	1.00%	1.00%	1.00%	1.00%
Cost of Capital	6.00%	6.00%	6.00%	6.00%	6.00%
Current Return	7.00%	8.00%	4.50%	6.00%	3.00%
Future Return	6.50%	7.00%	7.00%	6.00%	7.00%
Book Value	1,000.00	1,000.00	1,000.00	1,000.00	1,000.00
Initial Income	70.00	80.00	45.00	60.00	30.00
Value formula	1,184.62	1,371.43	771.43	1,000.00	514.29
Value/Earnings	16.92	17.14	17.14	16.67	17.14
Transition Period	5	5	5	5	5
Corrected Value	1,108.87	1,217.53	1,151.14	1,000.00	1,116.27
Corrected P/E	16.08	15.63	23.42	16.67	31.41

Why Simple Application of the Value Driver Formula Does Not Work

You may be yelling at me that I keep telling you what is wrong and not exactly how to fix things. But the nice little value driver formula is does not provide an answer to the crucial terminal value problem. This time I am not even talking about information going into the formula – the ROIC, the WACC and the growth. The formula itself cannot handle the key issue of how things will change in the future. Comment on the McKinsey crap that ROIC is stable. This is like their statement on synergies. It you are reading this still, I hope you can make it.

Now doesn't that sound if it sounds too good to be true well unfortunately it really is. There is a lot wrong with simple value driver formula.

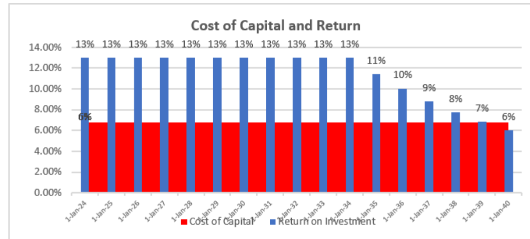
The NOPAT can be computed as the level of invested capital multiplied by the return on invested capital. We have an implicit return on invested capital if that's the capital over from the detail explicit controls. And then we invested capital and here is the problem we have no idea about how we do difference capitals work in the formula. This is another enormous problem with our very famous McKenzie book.

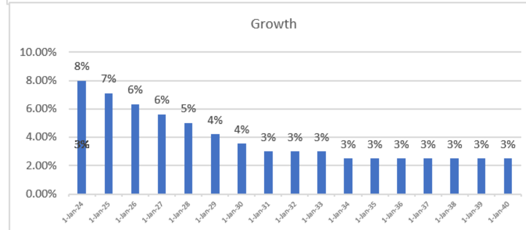
Explicit discussion there was no proof about kind of return on invested capital you were actually making.

We could then easily compute NOPAT which is necessary to compute the free cash flow anyway. You need to multiply the NOPAT by one minus the tax rate. We can compute NPOAT, and we can just multiply NOPAT. There is no requirement for making assumptions about capex to depreciation about making adjustments to the capital you just have NOPAT, and we have the multiple.

☑ Stable Period Adjstment to Growth Method | Higher Return, Lower Growth

	Theoretical Value	Growth Rate	Value Driver Basic	Value Driver Sudden	Value Driver Fade Period
Value of Corporation	**154.87**	**268.53**	**214.89**	**139.80**	**155.06**
Driver (g or ROIC)		2.50%	6.00%	6.00%	013% -- 006%
Price to Book	1.55				
Price to Earnings	11.91		Lower Final Terminal Return Ext		
Explicit Period	10				
Fade Period	6		Decreasing Growth Case		
Cost of Capital	6.80%				
Terminal Period	12-Jan-34	Value Driver Basic = Income * (1-g/ROI)/(k-g)			
End of Post Terminal	12-Jan-40	Value Driver Basic = Capital * ROI * (1-g/ROI)/(k-g)			





Implicit Return on Invested Capital Assumption

Re write the formula for value with some substitution.

NOPAT = ROIC x Invested Capital
1/ROIC = (NOPAT/(WACC-G) – Value) / (NOPAT x G)

Value = Current ROIC x Invested Capital x (1-Growth/Other ROIC)/(WACC – Growth)

The issue here is the ROIC in the first part of the equation and the ROIC in the later part of the equation. I had to go back and try to understand if there was some kind of magic and some kind of elegant and some kind of a justifiable progression return on invested Capital to the new return on invested capital . When I work through this analysis there were clear logical problems. Begin with the case where the growth is zero. In this case, the formula becomes.

Value = ROIC x Invested Capital x /(WACC)

When this time the second ROIC goes away and it is assumed that the ROIC is always equal to current ROIC. There is no flexibility in evaluating what happens to the ROIC. I doubt that that results that you want to if you input the ROIC less WACC in the formula. Now if we go growth rate is very high. We could never in the formula make the growth rate higher than or equal to WACC because the denominator goes to 0 . But if we make the growth rate relatively high then there is a larger subtraction for the Growth/ROIC. I used the interpolation process again I back into the number of years It takes for the current return to progress from the existing return. The incremental return with different growth rates. Now this might be a nice graph, and maybe you could try some sort of theory that would somehow go along with his change in the ROIC. To make this graph

Interpolation of ROIC – Need Trend in Invested Capital

I suggest that trying to come up with some kind of economic explication that's all a lot of crap. Instead why don't you interpolate over time over which you believe the return on investment. You cannot anymore use the value driver formula and you need to make a little if you want to get fancy could make an automatic function in Excel called an user-defined function okay I think you there now that's more progression terminal value thinking and Analysis with some creativity rather than trying to find a magic formula

when we look at the Dow 30 return on invested capital for most companies is enormous apples invested Capital balance sheet. Is the debt and Equity is blank by car it still has some Surplus where is the operating profit the heavy toll on my income tax rate notice that the tax rate is pretty low is in the figure XXX. For Nike turn on invested capital is except a list of the return on invested capital is presented below. I have attempted to write hey program automatically goes to publicly available data get the data into excel and allows you retrieve the data compute cost of capital from the data evaluate the multiples from the data comes from MarketWatch and finance.yahoo. The amazing thing is that you can get the data for just about any company in the world,

Corporate Finance Process – Cash Flow Forecast and Ridiculous Terminal Value

You can make growth rate forecast – CF x (1 +g)/(WACC-g) or you can use multiple. Multiples must reflect specific growth, cost and return. By the time you get this right, use an alternative method. When use the growth rate method, you do not even know what implicit assumptions you are making.

Problems with Using the Ratio of Capital Expenditures to Depreciation

Example of capital expenditure to depreciation of 1.0. Use for forecast. Examples – very simple to derive return from the capital expenditure to depreciation. Examples of bad capital expenditures to depreciation. Alternative methods.

Basic idea, if the return changes, the cap exp is higher relative to the depreciation. If you use the historic level, you do not know what kind of assumption you are making. Show some scenarios. If the return is changing you can do two things. The first is to change the income level and maintain the growth in capital expenditures. Simple example is shown below where the return changes and there is a growth assumption. The second is where the income grows and the capital expenditures are used to change the rate of return. This is shown in the second simple example. Note the same/different valuation.

Discuss the introduction. How to compute stable capital expenditures for a corporation. Examples of capital expenditures (investment) to deprecation. Recall that need investment to make money. Show how to compute and then show what is wrong. What is deprecation rate. No idea about what assumption making with respect to return on invested capital. Example if higher growth than will have higher cap exp to deprecation.

Problems with Traditional Terminal Value – Terminal Growth without Normalization. How can possibly not change capital expenditures and working capital investment when change the growth rate. Problems with Traditional Terminal Value – Terminal Growth with Normalization. When change, still do not know the implied ROIC. Need to derive.

Problems with Traditional Terminal Value – Value Driver without Adjustment

Problems with Traditional Terminal Value – Sudden Movement of ROIC and Growth to Long-term Values

Problems with Traditional Terminal Value – Gradual and Explicit Movement of ROIC and Growth to Long-term Values

Case 1 – Stable Returns, Stable Growth and Constant Age

Portfolio model with UDF. With and without economic depreciation. Value of portfolio of assets. Include the quantity of production and production of capital expenditures. Use the Burton Sensors case.

Case 2 – Slower Capital Expenditure and Increasing ROIC

Case 3 – Effect of Age of Plant and Measuring ROIC with Straight Line Depreciation

Case 4 – Effect of Changing Growth in Measuring ROIC and Terminal Value

Points in this chapter

1. Terminal value and Growth Rate – Have No Idea of What ROIC
2. For corporations, ROE and ROIC will be high when investment or re-investment is low and the plants are ageing

3. ROE is a bad statistic for gauging future performance for a corporation because of things like stock buybacks and changes in leverage
4. ROIC is a bad static for gauging future performance because is distorted because of plant age, plant write-offs and vagaries in computing ROIC
5. Terminal Value
6. Ambiguities in basic measurement of Corporate ROIC and Evaluating Future ROIC
7. Corporate analysis and ROIC versus ROE for evaluating future cash flow
8. Incorrect terminal value – no stable cash flow
9. Incorrect terminal value – don't know implicit assumption for EV/EBITDA
10. Terminal value with basic McKinsey formula
11. Terminal value formula with Corrected formula

Chapter 27: Importance of Measuring Capital Expenditure and Depreciation

How important it is to come up with investment to support the future expenditures. Maybe repeating too much that just forecasting earnings without the investment required to sustain the growth is an absurd exercise. When you make a forecast of return on invested capital, you are implicitly making a capital expenditure forecast. If you make an assumption about capital expenditures separate from the cash flow or income, you have no idea what kind or return assumption you are implicitly making.

The real issue is evaluating capital expenditures and making sure that the capital expenditures are consistent with the growth rate in EBITDA. I begin by discussing the general use of capital expenditures to depreciation. The main point is that even if one is careful with capital expenditures to depreciation you do not know what the implicit return on invested capital is. For purposes here, I will pretend that investments in development, research, software and other items are correctly accounted for.

I illustrate valuation created by cash flow from not normalizing the Investments sustain the capital expenditures. In my classes I noticed something even worse. I can remember a man 15 or 20 years ago told me that his management instructed him to use a ratio of the depreciation expense to capital expenditures of 1.0 in the normalized cash flow. I was a little bit impressed with this because at least there was some attempt to address the question of what level of capital expenditures is appropriate in valuation and at least there was not But in the last chapter in working through the issue of straight-line depreciation (remember the graph with the ROIC starting low and getting really high), we demonstrated that even if there is no future growth, the capital expenditures must grow to simply replace the prior plant.

	Est.	Projected (period ending 12/31)					
	2015	2016	2017	2018	2019	2020	2021
Income statement items							
Revenue	$10,649	$10,698	$11,175	$11,671	$12,191	$12,557	$12,871
Growth rate (%)		0.5%	4.5%	4.4%	4.5%	3.0%	2.5%
Operating expenses	$6,548	$6,397	$6,570	$6,808	$7,049	$7,139	$7,440
Depreciation [1]	$1,049	$1,091	$1,135	$1,180	$1,227	$1,300	$1,313
EBIT	$3,052	$3,210	$3,470	$3,683	$3,915	$4,118	$4,118
Operating ratio	71%	70%	69%	68%	68%	67%	68%
Balance sheet items							
Capital expenditures	$2,365	$2,070	$1,910	$1,930	$1,930	$1,949	$1,969
Net working capital [2]	($192)	($128)	($134)	($140)	($146)	($151)	($154)

Source: Compiled from UBS Global Research, Norfolk Southern Corporation, October 28, 2015; and casewriter estimates.

[1] Because the expected useful life of a railroad's fixed assets was very long (up to 40 years) and depreciation was based on historical cost, the ratio of Cap Ex to Depreciation was typically greater than one. Historically, the average ratio of Cap Ex to Depreciation for Norfolk Southern was about 1.5. The historical ratio of Cap Ex to Depreciation of 1.5 was expected to hold during the period after 2021.

Figure xxx shows the amount of capital expenditures that are necessary to replace plant where straight line depreciation is used and also where the lifetime in depreciation reflects the economic lifetime of assets. The figure demonstrates that capex to depreciation ratio should be well above 1.0 even with no growth. Figure xxx illustrates the errors in valuation of a company through errors in ratio of capital expenditures to depreciation. The zero future growth case where we only have enough to replace our address again just to try to think through some of these issues once you get the issues. The modelling here is simple and this type of simple model can be effective.

Once we have established depreciation to the capital expenditure ratio for a case where there is no growth now let's move to a case where there is growth. When beginning to work through Pepsi in the room volume, I would propose and suggest making proofs proving one method works and one method an example of this is the working capital adjustment discussed above . We could make a very long term model supposed to simulate or it's supposed to simulate going concern

then we have simulation of what happened for example when the growth changes from to 0% we can first simulate the actual value of the company. This is a benchmark. Next can try different terminal value techniques and attempt to understand whether the terminal value techniques the correct value incorrect value. The analysis in table XXXX above does exactly.

We have established ratio of capital expenditures to depreciation of 0% would imply that you should use a ratio of capital expenditures to depreciation that is higher than 1.0 if the nominal growth rate is above zero. Then you are replacing assets the ratio of capital expenditures bro and be higher to reflect the grow simulation up results. Now back to the terminal value discussion so, it's really not showing you how things look and by how things work I mean what happens if growth rate changes to return changes all of the items I have already discussed. It also did not discuss distortions the measurement of the rate of return.

When I read the book the current time I had a negative opinion I thought this book is talking about how wonderful companies are that are able to charge Monopoly profits and it was essentially a worshipping Monopoly. Sorry again about the rambling. I thought the book was the ultimate look In Praise of capitalism being afraid of learning did the first version of the book on the statement that and because they have overstated the car to get the value increase Value Inn pay for both domestic or something.

That was aggressive credit that statement does not subsequent versions. I had been as we work through the history personal history of terminal value I thought wouldn't doesn't it isn't it a little fancier either Use multiples all the problems in multiples in the last chapter. To use the Gordon's growth method I have just have just tried to recruit some problems. Wouldn't it be better to use this value driver for me.

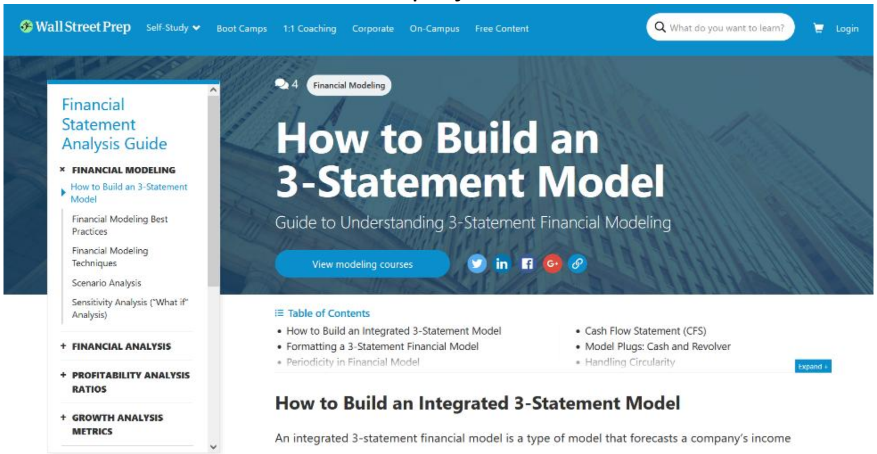
Chapter 28: Terminal Value Formulas and Philosophy – the Elephant in the Room

To compute need the prospect of earning above cost of capital in the long run. Could simulate this.

Repeat how lucky not to be trapped by statistical analysis of academics, rules by investment bankers or formulas of investment bankers.

When Somebody Talks about Three Statement Financial Models You Should Throw-up

For a while an engineer named Max called me every day. We had made a deal where Max would tell me about hydrogen and I would explain financial modelling to him. Max listened to me a bit, but he did completely trust me. So, he went to a website and took a course in how to build a three-statement financial model. After working on a model for Amazon (the company, not the river), he asked for help on balancing the balance sheet. Now as a modeller, I do understand the extasy of balancing the balance sheet. But I asked him where the presentation of long-term growth and return on investment was in his model from the corporate finance institute. It was nowhere. He was able to balance the balance sheet but could not present the historic return on investment relative to the projected return on investment. Nor could he show me a nice presentation of the assumed growth rate and whether the implicit assumptions meant that absolutely everything that you bought – from houses to cars to financial modelling courses – would be from Amazon.



The key output from this three statement financial model should have been the company value. But this calculation used a simple terminal growth and applied the terminal growth to cash flow that was not normalized. There was no way to evaluate whether the expenditures for warehouses, trucks or other things was sufficient to support the assumed long-term growth. You could not see whether the economic return on investment was reasonable compared to other possible ways to buy things. Even though Amazon may be very efficient, other companies can sell things on-line and other stores can still realize a margin from selling stuff in stores. So making some kind of implicit assumption that Amazon can earn a really high return may not be reasonable.

Overview of Terminal Value Methods

When You meet the CEO, you Better not Tell Him or Her that Your Company will End Soon

Let's say you are an employee of Amazon. Jeff Bezos calls you to his office and asks you how long do you think Amazon will last. You probably should say that it will last for ever or maybe more properly say that it is on-going. That is a long time. If you computed the duration like the duration on a bond, it would have a very long life. When computing value you could split cash flow from the first five years and compute the value from year six until forever. One would think the value of the second piece would be much bigger.

This chapter and the next address what can be done to assess the value of second piece. In part the long-term value is the continuing advantage you have from developing existing assets. But it also depends a lot on whether you believe future generations of management can do the things like forced obsolescence mentioned in Chapter 2 to earn economic profit. Now assume you don't even know what return you are assuming in the second piece. You may be assuming a higher return or a lower return than has been earned in the past. Given how important this assumption is, how you can make a forecast where you don't even know what you have assumed. But this is the case with using the constant growth method or, as pointed out in the last chapter, the multiples.

Given the intuition that Amazon valuation it is not surprising that it is a popular company to use in teaching financial modelling and valuation. Amazing that people have no idea what the implicit ROIC is in terminal value. Either in growth rate or in multiple do not know explicitly know what the assumption is. Heard stories where the capital expenditure is less than the depreciation and growth rate is positive.

Incredibly bad, and nobody will probably use my suggestions. But hopefully make you think. Second chapter uses a couple of examples.

INSERT TERMINAL VALUE AS RELATIVE TO TOTAL VALUE

What You Are Really Measuring with Terminal Value – The Ability of Management to Continue Earning Economic Rent

May want to stop all economic profits – earnings above the cost of capital. Before working through terminal value methods that can account for return on invested capital, growth and the changing risk. When presenting basic discounted cash flow analyses, we would use a constant growth rate. I would show how, because the discount rate is used in the terminal value: TV = Cash Flow x

(1+g)/(WACC-g). This is on top of the cash flow and the terminal value being discounted by the WACC. The other method is to use the terminal value from multiplying the EV/EBITDA ratio.

Recall the keep calm and carry on box. Have low risk here.

Remarkably, Financial Models do Not Explicitly Consider Rate of Return in Terminal Value

I have reviewed a model that is taught by the Corporate Finance Institute that shows you how to be proud of yourself for creating a three-statement financial model. Remarkably, the return on invested capital is not presented and there is no comparison between historic and projected returns. Instead, there is a valuation using a constant growth model where the assumed capital expenditures do not change with the alternative growth rates. Looked at case studies used in an MBA program. Provide spreadsheets with history and forecast. No calculation of ROIC or even ROE. No comparison of history and forecast.

If ROIC declines because of increased capital expenditure instead of trends in income, you can set this up in a schedule using a flag or a percentage. In one extreme, all of the change in return results from the change in income. In the other extreme all of the change in return comes from changes in the capital expenditures.

Problems with Traditional Terminal Value – EV/EBITDA as Terminal Value

Proofs of Terminal Value

Prove that what is wrong. More difficult to find a good method. The idea of proofs. Don't know what will happen in two years much less three hundred years. But we can make a simulation.

Stable Period Adjstment to Growth Method

Constant Return, Growth

	Theoretical Value	Growth Rate	Value Driver Basic	Value Driver Sudden	Value Driver Fade Period
Value of Corporation	**184.21**	**184.21**	**184.21**	**184.21**	**184.21**
Driver (g or ROIC)		3.00%	10.00%	10.00%	10.00% -- 10.00%

Price to Book 1.84
Price to Earnings 18.42

Flat Constant Return Case

Explicit Period 10
Fade Period 6

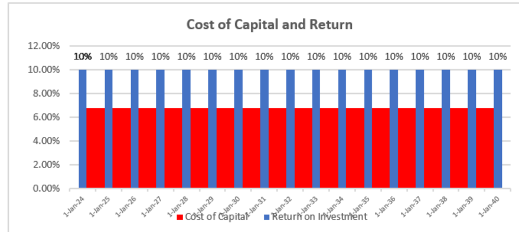
Flat Growth Case

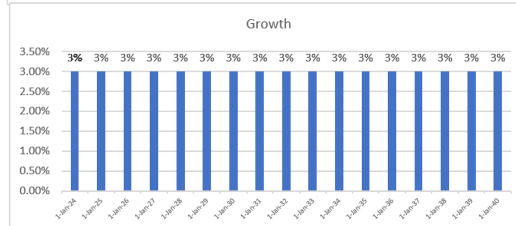
Cost of Capital 6.80%

Terminal Period 12-Jan-34
End of Post Terminal 12-Jan-40

Value Driver Basic = Income * (1-g/ROI)/(k-g)
Value Driver Basic = Capital * ROI * (1-g/ROI)/(k-g)

Cash Flow 6.80
Cash Flow x (1+g)/(WACC-g) 184.21





Gordon's Method

What would assume in the constant growth method. Of course the TGR. But also the level of investment necessary to maintain the growth, the level of investment necessary to replace assets, the level of investment to grow, the implied rate of return, the change in risk associated with moving around the competitive strategy boxes.

After working through the terminal growth method sometimes called the Gordon's method. I admit I am biased. It is a good example of I have to talk about disgusting which the growth with method is named the Gordon. If you could find it found a little book written by a man named Gordon subjective was to increase cost of capital estimates so utility companies could get higher rates. He basically came up with a formula that's cost of capital value of a stock is the dividend / stock price. More specifically the future dividend if you're using an annual cost of capital, it would be the if you're using a quarterly it would be the next quarter's dividend. I suppose you would have to an annual eye quarter dividend 1 plus the number raised to the 4th power. If you have this value formula it's extremely simple to reverse the formula and derive the cost of capital so in utility cases where companies have a pretty record of continual record of dividend is compute the dividend yield Kylie has the growth rate estimate of the cost of capital.

☐ Stable Period Adjstment to Growth Method — Low Terminal Growth

	Theoretical Value	Growth Rate	Value Driver Basic	Value Driver Sudden	Value Driver Fade Period
Value of Corporation	**183.72**	**155.43**	**181.79**	**181.79**	**181.79**
Driver (g or ROIC)		2.50%	10.00%	10.00%	10.00% -- 10.00%

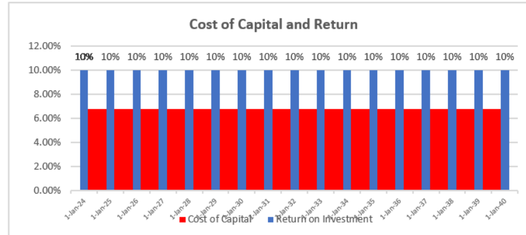
Price to Book	1.84
Price to Earnings	18.37
Explicit Period	10
Fade Period	6
Cost of Capital	6.80%
Terminal Period	12-Jan-34
End of Post Terminal	12-Jan-40
Cash Flow	5.85
Cash Flow x (1+g)/(WACC-g)	139.53

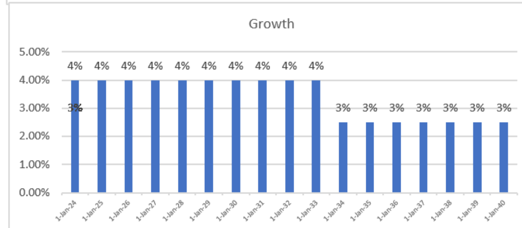
Flat Constant Return Case

Lower Terminal Growth Case

Value Driver Basic = Income * (1-g/ROI)/(k-g)

Value Driver Basic = Capital * ROI * (1-g/ROI)/(k-g)





How can somebody have there be dang attributed to this simple formula that basically is a perpetuity formula that adds the fact that the growth rate learning and growth are the same thing. Writing a whole book about this simple formula. That's fine it. I got off track.

The capital asset pricing model became more was that should we fight over the estimation of key the growth rate or should we fight over the estimation of beta in the Caravan by the way. By the way this is completely wrong because the equity Market risk premium much more controversial item in the model.

Other things remarkable the way people tell value is that if there was a cyclical in industry there would not be a big effort to use the return on invested capital for a typical year rather than a high or next year or lower. the further north there was also never attempt that I saw I just captain of the ratio of the capital expenditures to depreciation for changes in the terminal growth. In other words, if there's a higher terminal growth rate higher, there should be associated capital expenditures ratio to depreciation should be higher. We can use a user defined function to derive the capital expenditures and depreciation to derive different numbers and make things more automatic expected terminal growth rate.

=IF(F13,V12*W8,V12*V8)

	D	E	F	G	H	J	R	S	T	U	V	W	X
1	Time Line		Driver 1	Driver2	Driver 3	Cost of Cap							
2	Low Terminal Growth												
3						0	8	9	10	11	12	13	14
4	Holding Period		10			TRUE	TRUE	TRUE	TRUE	FALSE	FALSE	FALSE	FALSE
5	Exit Period		10			FALSE	FALSE	FALSE	TRUE	FALSE	FALSE	FALSE	FALSE
6	Rate of Return Earned on Capital (Equity or Total)			Flat Constant Return Case			10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%
7	Growth Rate			Lower Terminal Growth Case			4.00%	4.00%	4.00%	2.50%	2.50%	2.50%	2.50%
8	Dividend Payout (Money Extracted)					60.00%	60.00%	60.00%	60.00%	75.00%	75.00%	75.00%	75.00%
11	Opening Balance						131.59	136.86	142.33	148.02	151.73	155.52	159.41
12	Add: Net Income						13.16	13.69	14.23	14.80	15.17	15.55	15.94
13	Less Cash Flow (Dividend or Income - Cap Exp + Dep)		FALSE				7.90	8.21	8.54	11.10	=IF(F13,V12*W8,V12*V8)		
14	Closing Balance					100.00	136.86	142.33	148.02	151.73	155.52	159.41	163.39
15	Change in Investment	Stable Period Adjstment to Growth Method					5.26	5.47	5.69	3.70	3.79	3.89	3.99
16													
17	Cash Flow Growth						4.00%	4.00%	4.00%	30.00%	2.50%	2.50%	2.50%
18	Income Growth		CoC				4.00%	4.00%	4.00%	4.00%	2.50%	2.50%	2.50%
19	NPV of Dividends: True Value	183.72	6.80%										
20													
21	Price to Earnings	18.37		Stable Period Adjstment to Growth Method									
22	Price to Book	1.84											
23						0	8	9	10	11	12	13	14
24	Net Income and Dividend												
25	Terminal Period Cash Flow Before Change		Term g	k			-	-	8.54	-	-	-	-
26	Value over Explicit Period	49.99		6.80%			7.90	8.21	8.54	-	-	-	-
27	Growth Rate Multiplier (1+g)/(k-g)	23.84	2.50%	6.80%			-	-	203.57	-	-	-	-
28	NPV of Terminal - Growth	105.44		6.80%									
29	Total Value	155.43											
30													

Contents | Summary | Control | Scenarios | Valuation Model | Steps for Incremental Method

Now show the adjustment for normalisation where the future growth.

☑ Stable Period Adjstment to Growth Method — Low Terminal Growth

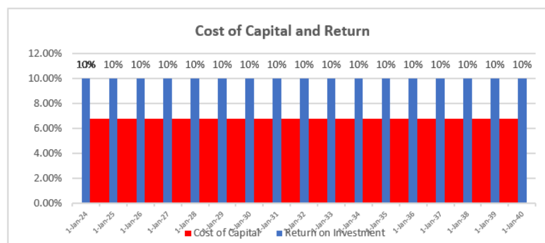
	Theoretical Value	Growth Rate	Value Driver Basic	Value Driver Sudden	Value Driver Fade Period
Value of Corporation	**182.90**	**182.90**	**182.90**	**182.90**	**182.90**
Driver (g or ROIC)		2.50%	10.00%	10.00%	10.00% -- 10.00%
Price to Book	1.83				
Price to Earnings	18.29				
Explicit Period	10				
Fade Period	6				
Cost of Capital	6.80%				
Terminal Period	12-Jan-34				
End of Post Terminal	12-Jan-40				
Cash Flow	5.85				
Cash Flow x (1+g)/(WACC-g)	139.53				

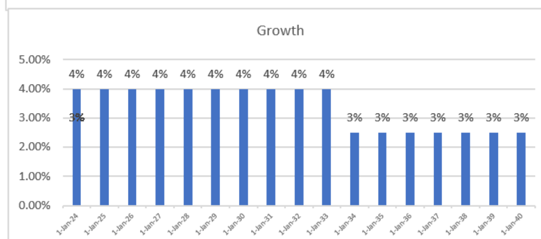
Flat Constant Return Case

Lower Terminal Growth Case

Value Driver Basic = Income * (1-g/ROI)/(k-g)

Value Driver Basic = Capital * ROI * (1-g/ROI)/(k-g)





Use of Value Driver Formula in Terminal Value

You can impress people with the formula and application is not very difficult all you have to do is add one more variable in your terminal analysis. Your terminal analysis should all already include the weighted average cost of capital the terminal growth rate. Please note I just cost of capital weighted average cost of capital tax treatment in the weighted average cost of capital in subsequent chapters. So wouldn't it be why don't we just dad for the turn on invested capital in addition to the growth rate.

Then we have all three formulas or something. Mechanically, all we have to do is compute a multiple. The multiple of the no cap and the value the formula below recounts this formula it's simply

Enterprise Value / NOPAT = (1 - G /ROIC)/(WACC-G).

We could then easily compute NOPAT which is necessary to compute the free cash flow anyway. You need to multiply the NOPAT by one minus the tax rate. We can compute NPOAT, and we can just multiply NOPAT. There is no requirement for making assumptions about capex to depreciation about making adjustments to the capital you just have NOPAT, and we have the multiple.

Use of Value Driver Formula in Terminal Value

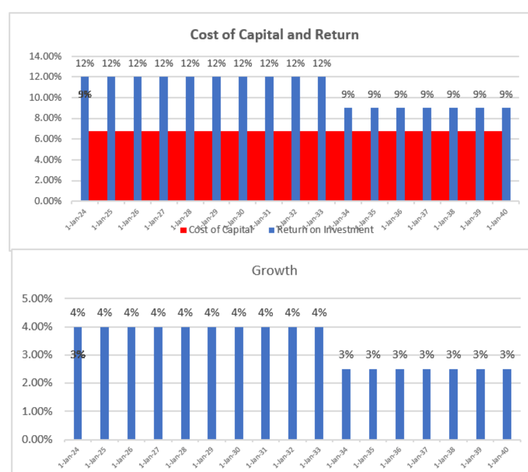
You can impress people with the formula and application is not very difficult all you have to do is add one more variable in your terminal analysis. Your terminal analysis should all already include the weighted average cost of capital the terminal growth rate. Please note I just cost of capital weighted average cost of capital tax treatment in the weighted average cost of capital in subsequent chapters. So wouldn't it be why don't we just dad for the turn on invested capital in addition to the growth rate. Then we have all three formulas or something. Mechanically, all we have to do is compute a multiple. The multiple of the no cap and the value the formula below recounts this formula it's simply:

Enterprise Value / NOPAT = (1 - G /ROIC)/(WACC-G).

☑ Stable Period Adjstment to Growth Method — Low Terminal Growth and Return

	Theoretical Value	Growth Rate	Value Driver Basic	Value Driver Sudden	Value Driver Fade Period
Value of Corporation	**182.30**	**219.45**	**219.45**	**181.37**	**181.37**
Driver (g or ROIC)		2.50%	9.00%	9.00%	9.00% -- 9.00%

Price to Book	1.82	
Price to Earnings	15.19	Lower Terminal Return
Explicit Period	10	
Fade Period	6	Lower Terminal Growth Case
Cost of Capital	6.80%	
Terminal Period	12-Jan-34	Value Driver Basic = Income * (1-g/ROI)/(k-g)
End of Post Terminal	12-Jan-40	Value Driver Basic = Capital * ROI * (1-g/ROI)/(k-g)
Cash Flow	7.80	
Cash Flow x (1+g)/(WACC-g)	186.05	



Normalizing Adjustments in Terminal Value

Start with idea of normalizing cash flow in the terminal period. If you are making a long-term forecast, you need to make things consistent. If you make a long-term forecast, you need to not distort things. This is a minimum. I start with this and then move to the key question of capital expenditures.

In computing terminal value, there should be adjustments that correspond to the assumed long-term terminal growth rate. A typical normalized cash flow adjustment is working capital. Because of the changing it growth rate the working capital in should be adjusted. The investment required grow the cash flow includes the terminal higher. Work through the investment in inventories or the investment in accounts receivable. Let's take an extreme example. Let's say the terminal growth rate is 0 the historic growth rate was 10%. The last period cash flow is affected by the investment in working capital. The proof of the working capital adjustment is illustrated in Table xxx.

In making the working capital adjustments, you could evaluate accounts receivable to revenues and inventories to cost of goods sold, and accounts payable to expenses etc. Growth rate is reduced to zero good working capital becomes stable. But the historic EV/EBITDA including a 10% growth and included an increase in working capital this investment for example in inventories is not needed play changes to a zero Growth Company. The most important is how to use a model to make a proof of something.

INSERT TABLE OF WORKING CAPITAL ADJUSTMENT AND EXISTING AND FUTURE CAPITAL EXPENDITURE

Fraud of Explicit Cash Flow Periods and Adjusted IRR

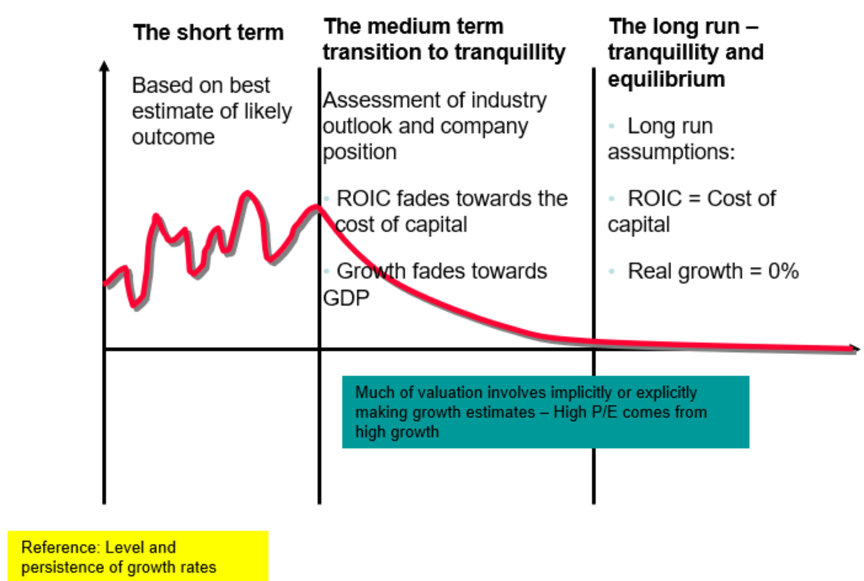
There is an idea in valuation that companies and business ventures have a life cycle and eventual become obsolete. This idea is behind all sorts of terminal value ideas in valuation where constant growth rates, continuing capital expenditures and normalized income are used, comes from the general ideas shown in Figure xxx. The notion shown in Figure xxx is that you can make some kind of short-term forecast (perhaps with some kind of company guidance). This is the first fraud. We all know that company guidance can be irrelevant to the valuation of a corporation that is supposed to last indefinitely. The second idea is that the business activity will have a real growth of zero (the growth is at the rate of inflation). This is the second fraud. Why not a negative growth rate or assume that the company can continue to make people addicted. The third point is that the return will go down to the cost of capital as other companies enter the business. This is the fourth fraud. Why would a company continue making investments if it is only earning the cost of capital. The final fraud is the biggest one. How could you be so crazy as to suggest that you know when a company will suddenly achieve some kind of mystical equilibrium where everything suddenly becomes very boring (but the cost of capital does not change.)

All of this does point out a whole lot of problems with valuation. But now I will be a hypocrite. Some of the ideas like that fact that nothing can keep growing for very long-term periods at really fast growth rates is reasonable. This is simply because when you grow you get bigger (think about your stomach). There is some limit to growth because otherwise you will explode. So, assuming some kind of gradual reduction in growth is reasonable (although when and how this occurs is a crazy notion). McKinsey claims to have found evidence that growth does slow but who knows what they really did. The general notion that companies cannot maintain high returns indefinitely is also reasonable. Here McKinsey suggests that there is less evidence, but this is probably because they are not looking at anything close to the correct measure of a return with economic depreciation, adjustment for impairment write-offs, goodwill and economic versus depreciation lives.

REDO THIS GRAPH

1. Earnings guidance
2. Your Own Judgment
3. Getting to Stable ROI with Correct Cap Exp
4. Philosophy of Return above minimum required return

Resolve the fraudulent issues with flexible sensitivity. In terms of the IRR you could apply a re-investment rate that gradually moves down if it is currently high (note I do not say that this movement is the cost of capital.) So, the AIRR is like the MIRR, but you assume the re-investment rate gradually converges to a number closer to the cost of capital. This is consistent with two economic ideas that drive the philosophy of valuation. Introduced here because I will use the idea elsewhere. The main reason I introduce this and make up a name, is that I will introduce analogous



concepts when discussing the terminal value. Note that I do not suggest that anybody will every use this method.

Chapter 30: Alternative Ways to Think About Terminal Value without Formulas

Value of Beethoven's Music

Way back in Chapter 3 I discussed the value of Justin Bieber's music. This hay be a radical idea for some young people, but I would suggest that if some private equity company in 1815 could have monetized Beethoven's music, it should be worth even more than Justin Bieber's songs. Pondering the value of Beethoven's music is a way you could think about terminal value. I am no music expert, but I submit that the joy in listening to this music has not diminished or converged to some kind of boring and stable value where the is nothing special left (where the economic return converges to the cost of capital). The hypothetical (disgusting) private equity company monetizing Beethoven's music hopefully would make you think about how silly it is to apply the same terminal value formula to different situations. To demonstrate some alternative ways to think about terminal value this chapter applies some practical cases.

Foolish Consistency is the Hobgoblin of a Petty Mind

Fraud to say that know the future. Different possible premium. Different possible investment strategies. Different possible surplus capacity.

MOVE OR DELETE NEXT PARAGRAPH

If you're working in the real world go to the website download data for your company's now you can get companies from all over the world. Go back to our companies with the extremely high return on invested capital. They have had a kitchen sink quarter kitchen sink is when you might take a lot of impairment studies or other write-offs when you do that take the right off your return on invested capital. It might also be the case Michael Jordan advertisement is the biggest investment for Nike and those do not show up at capital and capital expenditures for inventory investment or other sorts of investments in cash flow statement it might be the case that other companies such as Coca-Cola consistently have a Federal expenditures to depreciation.

The capital expenditures to depreciation is less than one if a company is not replacing it assets are older with a lower investment Capital base and I'm very high computed return new assets. Let's say has a valuable brand Nick or let's say company that has made Harry Potter film has very high profit and that we don't need any more new capital expenditures for the food . First question is predict my suggestion throughout the that it's almost impossible best way to make a big cash flow without making the investment.

Will Nike at some point made some kind of investment to start their business and some executive decided to pay Michael Jordan to make the advertisements somebody paid some artists to make the picture of Michael Jordan those were Investments and the return big return on that the existing investment. It's really hot and very bad investment should be a capital asset and that investment economic depreciation arrived at a to Thrivent the rate of return that rate of return enormous. But of course don't have account to get done is my point is we don't have to apply formula explicitly we cannot because of accounting because it wouldn't make sense we need to make some judgments about probability of being maintained or value or decreased in value . Testing

I would have any expertise at all whatsoever in any kind of fashion at all but when we make our valuation, we could we need to pick creatively I have a much more open mind been simply applying a formula even if it's a beautifully elegant formula. Let's take the case of Coca-Cola. GE Case Study of Terminal Value Amazon case study

Berton Sensors Harvard case study on sensors.

Introduction case study rehab valuation dad except the current ROIC and perhaps make an adjustment for the normalized ROIC adjustments for normalizing the terminal value. Once we have a procedure for terminal value in a more sophisticated and rigorous manner, I will now work through some selected case studies and examples. Examples illustrate that you cannot just apply a nice little terminal value but that for this elephant in the room you often need to have some creativity. Alternative ways in order to come up with these alternatives I work through some selected case studies.

The first case study General Electric and illustrates analysis of changing ROIC and application of the interpolated formula. The second case study on what not to do and it uses the case of Air Arabia and distortions in the terminal value. The third case study of Norfolk Southern and Canadian Pacific HBS case and it illustrates the first thing is using ratio of capital expenditures to depreciation and the second thing is using the implied return on invested capital when using the Gordon's growth.

The fourth case study call Burton Sensors simple case written up by Harvard issues associated with change return on investment. The terminal value forever funny and just exclude life of the company how could you offer volume. The fifth part is a series of case studies discussing general issues. This case study is a survey of a few of them for the Dow 30. Is a case study of applying the interpolated return on invested Capital technique using Amazon as an example. Some percentage of the total value of the company.

The theoretical model compute cash flow given the return, best way to achieve the return given the growth rate in the investment. This example will be extended and modified for changes in changes in growth and numerous complications that arise when using EBITDA have a provision for depreciation on Capital assets, nor taxes that must be paid nor working capital Investments that must be met. All of the examples that are technical you can Associated spreadsheets and detailed documentation of the associated spreadsheets on the website. Change in Return on Investment and Growth

Terminal Value Case Studies

The general point of the chapter is being more creative when evaluating terminal value and don't using a simple formula. If you're working in the real world go to the website download data for your company's now you can get companies from all over the world. Go back to our companies with the extremely high return on invested capital. They have had a kitchen sink quarter kitchen sink is when you might take a lot of impairment studies or other write-offs when you do that take the right off your return on invested capital. It might also be the case Michael Jordan advertisement is the biggest investment for Nike and those do not show up at capital and capital expenditures for inventory investment or other sorts of investments in cash flow statement it might be the case that other companies such as Coca-Cola consistently have a Federal expenditures to depreciation.

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Change in Return on Investment and Growth

PART VI -- Cost of Capital; Equity and Country Risk Premium, CAPM Alternatives

Chapter 29: Estimating Cost of Capital with Capital Asset Pricing Model

So far, we have been skating around the issue the cost of capital but direct there has been no direct measurement of the cost of capital number. Chapter 13 and the remaining chapters in the book turn to direct measurement of the cost of capital. Chapter 13 introduces quantification of the cost of capital by presenting a test that can be used to determine when a company is earning more or less than the cost of capital using the market to book ratio. The test does not necessarily provide a direct estimate, but it can evaluate what the cost of capital is not in certain circumstances. This notion of finding particular cases that disprove estimates of the cost of capital can be applied to different industries as much of the cost of capital (the risk-free rate and the EMRP are economy-wide numbers). This method that I use to introduce quantification of the cost of capital contrasts dramatically with investment banks who proudly present mean reverted betas that are un-levered and re-levered using a sample of supposedly comparable companies.

To illustrate what can be done through evaluating the market-to-book ratio I begin with a statement that I have heard for decades – "we need a return in double digits." This type of statement that is almost comical does not seem to change with different inflation or interest rates or with different risk of projects means that returns of 10.0001% can be the target. The market-to-book analysis can be used to demonstrate that arbitrary targets of something like 10% with a risk-free rate of something like 3.5% implies a risk premium of 6.5%. To see what this means to capital intensive investments return to the philosophic discussion and the fact that the 6.5% which is far above the real growth in the real growth of the economy compounds to very high investor returns.

A couple of mathematical formulas can be used to demonstrate that when the market to book ratio is equal to one and the return earned on equity is stable, the return on equity is equal to the cost of equity. When the return on equity is stable and the market to book ratio is above one, this is evidence that the company is earning more than the cost of capital. The idea of using the market-to-book ratio to test the cost of capital comes from the fundamental idea that the cost of capital is part of the cost of an investment and when the returns equal costs, the market value of an investment is equal to the amount of money put into the investment. When the market to book ratio is one, there is no increase in value from earning more than the cost and no diminution of value from earning lower cash flow than the investment.

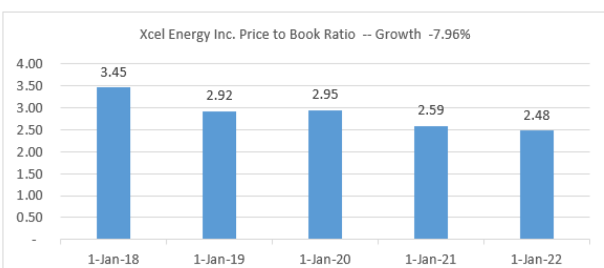
Establishing a formula for the market to book ratio is not controversial if you assume that returns, growth and cost of capital are constant. I have presented proof of some fundamental valuation formulas in Chapter 13. It is very easy to show that the market to book ratio is equal to:

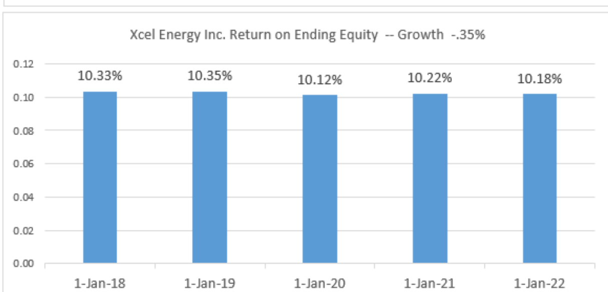
Market to Book = (ROE-growth)/(cost of equity – growth)

If you imagine that the ROE and the cost of equity are the same numbers in this formula, then the top of the equation is the same as the bottom of the equation and the market to book ratio is 1.0 no matter what the growth rate is. This is the most essential part of the equation because you do not have to get into debates about the growth rate. You can go further and demonstrate that the cost of equity depends on both the market-to-book ratio and the growth rate. This means that you must make an estimate of the growth rate and higher growth rates assumed by stock analysts imply a higher cost of capital. But if look at the formula carefully and split it up, you can see that if the market to book ratios is above 1.0, then the return on equity is above the cost of equity.

Cost of Equity = (ROE - Growth)/MB + Growth

To illustrate how the market to book ratio can be used to demonstrate that the cost of equity is far below 1.0 for investments that are stable (like project finance investments) I have used two examples. The first is a utility company named Xcel Energy, which is a regulated electric company in the U.S. Xcel Energy is earning returns on equity above 10% and it has a market to book ratio of more than 2.0 demonstrating that the company is earning a lot more than its cost of capital as shown below. The decline in the market-to-book ratio illustrates the increase in the nominal cost of capital in 2021 and 2022.

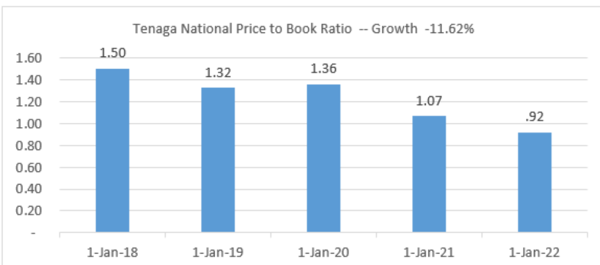


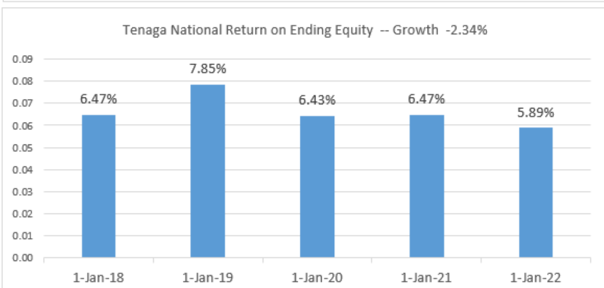


Xcel Energy Inc.	1 Year	5 Year
Expected Growth in EPS	6.80%	6.40%
Past Growth in EPS		8.55%
Year Ago Earnings Mktwatch	3.16	
Forward P/E Ratio (Yahoo)	21.14	
P/E Ratio (Marketwatch)	22.38	
Trailing P/E (Marketwatch)	22.48	
Price to Book (Yahoo)	2.35	
Price to Book (Maretwatch)	2.31	
Return on Ending Equity		
ROIC Reported (Marketwatch)	4.38%	
ROE TTM (Yahoo)	10.75%	
ROE (Marketwatch)	10.75%	
ROE - Forward EPS	10.91%	
ROE - Second Yr EPS	11.17%	
Yahoo Beta (5Y monthly)	0.42	
MarketWatch Beta	Beta 0.62	

A second example is from Malaysia with interest rates, inflation rates that are different from investments measured in Euro or USD. In addition, if you look up country risk premiums, you will find that Malaysia should command a risk premium ranging from 1.16% to 1.95% with a

2023 value of 1.89%.[61] The country risk premium is applied to overall cost of capital meaning that it would be magnified on equity returns. With all of this, the analysis of Tenaga, the large electricity company in Malaysia has a market to book ratio of about 1.0 and returns in the neighbourhood of 6%, demonstrating a cost of capital of around that number. Taking away the country risk premium of 1.89% would yield a cost of equity below 5%.



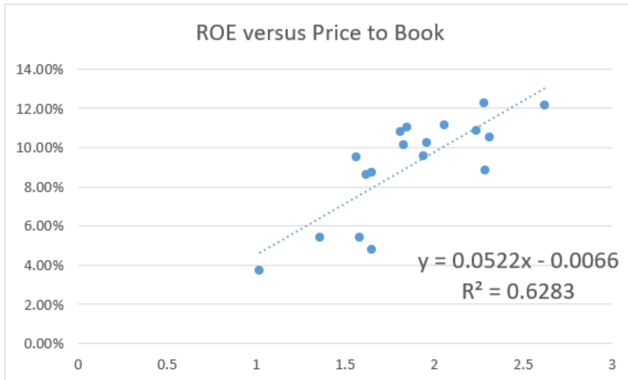


Tenaga National	1 Year	5 Year
Expected Growth in EPS	10.80%	3.00%
Past Growth in EPS		-8.59%
Year Ago Earnings Mktwatch	FALSE	
Forward P/E Ratio (Yahoo)	11.64	
P/E Ratio (Marketwatch)	FALSE	
Trailing P/E (Marketwatch)	18.89	
Price to Book (Yahoo)	0.98	
Price to Book (Maretwatch)	FALSE	
Return on Ending Equity		
ROIC Reported (Marketwatch)	FALSE	
ROE TTM (Yahoo)	4.95%	
ROE (Marketwatch)	0.00%	
ROE - Forward EPS	7.05%	
ROE - Second Yr EPS	7.27%	
Yahoo Beta (5Y monthly)	0.3	
MarketWatch Beta	Beta 0.89	

I have suggested creating a regression analysis of the market-to-book ratio and the return on equity to evaluate the level of return at the market to book ratio of 1.0. The nice thing about the graphs is there is typically within an industry a strong correlation. When I have tried this method, the implied cost of capital is a low, again meaning that capital intensive projects are favoured relative to fuel intensive investments.

[61] This comes from looking at Damodaran published numbers since 2011. The historic numbers are not published on the Damodaran website and I have put them together.

Mkt Watch



Slope	5.22%
Intercept	-0.66%
Cost of Capital	4.56%
R Squared	62.83%

EMRP And Understanding Growth Together with Return on Investment and Risk

Chapter 15 is the first chapter that addresses direct measurement of the cost of capital which as explained at the outset is so important for capital intensive investments that can potentially combat climate change. Every MBA student learns how to use the capital asset pricing model (CAPM) that to compute the cost of equity capital using the simple formula at the bottom of this paragraph. Eugene Fama claims that the CAPM has been dead for more than twenty years and should be replaced with that Arbitrary Pricing Model (it's true name is the Arbitrage Pricing Model). But surveys show the CAPM is overwhelmingly the most used model for estimating the cost of capital by practitioners. Out of the three variables in the equation, two – the risk-free rate and the EMRP -- apply to the entire economy and in theory should be the same for anybody using the model. The only variable unique to a company or a project is the beta statistic which is addressed in Chapter 16. The general theme of this chapter is that the two macro variables are too high creating a bias against investments that can combat climate change.

Cost of Equity = Risk Free Rate (Rf) + Beta x EMRP

You could try to relate the EMRP to the kind of nominal returns you may hope for on a stock portfolio (say 7%), but you must be careful. The EMRP does not include inflation because inflation is already included in the risk-free rate. You can separate the CAPM formula into items that are affected by inflation and items that are not affected by inflation. People who live in countries with high inflation know very well that when they borrow money or when they lend money the interest rate must compensate for inflation over the borrowing or lending period. If you are putting money away to buy a car in a year, and the inflation rate is 20%, the interest rate on the loan should be at least 20% so that the increase in the cost of the car over the year is covered. This means that interest rate including a risk-free rate and inflation can be written as:

Nominal Cost of Equity = Real Rf + Expected Inflation + Beta x Real EMRP

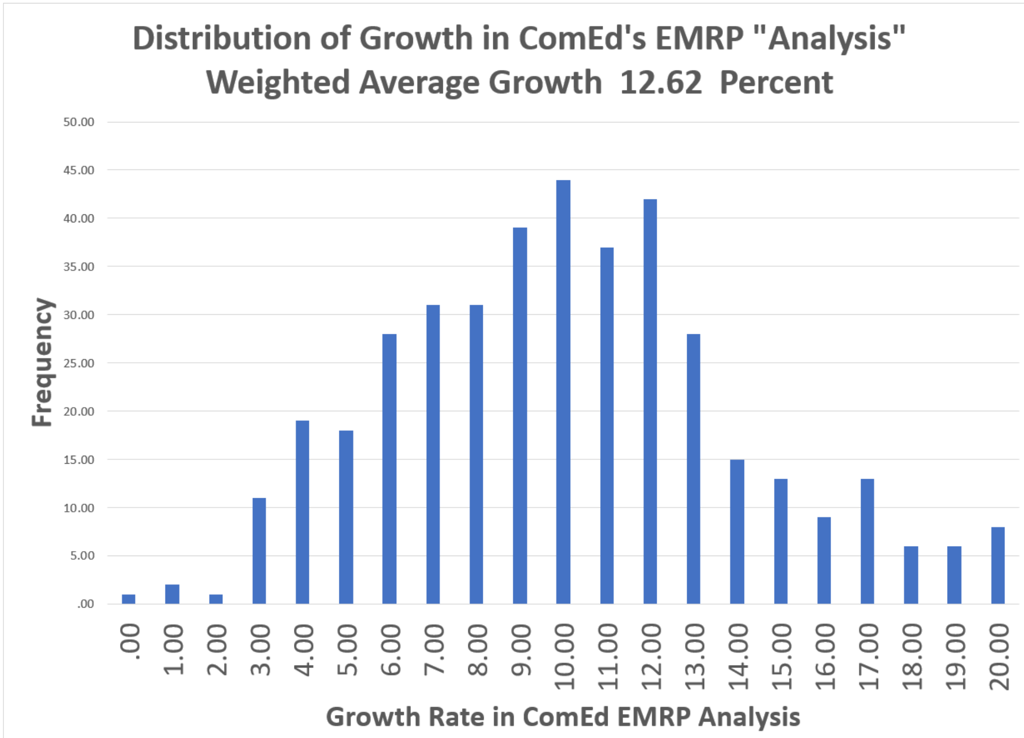
The primary question addressed in Chapter 15 involves the EMRP. But what interest rate should be used as the risk-free rate is not as straightforward as one may think. This is because of the risk associated with forecasting inflation that is inherent when investing in treasury bonds which are often used to represent the risk-free rate. When inflation changes during the maturity of a Treasury bond with a fixed nominal interest rate, cash flow in real purchasing power terms will change as well, even though the nominal recovery is fixed. If the inflation rate turns out to be higher than the inflation rate implied when the bond is purchased, the investor loses real purchasing power to buy things. This is a big risk, and it means that the long-term bond yield does not represent a risk free asset. and using a long-term bond yield overstates the cost of capital. There are a number of nuancedissues associated with the risk free rate that are further elaborated on in the chapter.

The appropriate EMRP to use drives much of the cost of capital and the economics of capital-intensive investments. When the CAPM was first established it was not unusual to see EMRP estimates of above 7%. The analysis was often taken from a study made by Ibbotson and Sinquefield assuming that historic returns reflect the supply and demand for risky securities relative to risk-free securities if the period is long enough. Instead of discussing details of measuring the number, I begin with some fundamental questions including the definition of the cost of capital in the context of the EMRP and the notion of diversification. The question of what volatility is acceptable in the context of overall economic growth and how the number is related to value relative to earnings is discussed. After reviewing the theory and fundamentals, I discuss some estimates of the number.

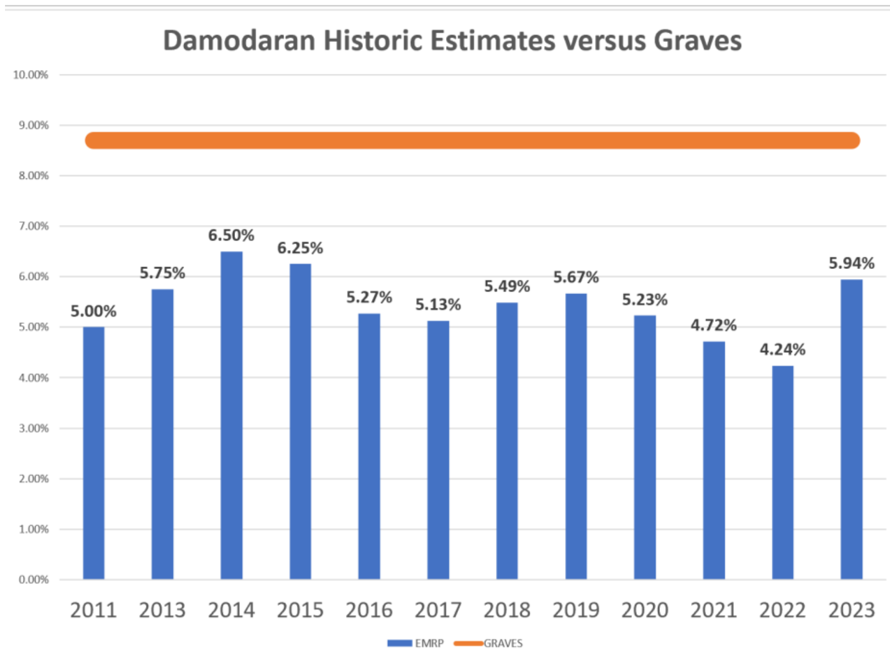
To begin analysis of the EMRP, you can recall the definition of the cost of capital and then apply it to the overall EMRP. The minimum acceptable return can be rephrased to be the minimum earned risk premium and it must be high enough to compensate for risk. We can work backwards and evaluate the possible return on a portfolio of all stocks in the economy to derive a realistic potential minimum return. Begin by assuming that the price to earnings ratio (P/E) is constant, let's say 15 which as shown in Chapter 8 is largely driven by the real cost of capital. In our imaginary portfolio, when earnings grow, the value of the aggregate portfolio goes up by the same amount as the earnings. If the economy goes up by 2% in real terms and corporate earnings grow at the same rate as the overall economy, and the P/E is constant, then the real return on stocks will be 2% above the risk-free rate that does not have growth. For the stock value to earn a premium above the risk-free rate, the earnings must grow if the price to earnings ratio remains the same. The equity risk premium can only be earned if the earnings grow or the price to earnings ratio changes and anything higher cannot be logical as the minimum acceptable risk premium.

Of course, some companies can earn much more than the overall rate of growth in the economy and other companies will go out of business (this is how capitalism works). Diversification of stocks through building a portfolio has been a principle of investments for more than 60 years and the growth rate of earnings for all stocks should then reflect the overall growth in corporate earnings that was presented at the outset and remember we are talking about real earnings. There will be volatility in corporate earnings and some years will be higher than others. But even if earnings are volatile, they should be mean reverting and the overall risks of a big portfolio are not like investing in a single company making handbags that can suddenly go out of fashion. If the P/E ratios are temporarily low or the level of earnings are at a low level because of a recession, the expected premium can be higher meaning that EMRP can vary. But over the long-term the returns should be driven by the economic fundamentals. As with other issues, these principles can be demonstrated with a simple model at a micro level.

To illustrate how the EMRP can be distorted, the graph below shows how an expert in the cost of capital (who I argued with in a contested case), suggested that the growth rate in earnings for the companies in the economy (the S&P 500) to be 12.62%. This growth rate is taken from analyst estimates for the next 5 years that you can easily find on the internet. If you subtract the risk-free rate of about 4% from the growth rate, you arrive at 8.62% premium. But this in turn implies that corporate earnings in the economy can grow at a rate of above 8% indefinitely. Either investors have unrealistic expectations, or the cost of capital is wrong. You can see that there is a big, vested interest in deriving a high cost of capital so that companies can achieve a high return, but the implications for climate change are very negative. This kind of cost of capital is a serious estimate made to establish prices of electric power in the City of Chicago.



The second culprit in estimating the overall cost of capital is our friend Mr. Damodaran who we met in discussing the country risk premium. Damodaran's estimates from 2011 to 2023 shown below had been gradually decreasing (in most years) from 2014 when the estimate was 6.5% down to 4.24% in 2022. Then, op-la, in 2023 it increased by 1.7% to 5.94% (an increase of 40% which, if earned would have dramatic effects for investors). In the details of Chapter 15 I demonstrate the kind of assumption about increases in P/E ratios and/or increases in earnings from low level that it would take to come up with such a change in the risk premium when the long-term growth is 2%. There is no way to justify a change of 40% from changes that occurred in 2023.



To demonstrate how out of line the Damodaran estimate is, I have listed studies that were included in a comprehensive survey from the first version of the book "Re-thinking the Equity Risk Premium" (I have not found an update of a list of studies like this). Out of the sixteen studies of EMRP, Damodaran's estimate of 5.94% is exceeded by only one of nineteen studies. You may believe that the risk premiums of around zero are implausible, but if you think seriously about the manner in which a portfolio can leave only risks that are mean reverting, the low numbers can be explained in theory. Note that half of the studies yield a premium of below 3%.

Chapter 16, Beta Estimation and Low Risk Stocks

If you really believe the CAPM and finance theory as it is taught, then the only way to measure is with the beta statistic. The theory is that risk comes from volatility of stock returns and all of the analysis discussed about project finance does not matter as risks not related to the market can be diversified. The beta that measures the risk of a company or project can be measured by un-levering betas for companies in an industry and then re-levered depending on the debt of the company in question. As discussed earlier, investments to combat climate change are often relatively low risk either because of contract structures and/or predictable mean reverting cash flow. Because of details in the way betas are typically measured, the risk measure using re-levered beta for a particular investment can end up being computed as a pretty big number. In Chapter 16 I address beta measurement issues and demonstrate that this supposed ultimate measure for risk is subject to great uncertainty at best and biased against the type of investments that combat climate change at worst. Distortions in beta come from many factors, including: (1) arbitrary computations of the reversion in beta toward 1.0 that come from a study made in the 1970's using data from the 1930's; (2) use of betas with weekly returns instead of monthly returns; (3) use of two-years of data versus five-years of historic data; (4) the process of un-levering and re-levering beta; and (5) studies of whether low-beta stocks understate risk.

Exhibit 1. Estimates as of 2001 of the ERP

Source	ERP Estimate (%)
Arnott and Bernstein (2002)	0.0
Campbell and Shiller (2001)	0.0
McGrattan and Prescott (2001)	0.0
Ross, Goetzmann, and Brown (1995)	Low
Reichenstein (2001)	1.3
Campbell (2001)	1.5–2.5
Philips (2003)	1.0–3.0
Siegel (2002)	2.0
Bansal and Lundblad (2002)	2.5
Shoven (2001)	3.0
Siegel (1994)	3.0–4.0
Asness (2000)	4.0
Graham and Harvey (2001)	4.0
Ibbotson and Chen (2003)	4.0
Goyal and Welch (2002)	3–5
Fama and French (2002)	4.3
Cornell (1999)	5.0
Ibbotson and Sinquefield (1976)	5.0
Welch (2000)	6.0–7.0
Average	3.7
Range	0.0–7.0

Note: ERP estimates are the expected long-term geometric return of equities in excess of the real risk-free rate.

To illustrate some of the issues with beta, the table below that includes our renewable companies and oil companies shows public data that you can use to extract betas from the yahoo.finance website and the MarketWatch website. Note first that when the beta is below 1.0, the yahoo beta in the left column is below the MarketWatch beta and the reverse is true when the yahoo beta is above 1.0. This is almost certainly because of something called the Blume adjustment that moves the computed statistic close to 1.0 for the MarketWatch beta (although this is not documented). Using the Blume adjustment, beta computed from the stock price variance – the raw beta – is adjusted by an arbitrary 33.33% to push the beta towards 1.0. This means that companies with raw betas of below 1.0 are adjusted upwards and companies with betas of below 1.0 have betas that are adjusted downwards.

Adjusted Beta = Raw Beta (0.67) + 1.00 (0.33)

To illustrate the effect of different betas as well as different EMRP's, I compare the computed cost of capital for Nextera, the largest company investing in the U.S. using different EMRP's and beta statistics. In the first case I use the Damodaran EMRP and the beta with the Blume adjustment. In the second case I use a 3% EMRP and the beta without the Blume mean reversion adjustment. For purposes of illustration, I use the same risk-free rate.

	Equity Cost of Capital =	Rf + Beta x EMRP
Damodoran and Blume Adjustment:	8.07%	= 3.5% + 5.94% x .77
EMRP of 3% and No Blume Adjustment:	5.12%	= 3.5% + 3.00% x .54

		Beta (5Y monthly)	Market Watch Beta	Total Debt/Equity (mrq)	Debt to Capital	Debt Less Cash to Capital
1	Tenaga National	0.30	Beta 0.89	1.53	60.53%	56.45%
2	Microsoft	0.88	Beta 1.19	0.48	32.38%	-20.98%
3	Apple Corporation	1.30	Beta 1.22	1.99	66.60%	50.07%
4	Consolidated Edison	0.38	Beta 0.50	1.13	53.01%	52.41%
5	Nextera	0.54	Beta 0.77	1.30	56.45%	60.40%
6	Ibederola	0.52	Beta N/A	0.81	44.61%	51.05%
7	EDP Renovaveis S/A	0.53	Beta N/A	0.66	39.61%	38.78%
9	Tesla	2.28	Beta 1.53	0.15	13.06%	-50.26%
10	Facebook	1.21	Beta 1.29	0.26	20.52%	-24.45%
11	General Motors	0.61	Beta 1.28	0.43	29.86%	17.10%
12	Shell Oil	1.49	Beta 0.97	1.55	60.78%	55.59%
13	Total Energy	0.86	Beta 0.94	0.49	32.99%	18.84%
14	BP Oil	0.63	Beta 0.95	0.68	40.50%	28.72%
15	Exxon Mobil	1.06	Beta 0.90	0.20	16.58%	3.95%
16	Cheveron	1.16	Beta 1.03	0.12	11.01%	8.16%
17	Saudi Aramco	0.21	Beta N/A	0.16	13.98%	-8.02%
18	Ford	1.69	Beta 1.18	3.22	76.32%	72.34%
19	Volkswagan	1.30	Beta 1.27	1.21	54.78%	65.50%
20	General Electric	1.20	Beta 1.17	0.76	43.31%	14.09%
21	Xcel Energy Inc.	0.44	Beta 0.64	1.57	61.10%	60.53%
22	Dominion Energy	0.53	Beta 0.67	1.72	63.27%	64.65%
23	Southern Company	0.55	Beta 0.69	1.77	63.93%	66.01%

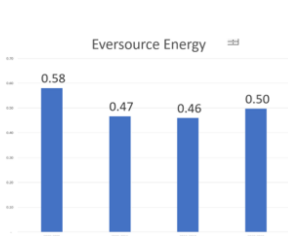
I get a little emotional about the Blume adjustment because it demonstrates much about how finance is practiced these days. First, even though betas can be computed and evaluated in seconds in an excel file using the SLOPE function, it is common to download the numbers from Bloomberg, Yahoo, MarketWatch or some other site and plop out the data. Second, for the most part, people who plop data from websites have no idea what is behind the beta computation and whether it is appropriate to use the adjustment. Third, testing the data on specific stocks is not evaluated to see if any reversion to a value of 1.0 exists.

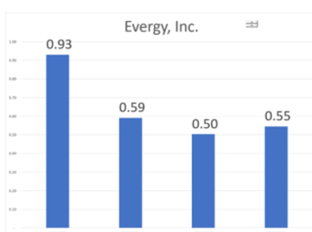
The reversion to 1.0 adjustment comes from a paper written in 1975 by a professor named Marshall Blume. With due respect to the Dr. Blume, when you read the paper, you see there is not much there. As shown in the insert, the study was made by creating portfolios starting in 1926 and then evaluating the movement of low and high beta portfolios over time. These days you can do this in minutes compute the beta for individual stocks or portfolios over different periods.

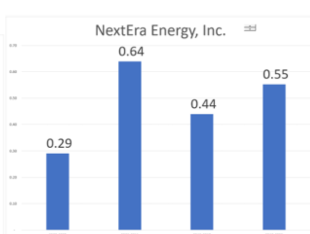
TABLE 3
BETA COEFFICIENTS FOR PORTFOLIOS OF 100 SECURITIES

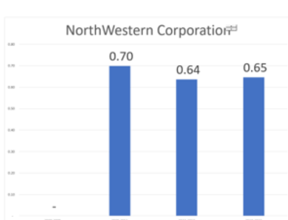
Portfolio	Grouping Period: Unadjusted for Order Bias	Grouping Period: Adjusted for Order Bias	First Subsequent Period	Second Subsequent Period
	7/26-6/33		7/33-6/40	7/40-6/47
1	0.50	.54	0.61	0.73
2	0.85	.86	0.96	0.92
3	1.15	1.14	1.24	1.21
4	1.53	1.49	1.42	1.47
	7/33-6/40		7/40-6/47	7/47-6/54
1	0.38	.43	0.56	0.53
2	0.69	.72	0.77	0.86
3	0.90	.91	0.91	0.96
4	1.13	1.12	1.12	1.11
5	1.35	1.32	1.31	1.29
6	1.68	1.63	1.69	1.40
	7/40-6/47		7/47-6/54	7/54-6/61
1	0.43	.50	0.60	0.73
2	0.61	.65	0.76	0.88
3	0.73	.76	0.88	0.93
4	0.86	.88	0.99	1.04
5	1.00	1.00	1.10	1.12
6	1.21	1.19	1.21	1.14
7	1.61	1.54	1.36	1.20
	7/47-6/54		7/54-6/61	7/61-6/68
1	0.36	.48	0.57	0.72
2	0.61	.68	0.71	0.79
3	0.78	.82	0.88	0.88
4	0.91	.93	0.96	0.92
5	1.01	1.01	1.03	1.04
6	1.13	1.10	1.13	1.02
7	1.26	1.21	1.24	1.08
8	1.47	1.39	1.32	1.15

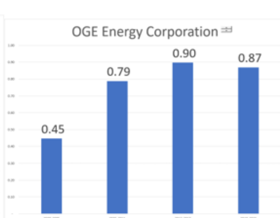
To discuss some of the problems with beta I use ConEd as a case study. In the above table, the yahoo beta is .38 and it is .50 using MarketWatch. Using the "fancy" formula above, .38 x .67 + .33 (I did not multiply by 1.0) gives you .58 or about the value of MarketWatch. A sample of utility companies shown below illustrates that the beta of utility companies and renewable companies do not converge to 1.0. Instead, the companies seem to converge to a number around .5.





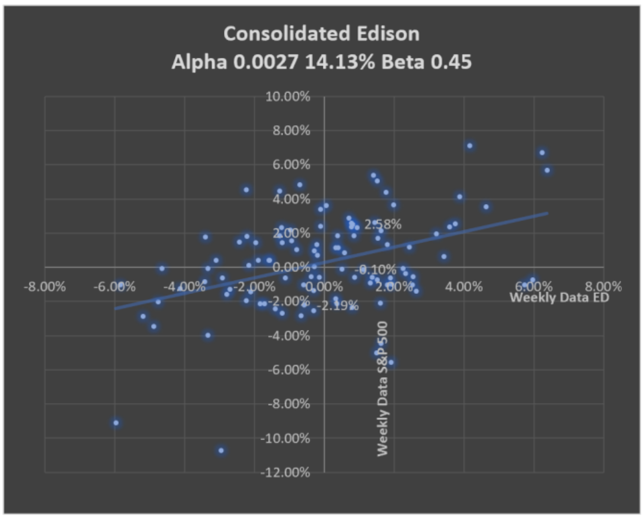




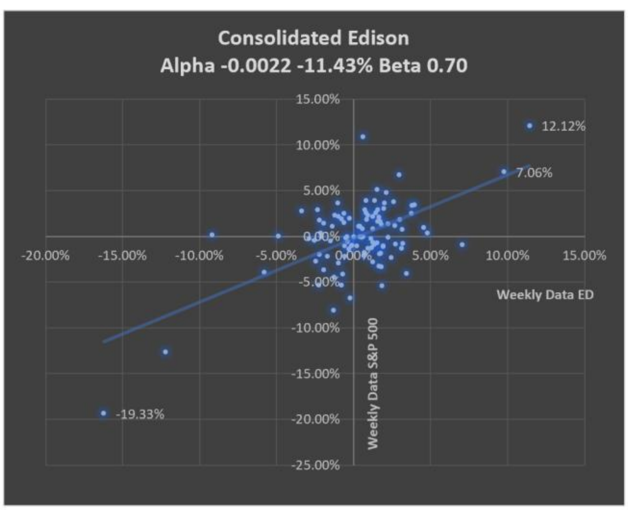


To illustrate other issues with beta, I use the case of ConEd, the electricity and gas distribution company in New York City. Using data from July 2021 to July 2023. For ConEd you can go back to the 1960's and in minutes compute the beta for different time periods. When the data is evaluated on a weekly basis over two years, the observed beta is .45. If you look at the scatter plots carefully, you can see where there were large positive or negative movements in the market return, the movements in the stock return were much less. This notion that when the overall market moves by a lot, utility stocks move less is the fundamental driver of beta statistics.

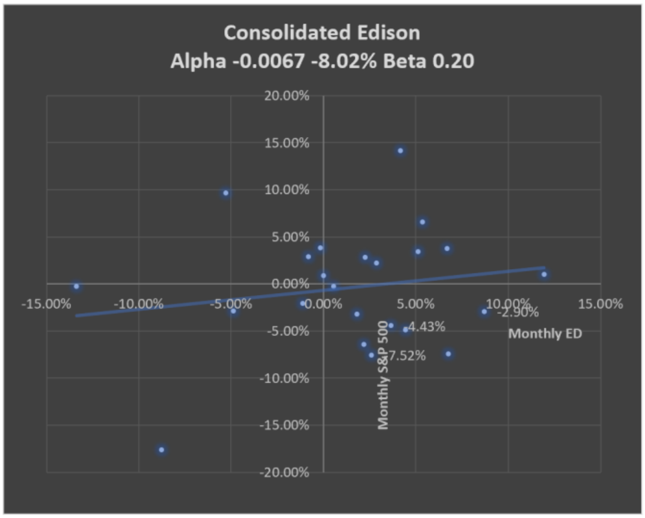
The second chart shows the data for ConEd for a period a couple of years earlier that cover the beginning of the COVID period. Note that the beta computed with weekly data from yahoo.finance.com produces a dramatically different result of a couple of weeks around COVID, the beta increased to .7 rather than the .45. When the short-term period is used with monthly returns as shown in the third chart, the beta falls to .2. You can test whether the timing should influence beta in theory, and you will find that there is no difference in theory. But in practice the time periods make a big difference.



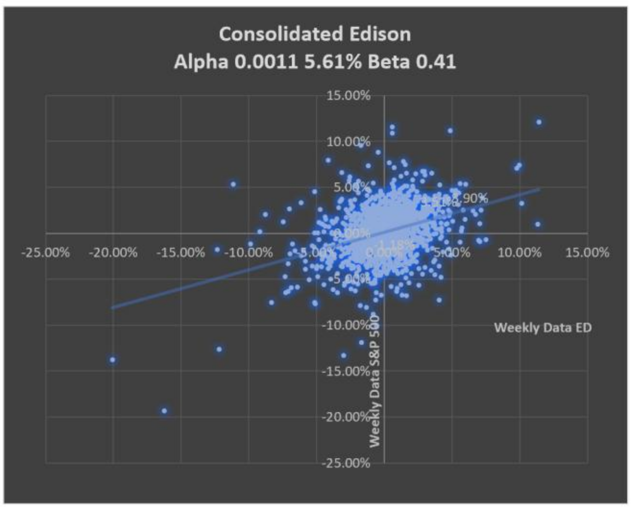
Weekly Da From	3-Jul-21	to	3-Jul-23
	S&P 500	ED	
21-Aug-21	-0.59%	-1.02%	
28-Aug-21	1.51%	-0.72%	
4-Sep-21	0.58%	0.87%	
11-Sep-21	-1.71%	-2.13%	
18-Sep-21	-0.58%	-2.19%	
25-Sep-21	0.51%	-0.10%	
2-Oct-21	-2.23%	-1.94%	
9-Oct-21	0.78%	2.58%	
16-Oct-21	1.81%	1.35%	
23-Oct-21	1.63%	2.15%	
30-Oct-21	1.32%	-0.91%	
6-Nov-21	1.98%	3.66%	



Weekly Da From	31-Dec-19	to	31-Dec-21
	S&P 500	ED	
18-Feb-20	-1.26%	-4.47%	
25-Feb-20	-12.21%	-12.65%	
3-Mar-20	0.61%	10.90%	
10-Mar-20	-9.20%	0.19%	
17-Mar-20	-16.23%	-19.33%	
24-Mar-20	9.77%	7.06%	
31-Mar-20	-2.10%	0.00%	
7-Apr-20	11.42%	12.12%	
14-Apr-20	2.99%	1.83%	
21-Apr-20	-1.32%	-8.04%	
28-Apr-20	-0.21%	-6.74%	
5-May-20	3.44%	-4.06%	



Monthly	From	31-Dec-19	to	31-Dec-21
		S&P 500	ED	
	31-Jan-20	-0.16%	3.83%	
	29-Feb-20	-8.79%	-17.61%	
	31-Mar-20	-13.37%	-0.23%	
	30-Apr-20	11.94%	1.02%	
	31-May-20	4.43%	-4.86%	
	30-Jun-20	1.82%	-3.20%	
	31-Jul-20	5.36%	6.59%	
	31-Aug-20	6.77%	-7.41%	
	30-Sep-20	-5.30%	9.70%	
	31-Oct-20	0.00%	0.88%	
	30-Nov-20	8.71%	-2.90%	
	31-Dec-20	3.64%	-4.43%	



Weekly Da	From	10-Jul-90	to	10-Jul-23
		S&P 500	ED	
	17-Jul-90	-1.56%	-2.65%	
	24-Jul-90	-2.29%	-1.08%	
	31-Jul-90	-2.46%	3.21%	
	7-Aug-90	-2.75%	-4.85%	
	14-Aug-90	-2.32%	-0.82%	
	21-Aug-90	-5.11%	-7.67%	
	28-Aug-90	3.49%	6.53%	
	4-Sep-90	0.26%	0.57%	
	11-Sep-90	-2.05%	-2.31%	
	18-Sep-90	-1.75%	-0.59%	
	25-Sep-90	-1.71%	-1.18%	
	2-Oct-90	1.77%	3.51%	

The final issue I address is the practice of un-levering and re-levering the betas (with tax adjustments suggested by Bob Hamada). There are many almost absurd implicit and explicit assumptions in computing making the calculation which on a pre-tax basis applies the following two formulas (I do not include taxes and assume that the debt to capital ratio is computed from the market value of debt and the market value of equity):

Asset beta = Debt Beta x Debt/Capital + Equity Beta x Equity/Capital

Re-levered Equity beta = (Asset Beta - Debt Beta x Debt/Capital) x Capital/Equity

The assumption that the debt beta is zero and therefore the interest rate does not have a risk premium distorts the calculation and leads to inconsistencies between using the cost of equity from the asset beta and using the WACC. Attempting to derive an implicit debt beta and adjusting the debt beta for the debt to capital ratio (as I have tried violates) the fundamental idea of beta as a measure of the non-systematic volatility.

The biggest problem with attempting the apply the re-levered beta is that when this process is applied to project financed investments such as the many types of investments that are financed to combat climate change. Here is how this may work (I have seen examples of this). First, it is generally difficult to find equity betas and market values of project financed investments. Therefore, you can try to find proxy investments such as utility companies that probably have lower debt to capital ratios than project finance. Second, the debt to capital ratios for the utility companies are adjusted for market value which increases the asset beta. Third, the high debt to capital ratio at the start of the project is applied on a book basis to re-lever the beta. Fourth, the debt beta is ignored which could serve to reduce the re-levered equity beta and the cost of capital. In the end, the cost of equity capital is measured to be high. But the whole process ignores the fact that project finance investments can have highly structured contracts to eliminate much of the equity cash flow risk. As discussed earlier, the equity cash flows have upside from refinancing and risk reduction.

We can illustrate this idea by evaluating a single company to compute the asset beta and then applying the asset beta with an 80% project financed investment to re-lever the beta. Use the Blume adjusted beta of .77 for NextEra. The market-to-book ratio of NextEra is 3.66 so that the debt to capital ratio of 56% is reduced to 56/(56+44 * 3.66) = 25.8%. The equity to capital ratio is the reciprocal or 74.2%. Without any debt beta, the asset beta is then .77 x 74.2% or .5713. This is the beta that would then be re-levered to 80%. The equity to capital is 20% and the capital to equity is 5. Without considering the debt beta, the re-levered beta is .5713 x 5 or 2.85. I hope this analysis is enough to have you scratching your head about all of the issues associated with measuring cost of capital and not to fall into the trap of applying bureaucratic equations.

Chapter 30: Testing Earned Return Relative to the Cost of Capital

Demonstrating what the Cost of Capital is Not

In the earlier chapters, cost of capital has been addressed. But direct there has been no direct measurement of the cost of capital number. This chapter and the remaining chapters in the book turn to direct measurement of the cost of capital. Chapter 13 introduces quantification of the cost of capital by presenting a test that can be used to determine when a company is earning more or less than the cost of capital using the market to book ratio. The test does not necessarily provide a direct estimate, but it can evaluate what the cost of capital is not in certain circumstances. This notion of finding particular cases that disprove estimates of the cost of capital can be applied to different industries as much of the cost of capital (the risk-free rate and the EMRP are economy-wide numbers).

Imagine some managing director of PE company demanding a high return.

Is It Worth Bothering to Study the Cost of Capital

I can imagine young people who have recently received an MBA working on some sort of private equity transaction thinking that spending time on thinking about the cost of capital is a waste of time. You can get the US 10-year treasury bond in an instant, you can stick in an equity risk premium of 5% or use the number Bloomberg gives you. Then, you can find the beta for a company right on your phone for a single company or a group of companies in a few minutes. You can even make adjustments for the debt leverage and de-lever the betas and then re-lever the betas (I discuss the problems with this in Chapter ___). I suggest that incorrect understanding and measurement of the cost of capital can lead to serious investment mistakes, pricing problems and even political issues involving income distribution. In particular I argue that estimates of a high cost of capital can be bad for society in general. If this is provocative good. I hope it will encourage you to read on.

Working through the cost of capital demonstrates the remarkable ways in which finance goes wrong, many of which have already been discussed. In the context of cost of capital analysis, some of these problems include: (1) EXPALIN not attempting to very cost of capital estimates with alternative models; (2) not applying basic logic in assessing inputs to financial models of the cost of capital; in particular the EMRP; (3) not making a minor effort to verify numbers (beta and EMRP) that are published by Bloomberg and other sources; (4) not using some simple philosophy to understand potential growth rates and what is a reasonable measure of the risk free rate; (5) not testing theories with simple checks (do betas really change over time); (6) using hodge podge samples rather than studying individual companies in assessing risk (samples of betas).

One of the way the cost of capital is directly used and is important is the setting of prices. In infrastructure contracts (PPA's in electricity), the cost of capital used to determine the level of prices for key things in the economy like toll rates, prices for water reclamation, prices for many healthcare services, and prices for electricity. There is a lot of economic theory that demonstrates if prices are set using a rate of return above the cost of capital, prices for infrastructure will be too high and over-investment will be encouraged. I have spent a lot of time working on estimation of the cost of capital in this kind of proceeding and I will use information from this process as a way to demonstrate the importance of making reasonable estimates of the cost of capital.

The case study I used in this chapter challenges a report presented by a high paid consultant that the cost of equity of a distribution company is 10.5%. You may think this is an absurd number, but presenting studies that come up with high numbers like this is very common in governmental proceedings. My objective in this chapter is to explain fundamental concepts underneath cost of capital measurement so you can form principled and logical analysis. My dream is that rather than simply regurgitating simple analysis you may have learned in your MBA courses, that you will apply some tests of the analysis that often have more to do with philosophy than fancy mathematical statistics.

Reviewing Cost of Capital Market to Book Ratios and Evaluating Companies That Have a Market to Book Ratio of Above 1.0

Given difficulties in finding the cost of capital, I begin by illustrating a method you can use to disprove cost of capital estimates made from the DCF method and the CAPM method. Cost of equity capital estimates can be tested from an analysis of the price of a stock relative to the investment made by the company in assets that are were made to generate cash flow. The statistic that divides stock price by the book value per share is sometimes called the price to book ratio and sometimes called the market to book ratio. If companies with similar risk that are earning a return on equity of around cost of capital estimate, should have a market to book ratio of approximately 1.0. Market to book analysis is the most objective thing you can do in assessing whether a company is earning more or less than its cost of capital.

The market to book ratio analysis I present here does not result in a definitive cost of equity capital number that you can use as a recommendation. Instead, it provides background for the cost of capital models. In a previous case I made a regression analysis of the market to book ratios and the market to book ratio. Then I set the market to book ratio to 1.0 in the equation and derived an estimate of the cost of capital. I am not doing this kind of analysis in this section. My objective here is to be transparent with financial data and show an overview which gives context to the cost of capital models where I do demonstrate how a definitive cost of equity number can be derived.

I use a couple of different ways to prove that when the market to book ratio is equal to 1.0. But first, some definitions. When evaluating the market to book ratio, you must first ascertain the book value of the company you are evaluating. The book value of a company is the amount of money investors (in aggregate) have taken out of their pockets and put into a company to make capital investments. Note that this does not include investors who are buying and selling stock from or to other investors. As a group, investors can put money into a company either by raising new capital (this is called paid in capital on the balance sheet) or they can indirectly put money into the company by not taking all of the income out as dividends (this is retained earnings on the balance sheet). In simple terms, the amount of investment that investors as a group have put into a company is the equity capital on the balance sheet. The amount of the investment can be divided by the number of shares on the balance sheet to derive the book value per share.

This investment that is made by investors as a group can be compared to the value of that investment in the stock market or the stock price per share. When thinking about the market to book ratio in simple terms, you can think of investors taking money out of their pocket and then seeing how much that money is worth now. Please note that I am not in any way suggesting that if an investor leaves his money in a company, that money should not grow. The money that is left in a company and that is not taken out as dividends should grow at the cost of capital (again, for investors as a group; not investors who have bought and sold stock from other investors).

Establishing a formula for the market to book ratio is not controversial if you assume that returns, growth and cost of capital are constant (this is why you could argue that a regression analysis can be difficult to implement and why I do not use the market to book ratio analysis to derive the cost of capital in this case). I have presented proof of some fundamental valuation formulas in PIRG Exhibit 1.2 along with a simple example of the market to book ratio using a bond example. In PIRG Exhibit 1.2 I start with the formula that the value of a share of stock is the present value of dividends (the same formula that Mr. Graves used), and the present value of dividends can be expressed as dividends next year/(cost of equity-forever growth). A second formula is that the growth rate is the return on equity multiplied by one minus the dividend payout ratio. After a bit of algebra and some substitutions it can be shown that the market to book ratio is equal to:

Market to Book = (ROE-growth)/(cost of equity – growth)

If you imagine that the ROE and the cost of equity are the same numbers in this formula, then the top of the equation is the same as the bottom of the equation and the market to book ratio is 1.0 no matter what the growth rate is. For example, pretend the ROE is 6% and the cost of equity is 6%. The growth could be anything less than 6%. When you plug in the 6% for the top and the bottom, the market to book ratio will still be 1.0.

In the second part of PIRG Exhibit 1.2, I use a simple financial model to prove the notion that a market to book ratio of 1.0 implies the return on equity is equal to the cost of equity. You first put in inputs for the ROE, the growth rate and the cost of equity. You then compute the dividend payout ratio that will allow the company to realize the projected growth. Next you set up an equity investment balance where the equity is the starting amount plus the net income (ROE x equity balance) less the dividends (payout ratio x net income). Finally, the value of the investment is the present value of the dividends. This present value is the same as the initial investment only when the return on equity is equal to the cost of equity.

The model documented in PIRG Exhibit 1.2 does not only demonstrate that when the return on equity equals the cost of equity that the market to book ratio is 1.0, but also how different levels of growth in earnings affect the market to book ratio. The table below, which is taken from the exhibit, demonstrates that a market to book ratio of above 2.0 is consistent with a return on equity of 10.5% when the cost of equity is 6.5%.

	ROE =COE 10.5%	ROE =COE 6.5%	ROE 10.5%; COE 6.5% Growth	Prior Case; Growth 5%/2%
Market to Book	1.00	1.00	2.33	1.99

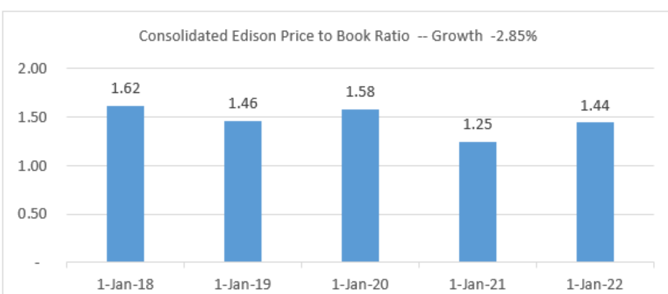
Q. Turning to actual market to book ratios for utility companies that are similar to ComEd, what company is most comparable to ComEd?

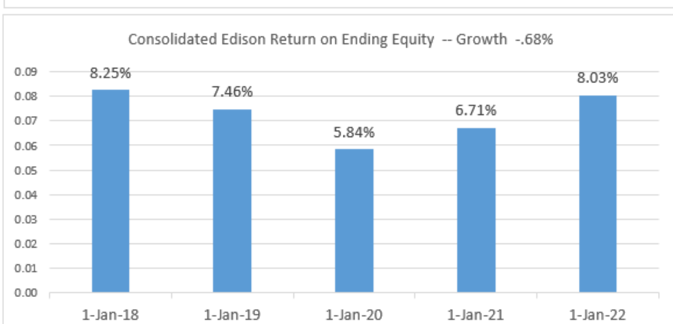
A. I think it is ConEd of New York, a company that ComEd witness Graves did not include in his sample. ConEd, unlike most of the companies in ComEd's sample, does not own generation assets. In PIRG Exhibit 1.3, I demonstrate why ConEd is the best company to use despite being excluded from Mr. Graves' comparative sample.

Continuing with use of ConEd as an example to question Mr. Graves' sample, I note that ConEd was included as a comparative company in ComEd's own impairment study that derives the value of its assets. In the screenshot below I compare the companies that Duff and Phelps used in its impairment study with the companies that Mr. Graves used. This comparison illustrates how Duff & Phelps used ConEd and there are only four companies that overlap between ComEd's own impairment analysis, and the set of companies that Mr. Graves used to argue for increasing rates. Later on, in working through the data, it will be clear that the comparison sample ComEd uses in its impairment study is much more representative of ComEd risks than the sample used by Mr. Graves.

When I teach corporate finance and talk about samples, I emphasize to my students that it is important to look at the underlying data and understand why financial metrics are different for different companies rather than playing with samples to achieve a result or using a lot of companies that may be different in terms of growth prospects, return levels, risk, and age of assets. In the case of ComEd, its sample included NextEra, the company with more non-regulated renewable energy investments than any other company in the U.S. as well as Edison International, the company in California that formerly owned vast projects around the world and is now subject to enormous liabilities from forest fires.

I have used a database that gathers actual data for the financial statements of utility companies and the stock prices for utility companies to present results of market to book ratios and returns. PIRG Exhibit 1.4 describes the way I have done this and the sources of the data. The spreadsheets with the data and the techniques to retrieve the data are available to all parties as part of my workpapers. I have tried to make the presentation of the data easy to see and interpret. I begin with ConEd as this single company provides more information about ComEd's risk and cost of capital than any other company. A picture of the return on equity, the market to book ratio and some other statistics for ConEd is shown below.





Consolidated Edison	1 Year	5 Year
Expected Growth in EPS	7.00%	6.12%
Past Growth in EPS		1.26%
Year Ago Earnings Mktwatch	4.55	
Forward P/E Ratio (Yahoo)	20.45	
P/E Ratio (Marketwatch)	21.29	
Trailing P/E (Marketwatch)	21.29	
Price to Book (Yahoo)	1.66	
Price to Book (Maretwatch)	1.64	
Return on Ending Equity		
ROIC Reported (Marketwatch)	3.92%	
ROE TTM (Yahoo)	7.76%	
ROE (Marketwatch)	8.15%	
ROE - Forward EPS	8.22%	
ROE - Second Yr EPS	8.54%	
Yahoo Beta (5Y monthly)	0.35	
MarketWatch Beta	Beta 0.49	

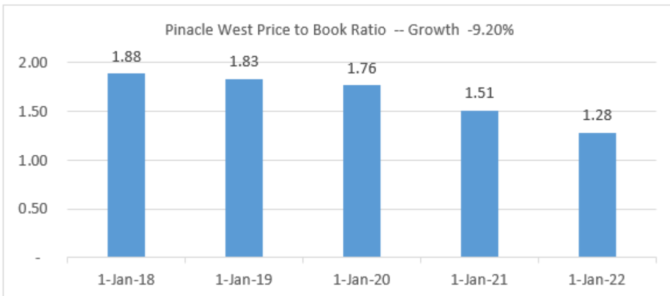
The screenshot shows that ConEd is earning returns below ComEd's 10.5% request and still has market to book ratios above 1.0. On the screenshot above for ConEd and for other comparative companies I show the historic annual market to book ratios for the past five years on the graph with blue bars as well as the current market to book ratio published by finance.yahoo.com and MarketWatch at the right of the graphs. The current levels of the market to book ratio and the return on equity reported by finance.yahoo.com and MarketWatch are shown on the right-hand side of the screenshot next to the graph. You can see that the current statistics for the market to book ratio of 1.66 and 1.64 for ConEd are even higher than the levels shown on the graph. I also compute the return on equity using return forecasts in the pictures. These returns of around 8% to 8.5% are consistent with the high market to book ratios.

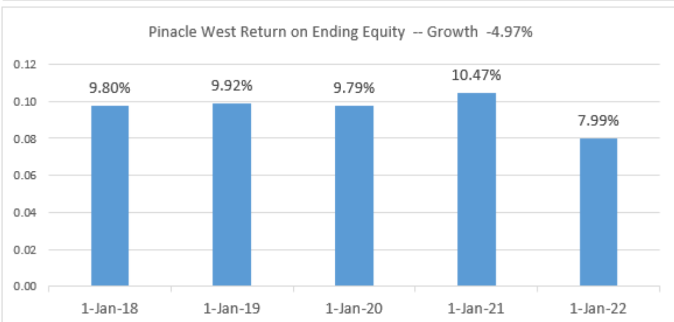
In the pictures for the comparative samples (one of which in my sample in ConEd) I also present the beta and growth statistics that are published by finance.yahoo.com and MarketWatch. I show this data as a way to introduce issues that are addressed in the CAPM and DCF sections. The beta statistics and in particular the Yahoo beta are used in the CAPM, and the expected growth rate is used in the DCF section. The assessment of whether the growth is reasonable can in part be evaluated by comparing the historic growth with the forecast growth. For ConEd the beta statistics of .35 and .49 are lower than the numbers used by ComEd's witness Graves for which the overall average is .87. The five-year forecast of earnings growth for ConEd -- 6.12% -- is higher than the historic earnings growth of 1.26%.

In the next questions and answers I will present more pictures like the above ConEd screenshot for other utility companies. I have included some of the companies in a separate exhibit – PIRG Exhibit 1.3. If you quickly scan the screenshots, a good picture of the cost of capital relative to the earned return jumps out at you. I suggest that it is more helpful to understand what is happening with respect to earnings and cost of capital in particular situations than to put all of the companies into a bundle and come up with some kind of average levels.

Q. What are the return and market to book statistics for the companies that ComEd's witness Graves excluded from his sample.

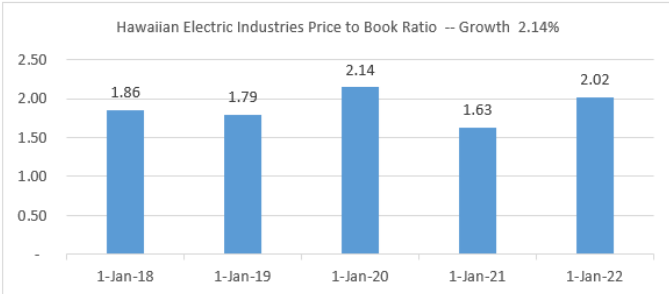
A. The next two screenshots present the data for Pinnacle West and for Hawaiian Electric. Mr. Graves excluded these two companies from its comparative sample which have low forecasted earnings growth as shown in the screenshots below. ComEd witness Graves discusses Pinnacle West as having a very negative return decision and quotes negative statements by Value Line. I have criticized Value Line as having a strong interest in favoring investors rather than consumers. This does not mean that I do not rely on Value Line data. The forecasts made by Value Line rather than the commentary and the beta statistics can be useful for investors. In the screenshot below note that even with a granted return below 8%, the market to book ratio for Pinnacle West is still far above 1.0. Note also that the beta of .43 published by yahoo.finance.com is again far below the beta of .87 that Mr. Graves applies to his overall sample. Unlike many of the other companies, the projected growth in earnings for Pinnacle West is below the very high past growth.

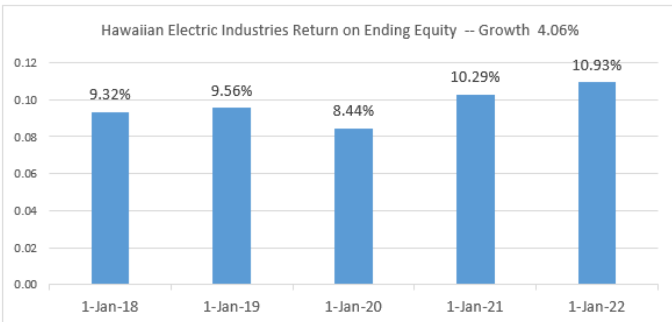




Pinacle West	1 Year	5 Year
Expected Growth in EPS	16.50%	7.05%
Past Growth in EPS		19.19%
Year Ago Earnings Mktwatch	4.30	
Forward P/E Ratio (Yahoo)	19.80	
P/E Ratio (Marketwatch)	18.84	
Trailing P/E (Marketwatch)	18.85	
Price to Book (Yahoo)	1.50	
Price to Book (Maretwatch)	1.42	
Return on Ending Equity		
ROIC Reported (Marketwatch)	3.46%	
ROE TTM (Yahoo)	8.22%	
ROE (Marketwatch)	8.09%	
ROE - Forward EPS	7.57%	
ROE - Second Yr EPS	8.71%	
Yahoo Beta (5Y monthly)	0.43	
MarketWatch Beta	Beta 0.70	

The third company for which I present a picture with financial data is Hawaiian Electric, another company singled out by ComEd's witness as not being appropriate for comparison. This company owns generation assets like many of the other companies in ComEd's sample. It has earned a return on equity in the neighborhood of ComEd's recommended request of 10.5%. With earnings of about 10.5%, it has a market to book ratio of above 2.0. This result is very similar to the simple model that is presented in PIRG Exhibit 1.2. Hawaiian Electric has an expected growth rate of only 1.3% which combined with a dividend yield of 3.9% implies a DCF cost of capital of about 5.2%. Finally, the company has a beta estimated by yahoo.finance.com of .4 which is below the beta that ComEd used in the CAPM.

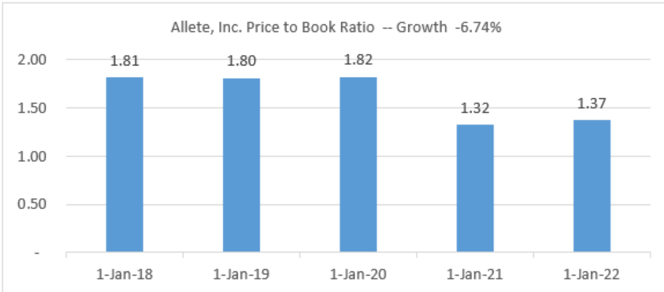


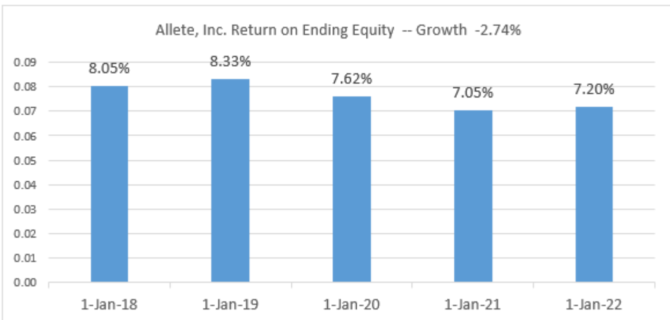


Hawaiian Electric Industries	1 Year	5 Year
Expected Growth in EPS	6.20%	1.30%
Past Growth in EPS		5.94%
Year Ago Earnings Mktwatch	2.21	
Forward P/E Ratio (Yahoo)	17.15	
P/E Ratio (Marketwatch)	17.76	
Trailing P/E (Marketwatch)	17.79	
Price to Book (Yahoo)	1.95	
Price to Book (Maretwatch)	2.08	
Return on Ending Equity		
ROIC Reported (Marketwatch)	4.64%	
ROE TTM (Yahoo)	10.35%	
ROE (Marketwatch)	10.43%	
ROE - Forward EPS	11.05%	
ROE - Second Yr EPS	11.27%	
Yahoo Beta (5Y monthly)	0.41	
MarketWatch Beta	Beta 0.60	

Q. Continue with illustrations of the market to book ratio and the return on equity for some of the companies ComEd used in its sample.

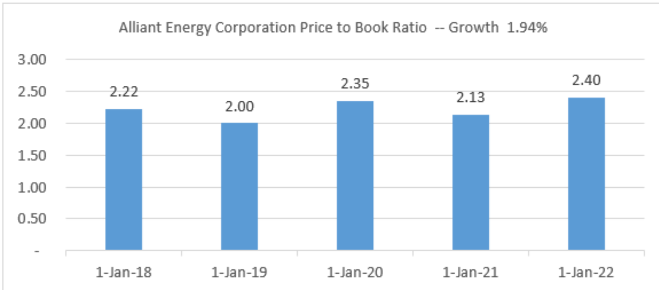
A. I have retrieved data for each of the companies in the ComEd sample and in the impairment study sample. ConEd is just one company in the comparative sample. In making the DCF and beta analysis I used both ComEd's sample and the impairment study sample. I have also looked at the investor relations presentations for each of the companies to understand if they are really comparable. Skimming through the investor relations reports demonstrated that many of the companies are not at all comparable to ComEd beginning with the first on the list, Allete. The picture of Allete below shows that companies earning returns on equity of around 7.5% are still earning more than their cost of capital. When you review Allete's investor presentation, you see the holding company owns Minnesota Power and Light Company, an integrated utility company that owns a lot of generation assets. It also owns companies named New Energy Equity, Allete Clean Energy, and BNI (a lignite mine), all of which the company calls non-regulated operations. Unlike ConEd, Allete is not very comparable to ComEd. It is not surprising that this company has a higher beta than pure distribution companies such as ConEd of New York, the company that I use as an example, which is only involved in retail distribution of energy. Its forecasted growth in earnings is greater than the negative historic growth.

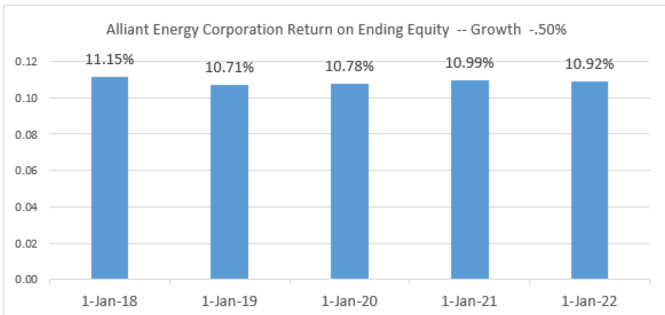




Allete, Inc.	1 Year	5 Year
Expected Growth in EPS	8.80%	8.70%
Past Growth in EPS		-0.74%
Year Ago Earnings Mktwatch	3.70	
Forward P/E Ratio (Yahoo)	17.36	
P/E Ratio (Marketwatch)	19.71	
Trailing P/E (Marketwatch)	19.30	
Price to Book (Yahoo)	1.39	
Price to Book (Maretwatch)	1.37	
Return on Ending Equity		
ROIC Reported (Marketwatch)	4.43%	
ROE TTM (Yahoo)	4.18%	
ROE (Marketwatch)	7.42%	
ROE - Forward EPS	7.86%	
ROE - Second Yr EPS	8.37%	
Yahoo Beta (5Y monthly)	0.71	
MarketWatch Beta	Beta 0.79	

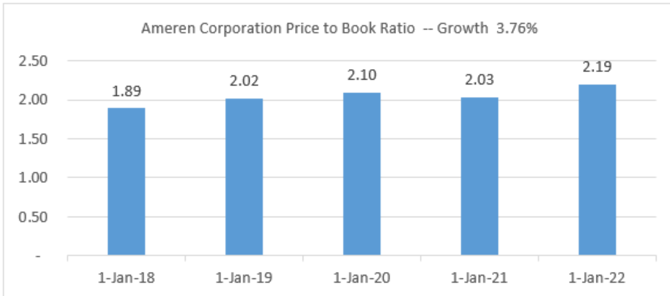
The second company, Alliant, owns Wisconsin Power and Light and Iowa Power and Light. The company owns a lot of coal fired generation and is making investments in renewable energy. After discussing ESG and Clean energy, Alliant presents its rate base growth as most of the other companies do. The picture of Alliant below in the screenshot demonstrates that when the earned return on equity is at the high end of what ComEd is requesting, the market to book ratio exceeds 2.0. This company that is investing heavily in renewable energy generation but has less non-regulated activities and has a yahoo beta of .52, well below the beta of Allete. This company also has expected growth below past growth.

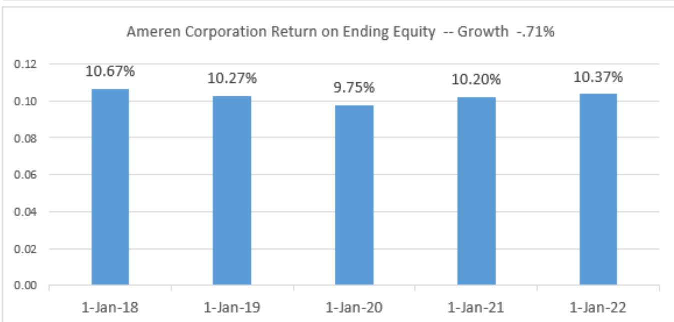




Alliant Energy Corporation	1 Year	5 Year
Expected Growth in EPS	11.10%	5.55%
Past Growth in EPS		7.36%
Year Ago Earnings Mktwatch	2.80	
Forward P/E Ratio (Yahoo)	18.98	
P/E Ratio (Marketwatch)	20.13	
Trailing P/E (Marketwatch)	20.16	
Price to Book (Yahoo)	2.21	
Price to Book (Maretwatch)	2.21	
Return on Ending Equity		
ROIC Reported (Marketwatch)	5.11%	
ROE TTM (Yahoo)	11.19%	
ROE (Marketwatch)	11.19%	
ROE - Forward EPS	11.32%	
ROE - Second Yr EPS	12.04%	
Yahoo Beta (5Y monthly)	0.52	
MarketWatch Beta	Beta 0.59	

The next company in alphabetical order that is included in ComEd's sample is Ameren. Ameren, as we know, is a regulated distribution company in Illinois. But its subsidiary in Missouri does own generation and the company is in the process of making big investments in renewable energy so that it can retire its coal fired generation (hence leading to a big increase in rate base over the near term). Ameren is earning returns on equity near ComEd's recommended return on equity and it has a market to book ratio of more than 2.0. This market to book ratio is consistent with the numbers from the model in PIRG Exhibit 1.3. Note that Ameren's beta as measured by Yahoo is .43 even though it has coal fired generation and is embarking on a big program of replacement. Unlike most of the other companies, the historic very high growth in earnings is below the expected growth rate of almost 10%.

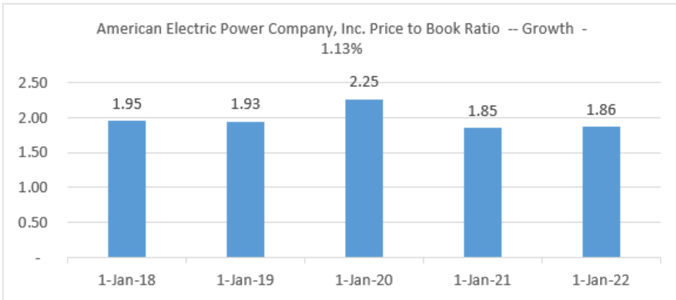


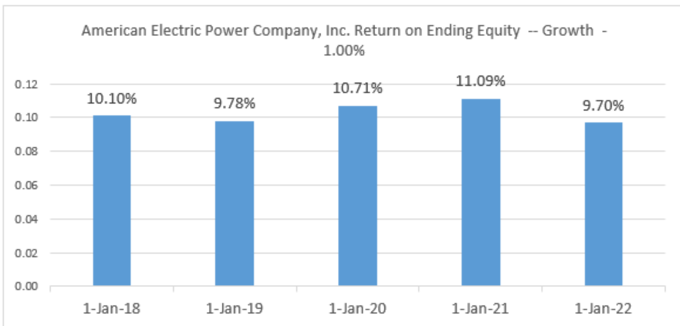


Ameren Corporation	1 Year	5 Year
Expected Growth in EPS	7.30%	6.90%
Past Growth in EPS		9.09%
Year Ago Earnings Mktwatch	4.08	
Forward P/E Ratio (Yahoo)	20.70	
P/E Ratio (Marketwatch)	21.81	
Trailing P/E (Marketwatch)	21.76	
Price to Book (Yahoo)	2.25	
Price to Book (Maretwatch)	2.22	
Return on Ending Equity		
ROIC Reported (Marketwatch)	4.62%	
ROE TTM (Yahoo)	10.54%	
ROE (Marketwatch)	10.63%	
ROE - Forward EPS	10.63%	
ROE - Second Yr EPS	10.90%	
Yahoo Beta (5Y monthly)	0.43	
MarketWatch Beta	Beta 0.66	

Q. Continuing with the companies that start with the letter A in ComEd's sample, discuss the case of American Electric Power and Avista Corporation.

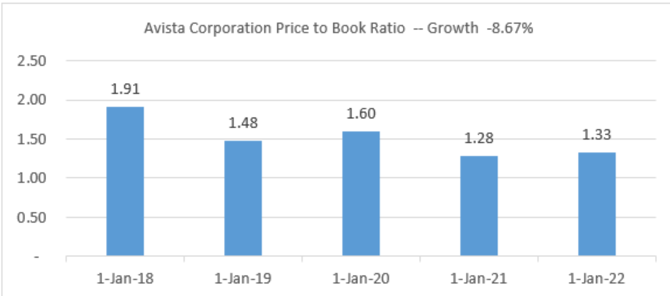
A. American Electric Power (AEP) is one of the largest generators of electricity, owning or operating about 25,000 megawatts of generating capacity. It sells much of this generation on a merchant basis in Ohio and the rest of the Midwest. Even though AEP is a very different company than ComEd, its return on equity and beta are consistent with high market to book ratios. The company has a yahoo.finance.com beta of .44 and its current market to book ratio is above 2.0.

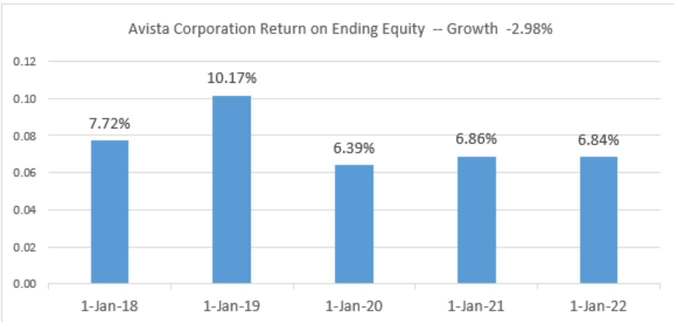




American Electric Power Company,	1 Year	5 Year
Expected Growth in EPS	6.60%	5.65%
Past Growth in EPS		6.32%
Year Ago Earnings Mktwatch	5.02	
Forward P/E Ratio (Yahoo)	17.92	
P/E Ratio (Marketwatch)	21.18	
Trailing P/E (Marketwatch)	21.13	
Price to Book (Yahoo)	2.04	
Price to Book (Maretwatch)	2.04	
Return on Ending Equity		
ROIC Reported (Marketwatch)	4.10%	
ROE TTM (Yahoo)	9.85%	
ROE (Marketwatch)	9.96%	
ROE - Forward EPS	11.14%	
ROE - Second Yr EPS	11.40%	
Yahoo Beta (5Y monthly)	0.44	
MarketWatch Beta	Beta 0.54	

The final company in ComEd's sample with the letter A is Avista. This company has assets in Alaska as well as Washington State, Idaho and Oregon. Avista has a lot of hydro generation which is sold into Western merchant markets. It is an interesting case because it has earned a recent return fairly near 6.5%, and it still has a market to book ratio of above 1.0. The case shows that the Hope and Bluefield criteria can be met with lower returns as this company has maintained access to capital.





Avista Corporation	1 Year	5 Year
Expected Growth in EPS	6.10%	6.30%
Past Growth in EPS		1.16%
Year Ago Earnings Mktwatch	1.89	
Forward P/E Ratio (Yahoo)	18.48	
P/E Ratio (Marketwatch)	21.26	
Trailing P/E (Marketwatch)	20.74	
Price to Book (Yahoo)	1.42	
Price to Book (Maretwatch)	1.42	
Return on Ending Equity		
ROIC Reported (Marketwatch)	3.45%	
ROE TTM (Yahoo)	6.91%	
ROE (Marketwatch)	6.91%	
ROE - Forward EPS	7.36%	
ROE - Second Yr EPS	7.69%	
Yahoo Beta (5Y monthly)	0.49	
MarketWatch Beta	Beta 0.66	

Q. Do you illustrate the market to book ratios, betas, and growth rates for the rest of the data for companies in ComEd's sample.

A. Yes, but I have included the discussion in a separate exhibit, PIRG Exhibit 1.3. In this exhibit, you will see that most of the companies are arguably riskier than ComEd and, more importantly, they all have market to book ratios above 1.0.

Chapter 31: Computing the Expected Equity Market Risk Premium

Risk-Free Rate and Inflation Risk

The EMRP represents the premium that investors need to invest in stocks that can move up and down a lot versus short-term treasury bonds that have a fixed interest rate. This number is important because whenever anyone uses the CAPM they must estimate this EMRP. There is nothing unique to a particular company when measuring EMRP; everybody who uses the CAPM theoretically applies the same number. In practice not everybody uses the same EMRP as this number is not something like a stock price that can be verified in the Wall Street Journal or found on the internet. But these days, it is very easy to find what people all over the world use.

Risk-Free Rate and Inflation Risk

The question of what interest rate to use as the risk-free rate in the CAPM is not as straightforward as one may think. This is because of the risk associated with forecasting inflation that is inherent when investing in treasury bonds which are typically used to represent the risk-free rate. If inflation changes during the maturity of a Treasury bond, its real purchasing power will change as well, even though the nominal recovery is fixed. For example, when an investor buys a 30-year bond, the return is in fact not at all risk free in real purchasing power terms even if the investor holds the bond to maturity. If the inflation rate turns out to be higher than the inflation rate implied when the bond is purchased, the investor loses real purchasing power to buy things. This means that the long-term bond yield does not represent a risk free asset, and using a long-term bond yield overstates the cost of capital. Similarly, the longer the bond maturity (i.e., 30 years) the more the inflation risk because you have to guess what inflation will be for 30-years. You can even look at the volatility of returns on long-term government bonds versus short-term bonds to see that calling 30-year treasury bonds risk free is not correct.

As I introduced above, the treasury bond yield is the only element in the traditional CAPM analysis that includes an implicit forecast of inflation. In theory, the period of inflation implicit in the cost of capital should correspond to the lifetime of the investment and the sensitivity of cash flow to inflation. A 30-year treasury bond is not appropriate for evaluating the risks of a long-term investment if cash flow of that investment varies with inflation. If cash flow can vary with the rate of inflation, the risk associated with the implicit inflation forecast in a 30-year treasury bond is too long.

To illustrate why use of a 30-year bond yield is wrong for most investments, you can think about a situation where it could be appropriate to use a long-term bond yield. Assume someone is setting prices for a purchased power contract associated with a single asset such as a solar project where pricing in the contract has a tenor of 30-years or more.[62] In this case, if the pricing in the purchased power contract is fixed in nominal terms, the investor wants to lock in inflation over a very long period. Here you could make a reasonable argument that the 30-year Treasury rate should be used because the project developer is taking inflation risk for a long period. Such a situation is not a typical because prices respond to changes in the inflation rate every time there is a rate case. If an investment has the option to ask chang prices when the inflation rate changes it does make sese to lock in a long-term inflation rate through applying long-term treasury rates.

Inflation Protection, Equity Securities and Treasury Bonds

In discussing utility stocks versus treasury bonds, an analyst stated the following:

> "The 10-year is repricing everything. I've got something that's even safer and yields even more … comparing Treasuries and utility stocks."

This comment implies that utility stocks are lower risk by virtue of the phrase that they are "even safer." If you invest in a treasury bond, your dividends will generally increase with inflation because of the option for companies to change their prices. This option to hedge inflation risk is not possible for treasury bonds that have a fixed nominal rate. If you earn 2% on a bond and the inflation rate turns out to be 5%, you have lost money in real purchasing power terms (if you want to buy a car in a couple of years, the money you receive on your bond will be less than the inflation in the car cost). But companies like with the ability to change prices can take away this risk as illustrated by this rate case that recovers inflated costs. All of this means that the last input into the cost of capital formula for the risk-free rate should be adjusted to account for inflation risk that is present in long-term government bonds.

It possible to take inflation risk out of the risk free rate using the Treasury Inflation Protected Securities ("TIPS")TIPS rates plus expected inflation, but you must then directly estimate inflation. are debt issues whose principal value is adjusted periodically when the inflation rate changes. As shown in the graph below, the 10-year TIPS interest rate is 1.36% and the 5-year TIPS rate is 1.29%. This means that if an investor buys a TIPS, he or she is assured of the fixed rate of 1.29% or 1.36% and then the inflation rate is added to this number. Here, ths investor does not take inflation risk because if the inflation rate increases, his or her purchasing power is maintained. When you look at this graph, remember that this rate excludes inflation and the inflation rate could be added to the yield to come up with a nominal risk free rate to use in the CAPM. This means investors do not have to fix the rate of inflation and take inflation risk.

When using TIPS debt as the risk free rate you need an inflation forecast. I have applied inflation rates projected by the EIA (I included the EIA speadsheet in my workpapers). Over the period 2024 to 2027, the expected inflation is 2.16% when using the GDP implicit price deflator (if you go to the grocery store you may not believe this number). Adding the inflation rate to the TIPS rate yields a nnominal risk

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[62] The contract that has a duration of 30-years (if the contract collects money over 30 years, the duration will be a lot less than 30-years).

free rate of 1.29% + 2.16% or 3.45%. I have inclued my souces for the interest rate data and some graphs in PIRG Exhibit 1.9.

Equity Market Risk Premium

When thinking about the EMRP you should understand what it represents. It is the minimum real growth rate in the wealth desired by equity investors for taking risks that the overall earnings in the economy rather than investing in a risk-free asset. The growth rate in equity investment will go up and down period by period relative to a fixed stream of income that will not vary. This risk of overall stocks may seem like a big risk to take, but growth in the economy over the long term does not vary that much and this number reflects that fundamental statistical fact that when you have a big portfolio, your risks quickly start looking like the overall risks in the economy.

Cost of Equity = Risk Free Rate (Rf) + Beta x EMRP

You could try to relate the EMRP to the kind of returns you may hope for on a stock portfolio, but you must be careful. You want your stock portfolio to cover inflation, but the EMRP does not include inflation because inflation is included elsewhere in the CAPM. The reason for this is that the risk-free rate already includes inflation and if you included inflation in the EMRP you would be double counting. To see how this works, you can separate the CAPM formula into items that are affected by inflation and items that are not affected by inflation. When regular interest rates are used for the risk-free rate, interest rates include the expected rate of inflation. People who live in countries with high inflation know very well that when they borrow money or when they lend money the interest rate on debt must compensate for inflation over the lending period. For example, if you are putting money away to buy a car in a year, and the inflation rate is 20%, the interest rate on the loan should be at least 20% so that the increase in the cost of the car is covered. This means that interest rate including a risk-free rate and inflation can be written as:

Rf = Real Interest Rate + Expected Inflation

Expected inflation should cover a time period that is until the next time a definitive rate of return is set. This means that setting fixed interest rates for 30 years does not make sense. If inflation is included in one component of the CAPM – the risk-free rate -- it cannot be included anywhere else, otherwise you will be double counting. This all means that the CAPM could also be written as:

Nominal Cost of Equity = Real Rf + Expected Inflation + Beta x Real EMRP

In the above equation, the word nominal means that inflation is included and the word real means that the inflation rate is not part of the calculation. The implication of this is that when we discuss the EMRP we must compare growth rates and returns implicit in the EMRP to other real rates.

EMRP and Economic Growth

The most basic concept is that the EMRP is a number that applies across the whole economy and the EMRP, like any measure of return, is a growth rate in your money. Now think about the overall economy. When discussing economic issues people often talk about growth rates and, more precisely, real economic growth without inflation. Like other numbers representing income, the GDP can be separated according to who receives money. For a company you can think of revenues being separated between employee salaries and stockholder income. Similarly, for the entire economy, investor returns received from companies represent one component of the GDP, employee salaries represent another and there are other items like government expenditures.

If you can imagine a graph of the overall economy represented by the GDP. Then you can make the area under the graph to represent money going to investors and money going to everybody else. If the EMRP is greater than the real growth in the economy, the investor share will go up faster than the line for the total economy. Investors will get richer and everybody else will be poorer. When you start assuming that investors will experience higher growth than the overall economy indefinitely, by assuming higher EMRP than the real growth in the economy, you get into dangerous territory.

To demonstrate the danger in assuming the rates applied by ComEd, I have made a simple simulation of the U.S. economy where investor money grows at 8.7% and the overall economy in real terms grows at rates forecast by the U.S. Energy Information Agency ("EIA") in their macroeconomic forecast which is about 1.9%. I have included details of this analysis in PIRG Exhibit 1.5 including the sources of the numbers. In the exhibit, I use the market value of stock investments in the economy and assume that they grow at the 8.7% rate that ComEd assumed EMRP – this is what the assumption does. Next, I find the real GDP of the U.S. economy and assume that it will grow at the EIA assumed rates. When you subtract the amount of income earned from the investor growth rate from the overall GDP you get the amount that is left over for everybody else. This produces the absurd result shown in the graph below where there is nothing left for anybody else in 2045.

I hope you can see from this simple analysis that evaluating concepts like the EMRP does not require some kind of highly mathematical prowess but rather a little bit of simple logical thinking. This is why I have structured my testimony by working through data and not putting all of the emphasis on discussion of a final number and pretending that the Commission will just look at my number and accept it.

As the EMRP is a number that everybody uses, I find that it is better to spend time evaluating what other people use than to try and compute the number yourself. As such I have included reference to a book that you can easily download from the internet. This book is titled "Rethinking Equity Risk Premium" and includes articles by people who have spent a lot of time studying the EMRP. It is surprisingly easy to review and one of the articles included the following statement63:

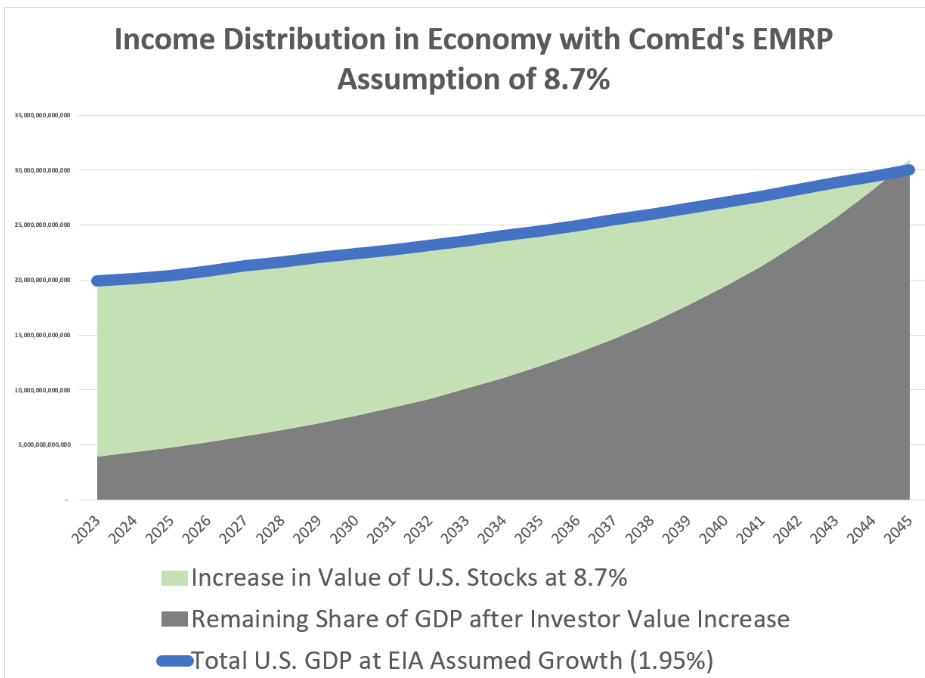
[63] Page 53 of Rethinking the Equity Risk Premium referring to Grinold and Kroner (2002).

The key insight, which draws on earlier work by a number of authors, was that aggregate corporate profits cannot grow indefinitely much faster—or much slower—than GDP. (And as Herbert Stein was fond of reminding us, any economic trend that cannot continue forever will not.) If profits grow faster than GDP, they eventually take over the economy, leaving nothing for labor, government, natural resource owners, or other claimants. If profits grow more slowly than GDP, they eventually disappear, and businesses will have no profit motive to continue operating. Thus, in the very long run, the ratio of profits to GDP is roughly constant.

Using the logic above you could make a powerful case that the EMRP should be around 2-3% and some people use EMRP numbers like this. But others use an EMRP number somewhat above this amount as I explain in the next question.

One of the sources people use is the material published by Aswath Damodaran from NYC on his website (I think the book "Rethinking the Equity Risk Premium" is much better). Whilst I disagree with the way Damodaran ignores basic concepts and about how he does not consider capital gains from changes in the interest rates when making historic analysis I do acknowledge that many people use his EMRP numbers.

In his recent analysis, Damodaran does something good. He does not put his number at the top so you can easily take it. Instead, he shows a table with alternative estimates that I have clipped below.



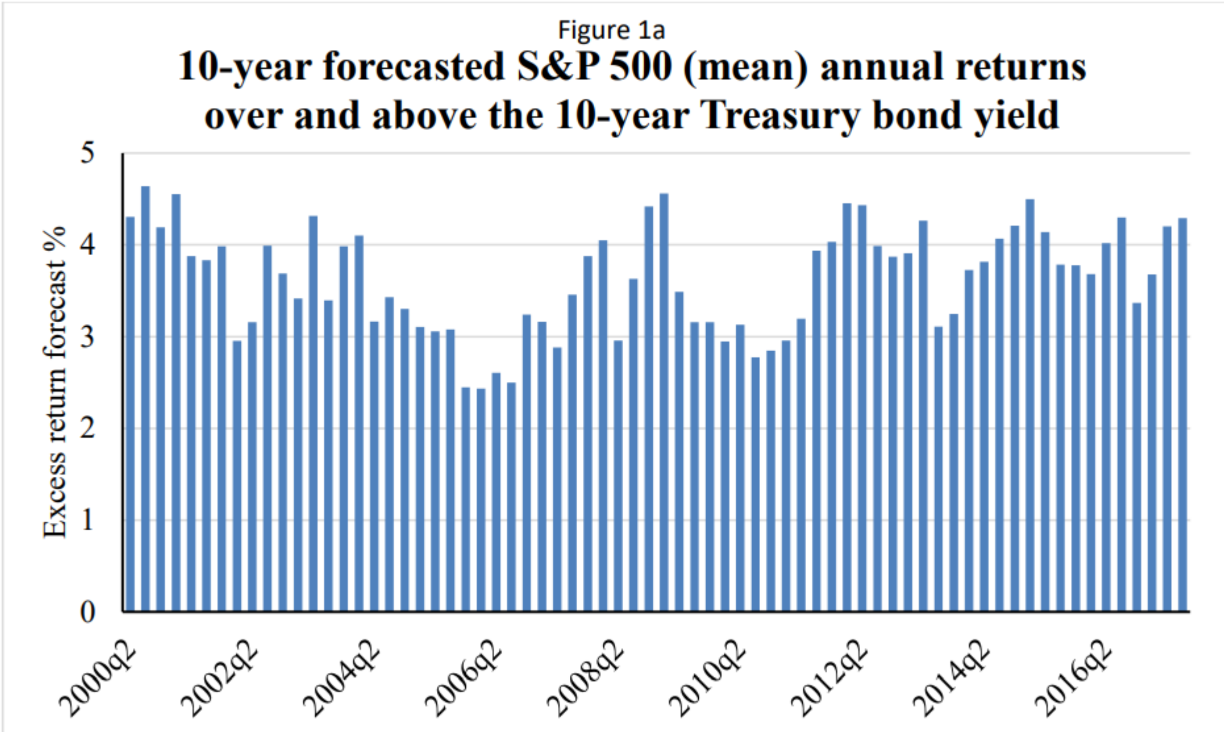
In writing up the EMRP, Damodaran refers to a survey of what other people use for the EMRP. As I have emphasized, the Commission can look at what other's use rather than spending a lot of time understanding an independent study. Damodaran includes the following statement about the surveys:

Professors from Duke University, Graham and Harvey have been conducting annual surveys of Chief Financial Officers (CFOs) or companies for roughly the last decade with the intent of estimating what these CFOs think is a reasonable equity risk premium (for the next 10 years over the ten-year bond rate). In their December 2018 survey, they report an average equity risk premium of 4.42% across survey respondents, up from the average premium of 3.37% a year earlier. The median premium in the December 2017 survey was 3.63%, close to the prior year's value of 3.55%.

Table 25: Equity Risk Premium (ERP) for the United States – January 2022

Approach Used	*ERP*	*Additional information*
Survey: CFOs	4.42%	Campbell and Harvey survey of CFOs (2018); Average estimate. Median was 3.63%.
Survey: Global Fund Managers	4.60%	Merrill Lynch (January 2014) survey of global managers
Historical - US	5.13%	Geometric average - Stocks minus T.Bonds: 1928-2018
Historical – Multiple Equity Markets	3.20%	Average premium across 20 markets from 1900-2017: Dimson, Marsh and Staunton (2018)
Current Implied premium	4.24%	From S&P 500 – January 1, 2022
Average Implied premium (1960-2021)	4.21%	Average of implied equity risk premium
Average Implied premium (2012-2021)	5.35%	Average of implied equity risk premium
Default spread based premium	3.62%	Baa Default Spread on 1/1/22 * Median value of (ERP/ Default Spread)

The most important thing for the Commission to do is to scan this picture and notice that 8.7% is way off the scale of the graph. The study of Graham and Harvey included the graph below.



The same table from the report posted on the internet on April 3rd of 2023 – "Equity Risk Premiums (ERP): Determinants, Estimation and Implications - The 2023 Edition" includes the Table 26 that I have replicated below. This table does include the 5.94% number reported by Mr. Graves. But it also includes other numbers that range from a low of 4.21%. The screenshot demonstrates that 5.94% is the highest number on the table and Dr. Damodaran reports a number of different possible ways to estimate the EMRP. I would understand if the Commission ultimately decides to select alternative estimates typically used in implementing the EMRP other than my recommendation. This could range from the 5.5% number used by Kroll to the low number in the table below. But the numbers that are computed of by Mr. Graves of 8.7% (and also by Mr. McNally of 8.5%) are far outside of the range.

For a corporation the EMRP is applied as part of the CAPM cost of capital to cash flows that last for an indefinite period (in making cash flow forecasts the assumption is made that the company does not stop its operations). This means that use of the EMRP as an estimate of how much the market requires to be compensated for risk and should not be expected to change much from year to year. To illustrate this notion, pretend you are making an investment that has a lot of cash flow coming in or going out 10 years from now. It is not reasonable to presume that this cash flow has a big difference in value because of current short-term market fluctuations. This is why in my direct testimony I illustrated the survey of what actual financial managers use as the EMRP in the CAPM. This number arguably corresponds to the very definition of the cost of capital, which is the minimum return that investors (in this case managers who represent investors) need to accept risk (in this context it is the minimum return that investors need to accept investing in equity investments relative to the risk-free rate). This graph which went all the way back to 2002 shows that when using numbers on what is the minimum return, the numbers generally varied between 3% and 4%. The top end of the graph was 5%. It is not credible to believe that the numbers applied by these representatives of investors would dramatically jump to anywhere near the 8.7% EMRP used by Mr. Graves.

I present a graph in the screenshot below that illustrates historic EMRP estimates made by Dr. Damodaran from his implied cost of capital estimate since he began publishing data in 2011. This does show some variation (one could argue that a higher level of the stock market implies that it is more difficult to realize returns) and it shows a large increase for the 2023 estimate even though the stock market at the end of 2022 was high. The key point is that Mr. Graves' estimate is far outside of the range over the 13-year period. Finally, I note that the McKinsey book referred to by Mr. Graves in his direct testimony recommends an EMRP of 5% as demonstrated in the excerpt below.

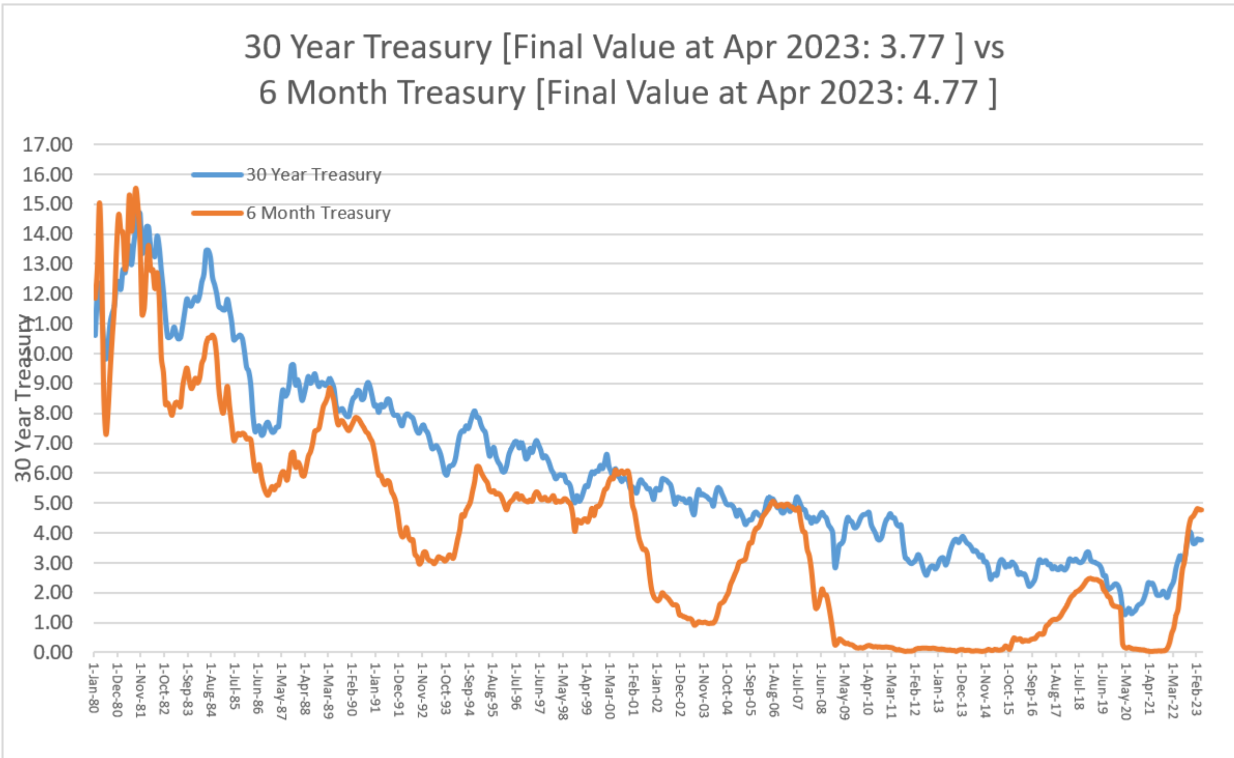
High Estimates of the EMRP and Historic Returns

There are very many analyses of the historic earned risk premium that suggest the number is something like 3%. If you look at the Damodaran article that I have referenced or the book about the EMRP, you can see many references and studies. Nobody suggests the historic EMRP number is anything like 8.7%.

The EMRP is supposed to map or translate to the cost of equity or the minimum required return for a company. When computing historic returns, it includes the effects of capital gains that come from changes in the interest rates in the returns. These capital gains from changes in the cost of capital itself have nothing to do with the ROE's earned by companies. During COVID, interest rates reached historic lows and that affected stock prices. Stock prices generally go down when interest rates increase. When interest rates changed, the increase or decrease in stock prices did not mean that the ROE realized for particular companies changed.

So, if interest rates go up and the measured historic return on stocks in the economy goes down, the decline in returns the market earns should not be mapped to the allowed rate of returns. This may be a little confusing, but unless the historic measured risk premium is adjusted for capital gains and the effects of these capital gains, then looking backwards at the overall stock market returns does not give you useful information.

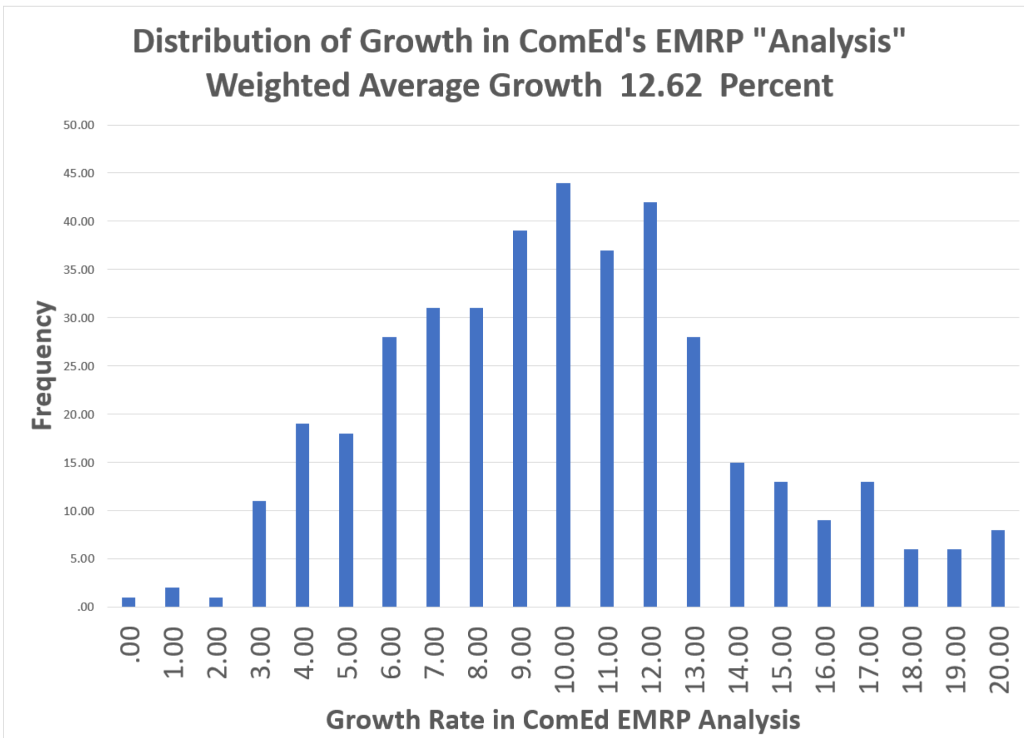
To illustrate the effect of interest rates on the measurement of historic returns, I have included a graph of interest rates below. The graph shows nominal rates where interest rates on a 30-year bond and a 6-month treasure bond over a long period of time. When you go back to 1980 you can see that there is a consistent decline that has generated increases in stock market indices. These increases in the stock market returns from declines in the interest rate do not mean that returns to individual stocks are going up. Indeed, the lower interest rates means the returns should be going down. These graphs demonstrate that if you look at the history of stock market returns and attempt to suggest that the returns reflect actual returns earned by companies, you will be wrong. Instead, it is essential to adjust the numbers for capital gains or losses generated by the real and nominal interest rate changes from the underlying earning power of corporations.



Part 4: Critique of ComEd's EMRP Analysis

By computing an economy-wide statistic that other people regularly apply in the CAPM, what ComEd has done is tantamount to making an elaborate GDP growth forecast with all sorts of regression equations and then trying to explain why its GDP growth forecast of 10% is so out of line with other forecasts (which we saw were are all around 1.8%). The Commission should not have to review a study of computing the expected minimum return for every company in the stock market, which is what ComEd has tried to do.

The way ComEd computed the EMRP shows how numbers can be distorted. ComEd tried to make a DCF calculation for the 500 companies in the S&P500 and it eliminated more than 100 companies for various arbitrary reasons. This alone would invalidate the analysis. For the companies that remain, ComEd used the Value Line five-year earnings growth estimate as the forever growth rate in its analysis. Whether analysts who forecast growth in earnings provide an unbiased estimate is a very big subject in finance and there is a lot of evidence that earnings are overestimated by analysts such as Value Line (I discuss this in the context of the DCF model below). But we do not even have to address this point. For companies that have not been excluded from the ComEd analysis, the weighted average growth rate is 12.2% and a distribution of the growth rates is shown on the graph below where you can see that the distribution is skewed with a median of about 10% (the distribution shown in the graph is not weighted by the size of the company). We are right back to the question of whether the earnings of companies can always be greater than the overall growth rate in the economy.



ComEd's growth rate estimate compared to historical growth in corporate profits for the economy

The historic growth in corporate profits has been consistent with the overall growth in the economy as shown in the graph below since 1950. You can see on the graph that the corporate profits have not grown anywhere near the growth of 8.7% in the ComEd study. In PIRG Exhibit 1.6 I discuss extracting stock prices and I present the graph with different starting periods. The most important point is that if corporate profits really did grow much faster than the economy, then we would be right back to the situation of the dramatic distribution effects shown in the earlier graph with the orange and grey graph above with nothing left for anybody else.

Do valuation analysts typically assume that high earnings growth rates can last forever as ComEd does both in the EMRP analysis and its DCF model?

They certainly do not. Even if we accept that companies like Apple can have high growth over a period of about 5-years, making this growth rate assumption forever as ComEd does is simply not done. To illustrate problems with indefinite growth, I have copied a graph that a colleague gave me many years ago. This graph illustrates how valuation analysts use short-term and long-term growth rate forecasts. This idea that analysts use long-term growth rates that are much lower in the short-run numbers is not some minor problem with ComEd's EMRP and, more importantly, the DCF analysis discussed below, but it changes everything. It certainly invalidates ComEd's EMRP analysis.

The problem with ComEd's calculations all come back to the idea that when you assume a compound growth rate that is high over the long-term, you get crazy results. I use the example of having a short-term growth rate in the size of your stomach by eating too much. You may have a fast growth in your stomach when your stomach is initially getting larger. But once your stomach is already large and you keep growing at the same high growth rate, you will eventually explode. The point is simple, it is a lot harder to grow fast when you are already really big.

The assumption of high infinite growth can be demonstrate using the example of Apple. Based on ComEd's witness Graves assumptions, Apple can grow at 14% indefinitely. If this happens you would have to wait not too many years until Apple would represent the whole economy. I demonstrate that Apple would take over everything else in less than 30 years in PIRG Exhibit 1.5.

ComEd's assertion that its EMRP is consistent with historic returns.

ComEd's comment is simply not true. There are many analyses of the historic earned risk premium that suggest the number is much more like 3% and ComEd's calculations are biased by interest rate changes and capital gains. I explain technical problems with ComEd's analysis in Exhibit 1.5.

When I heard that ComEd is earning 5.8% above the Treasury bond rate in its formula rates, I immediately thought about the EMRP and beta. With a beta of 1.0, which is an absurd number for any utility company (see the next section), this implies an EMRP of 5.8%. The 5.8% is far too high and allows ComEd to earn a return higher than its cost of capital. With a much more reasonable beta of .5, the implied EMRP doubles, implying a sky high EMRP of 11.6% (5.8% = 11.6% x .5). The fact that ComEd earned more than its cost of capital during the formula rate period is confirmed by ComEd's own cost of capital calculations in its impairment studies.

Chapter 32: Stealing Money from Developing Countries; the Country Risk Premium

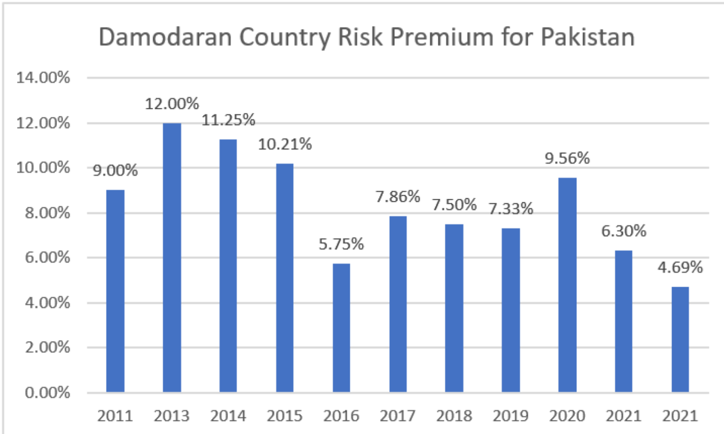
The Corruption of Country Risk Premiums: Published Estimates of Country Risk Premium Can Kill Important Climate Change Investments

I have been emotional about the way finance treats developing companies for many years. If demanded returns are high for investments in developing countries and these returns are distributed to investors outside of the country, the ability for people in the countries to experience a reasonable standard of living is arrested. The situation is very much like the GDP distribution graph presented at the beginning of this chapter where providing returns higher than the overall growth rate in an economy leaves nothing left for anybody else.

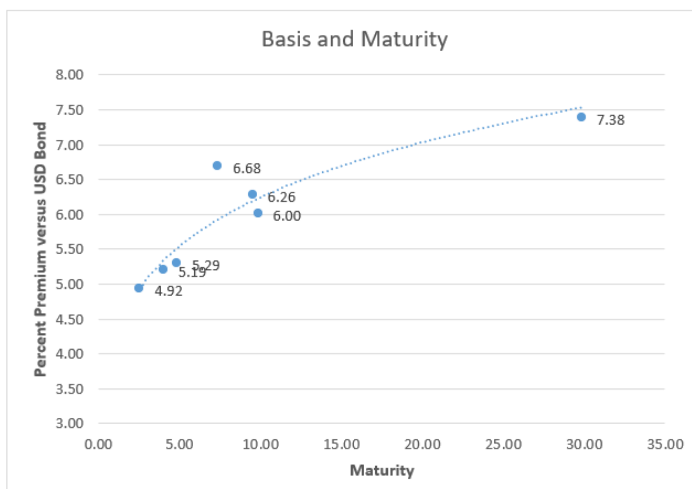
High returns that are allocated to investors outside of the country are justified by the country risk premiums that are published by a man named Aswan Damodaran, a professor at NYU Stern. Mr. Damodaran applies traditional finance like the CAPM and high estimates of the equity market risk premium. His numbers on the country risk premium are very easy to download and are high. Dr. Damodaran seems like a very pleasant man, but he does not seem to understand the very serious implications of his published statistics. Further, he does not address items that are contrary to his numbers including credit spreads by local banks in developing countries, implied probability of default in his data, implied cost of capital from price to book ratios.

If these numbers are used in measuring the cost of capital for investments that can combat climate change are applied to investments in Africa, the effect on investments can be dramatic. For example, I understand that a solar project in Saudi Arabia using Chinese modules can obtain prices of less than 2 USD cents per kWh. A project with similar modules and similar sunlight in Chad costs 15 USD cents per kWh. The primary difference between the projects is how they are financed. I hope you now understand my emotional reaction.

When working on a project for measuring the cost of capital in Pakistan for the National Electricity Regulatory Agency I made an effort to study what is behind the country risk premium. I read the articles from Mr. Damodaran and compiled some historic data. As I have mentioned above this kind of project where vested interests attack my work involves more critical evaluation than any peer review that I could imagine. This research from my project in Pakistan demonstrated that: (1) country risk premiums are not consistent or logical over time; (2) most of the country risk premium comes from evaluating the country risk rating from U.S. credit rating agencies with no adjustment for the tenure of the debt; (3) the country risk premiums result in implied probability of default that makes no sense in the context of actual defaults and (4) the credit spreads used by Damodaran are completely inconsistent with credit spreads charged by local banks.



In compiling the quoted country risk premiums, I have read articles written by Damodaran and compiled historic data. The accompanying insert shows that the country risk premium has ranged between 5.75% and 12% before 2021. In 2021 Damodaran published two estimates, one for 4.69% and 5.3% while the yield on the bonds ranged between 4.92% and 7.28%. These risk premiums are taken from either credit spreads on sovereign debt in USD or the credit spread on bonds with equivalent credit ratings. Some increase in the risk premium is added for taking equity risk rather than credit risk. In 2013, the risk premium was 12% meaning that within seven years the earned credit spread would pay for the entire of a loan or equity investment (1+12%)^7=1.97. This implies that lenders would receive the entire proceeds of the bond twice on top of earning the USD interest rate. As shown above, the typical credit spread for a BBB bond is about 1.3%.



When evaluating credit spreads there is a basic formula to evaluate the minimum credit spread that will compensate for losses when there is a default. This formula is a simple one that defines the credit spread or the premium on debt as a function of the probability that the loan defaults and, if the loan does default, what will be the final loss.

Minimum Credit Spread = Probability of Default x Loss, Given Default

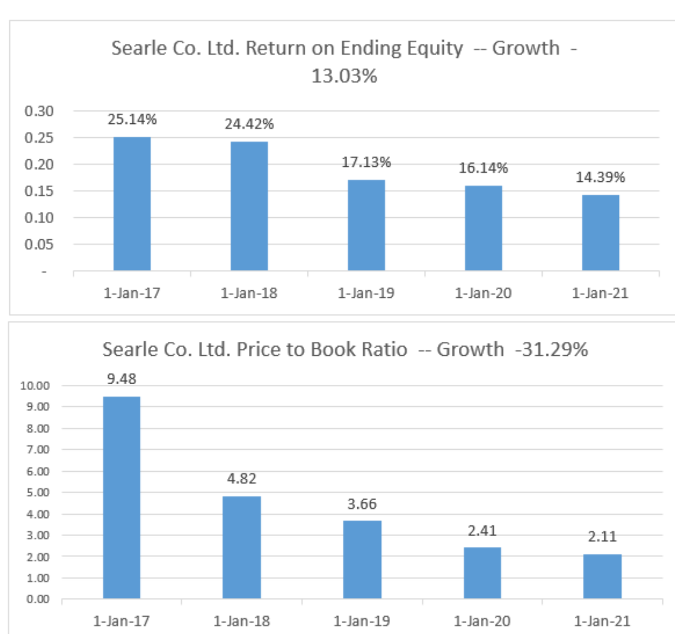
Probability of Default = Minimum Credit Spread/ Loss, Given Default

For a one-year loan, the implied probability of default may be reasonable. But as the credit spreads compound, the results become extremely high as discussed in the section on philosophy. The table below shows how the implied probability of default with different debt tenures assuming that there was no default until the particular year. For the BBB credit spread of 1.32%, the implied probability increases to 16%, meaning that without any default until year seven, the loan can default 16 times out of 100 and the lender will break-even. For the 4.69% credit spread, the probability of default increases to 63% and for the 12% credit spread, the probability of default is more than 100% to by year five. When you suggest to somebody in Pakistan that the probability of default can be 50%, they will tell you that you are crazy as there have not been any defaults in the past.

	1	2	3	4	5	6	7
Credit Spread	1.32%						
Compound Rate	1.00	1.01	1.03	1.04	1.05	1.07	1.08
Loss Given Default		50.00%	50.00%	50.00%	50.00%	50.00%	50.00%
Implied Probability of Default		**2.64%**	**5.31%**	**8.03%**	**10.77%**	**13.55%**	**16.37%**
Credit Spread	4.69%						
Compound Rate	1.00	1.05	1.10	1.15	1.20	1.26	1.32
Loss Given Default		50.00%	50.00%	50.00%	50.00%	50.00%	50.00%
Implied Probability of Default		**9.38%**	**19.20%**	**29.48%**	**40.24%**	**51.51%**	**63.31%**
Credit Spread	12.00%						
Compound Rate	1.00	1.12	1.25	1.40	1.57	1.76	1.97
Loss Given Default		50.00%	50.00%	50.00%	50.00%	50.00%	50.00%
Implied Probability of Default		**24.00%**	**50.88%**	**80.99%**	**114.70%**	**152.47%**	**194.76%**

When studying the cost of capital in Pakistan and reading annual reports from individual companies, you see something surprising. The credit spreads charged by local banks look a lot more like the 1.32% BBB cred

Ultimately the country risk premium can be thought of by asking the question whether eating chocolate or drinking beer is riskier in Nigeria than in Switzerland which would imply that Nestle Nigeria and Nigeria Breweries require a higher risk premium and must charge higher prices for their products than for Nestle in Switzerland or for the Swiss beer company Feldschlösschen. Similarly, economic value comes from solar reducing other energy sources where the cost of the other energy sources includes the environmental damage. One can ask why the risk of



an investment in Togo should be so much more than the risk of an investment in Kansas City where the risks are related to Chinese modules and clouds. Ultimately you can use the market-to-book method and evaluate the implied cost of capital in local currency. You can then adjust to put the returns in a western currency.

Countries Cannot Develop When Foreign Investors Take Out High Country Premiums

You can see from this title that I get emotional about issues like this. To illustrate I demonstrate a real case. This is a project in Mozambique. If western cost of capital with PPP were applied I estimate that the cost of electricity (the real starting point or the real LCOE) would be ___. Because of IRR requirements, the cost from an actual bid is ___ per kWh. If Damodaran estimates were used, the cost would be ___ kWh. If investors are a western company owned by the government such as OPIC or TVA, the high price gives people who live in the US a higher growth rate in their money at the cost of higher prices. There is nothing that illustrates the IRR more than this example.

Why the country risk premium is so important. All of the premiums are in real terms and not in nominal terms. Say a country does not generate internal savings and to make investments in infrastructure it must get capital from outside of the country. If the risk premium is 5% above that for non-developing countries, the country must grow and increase its productivity by 5% just to pay back the cost of capital premium to investors.

You Cannot Analyse Country Risk Premium by Plucking Off Numbers from the Damodaran Website

The final part of the risk premium involves the country risk premium or CRP. The CRP is a controversial item that suggests the risks of investing in countries like Pakistan are greater than investing in developed countries because the country of Pakistan may not repay debt. In the context of price regulated electricity where payments are made by the government, it may seem reasonable to expect that if the government cannot pay foreign debts, that it will also not be able to make payments associated with the PPA contracts. In addition to the credit spread that corresponds to the default risk, it can be argued that equity experiences added risk because of the priority for debt in paying cash flow. The CRP has been derived from differences in the borrowing rate between Pakistan and the yield on US bonds in other studies (e.g., Damodaran). But note that the entire theory of using the default premiums depends on the assumption that credit rating agencies and foreign investors are valuing the bonds with objective and reasonable assessments of the probability of default. I question this assessment later in this report.

Attempting to use the CAPM to dissect the cost of capital to specific segments of the electricity industry such as hydro plants with output risk versus a coal plant with a fixed capacity charge is not practical. To evaluate cost of capital by segment using the CAPM one would need to find companies that look exactly like the projects in question and try to find differential betas. For example, it would involve finding betas for a set of companies that only invest in wind projects with fixed PPA's of the same type that are allowed by NEPRA. Even companies that are distribute electricity are generally not pure distribution companies as they typically engage in non-utility activities and could not be used for example to measure the cost of capital for KELEC.

Figure 1 demonstrates the risk premium estimated by Damodaran and illustrates the dramatic decline and variability over time. If you are asking whether the dramatic changes in country risk premium represent swings in true risks faced by investors of contract defaults (what country risk is supposed to measure), I think your scepticism would be correct.

- The final part of the risk premium involves the country risk premium or CRP. The CRP is a controversial item that suggests the risks of investing in countries like Pakistan are greater than investing in developed countries because the country of Pakistan may not repay debt. In the context of price regulated electricity where payments are made by the government, it may seem reasonable to expect that if the government cannot pay foreign debts, that it will also not be able to make payments associated with the PPA contracts. In addition to the credit spread that corresponds to the default risk, it can be argued that equity experiences added risk because of the priority for debt in paying cash flow. The CRP has been derived from differences in the borrowing rate between Pakistan and the yield on US bonds in other studies (e.g., Damodaran). But note that the entire theory of using the default premiums depends on the assumption that credit rating agencies and foreign investors are valuing the bonds with objective and reasonable assessments of the probability of default. I question this assessment later in this report.

- Credit spreads on Pakistani sovereign bonds issues in U.S. currency versus U.S. treasury bonds with a similar maturity are shown in Figure 5. The graph shows that credit spreads have come down since the beginning of the pandemic. Current spreads for Pakistani government default risk vary between 4.5% and 7.5%. If markets were efficient, these spreads which are theoretically driven by the risk of default on government debt would yield realistic assessments

of default probability. The spreads shown in Figure 5 imply very high implied probabilities of default and are driven by questionable assessments of risk made by credit rating agencies.
Figure 5 - Credit Spreads on Pakistani Bonds versus US Bonds

While the general idea of using government bonds of Pakistan seems reasonable at first glance, there is counter evidence that suggests that this method of using sovereign bond spreads significantly overstates the true risk premium for country risk. One piece of evidence is the interest rates actually paid by realised by the nine Pakistani IPPs in Rs. Using public financial statements, the average interest rates paid in Rs can be computed. When converted to USD, these interest rates paid by Pakistani IPP's are far lower than the sovereign bond rates. Figure 6 shows the average annual interest rate paid Nishat Chun Power in Rs by year and by quarter from financial statements. This is computed through dividing the interest expense in the income statement by the debt on the balance sheet. The annualized interest rates shown in Figure 6 are similar for other IPPs (the quarterly data is annualised because the interest expense is for a quarter rather than for a year and it is therefore multiplied by four). If adjustments are made for Rs/USD inflation, the implied USD interest rate would be much less than the interest rate paid by the Pakistani government.

The lower interest rate for Pakistani IPP's could be explained in a few ways as elaborated below:

1. The interest rate on the Pakistani sovereign bonds issued in USD have had a bond yield that does not reflect the true risk of default for Pakistan because of the manner in which bond rating agencies such as Moody's and S&P evaluate bonds and irrational risk perceptions. This position is that the sovereign bond markets are not efficient in terms of measuring the probability of default.

2. The interest rates for the IPP's are influenced by NEPRA regulation that mandates allowable credit spreads. This rational is difficult because it assumes that local banks will accept credit spreads that do not cover their risk adjusted cost. If you take this argument to the extreme, one could for example make an argument that if NEPRA mandated negative credit spreads, that local banks would still make loans.

3. The interest rates for local banks consider the relatively low debt to capital ratios of the Pakistani IPP's (documented below). This could mean that if the government of Pakistan defaults on sovereign debt and also on the PPA contracts, there is enough equity buffer to protect against a default on the local debt.

Figure 6 - Average Interest Rate for Nishat Chun Power in Rs

Credit spreads on Pakistani sovereign bonds issues in U.S. currency versus U.S. treasury bonds with a similar maturity are shown in Figure 5. The graph shows that credit spreads have come down since the beginning of the pandemic. Current spreads for Pakistani government default risk vary between 4.5% and 7.5%. If markets were efficient, these spreads which are

theoretically driven by the risk of default on government debt would yield realistic assessments of default probability. The spreads shown in Figure 5 imply very high implied probabilities of default and are driven by questionable assessments of risk made by credit rating agencies.
Figure 5 - Credit Spreads on Pakistani Bonds versus US Bonds

While the general idea of using government bonds of Pakistan seems reasonable at first glance, there is counter evidence that suggests that this method of using sovereign bond spreads significantly overstates the true risk premium for country risk. One piece of evidence is the interest rates actually paid by realised by the nine Pakistani IPPs in Rs. Using public financial statements, the average interest rates paid in Rs can be computed. When converted to USD, these interest rates paid by Pakistani IPP's are far lower than the sovereign bond rates. Figure 6 shows the average annual interest rate paid Nishat Chun Power in Rs by year and by quarter from financial statements. This is computed through dividing the interest expense in the income statement by the debt on the balance sheet. The annualized interest rates shown in Figure 6 are similar for other IPPs (the quarterly data is annualised because the interest expense is for a quarter rather than for a year and it is therefore multiplied by four). If adjustments are made for Rs/USD inflation, the implied USD interest rate would be much less than the interest rate paid by the Pakistani government.

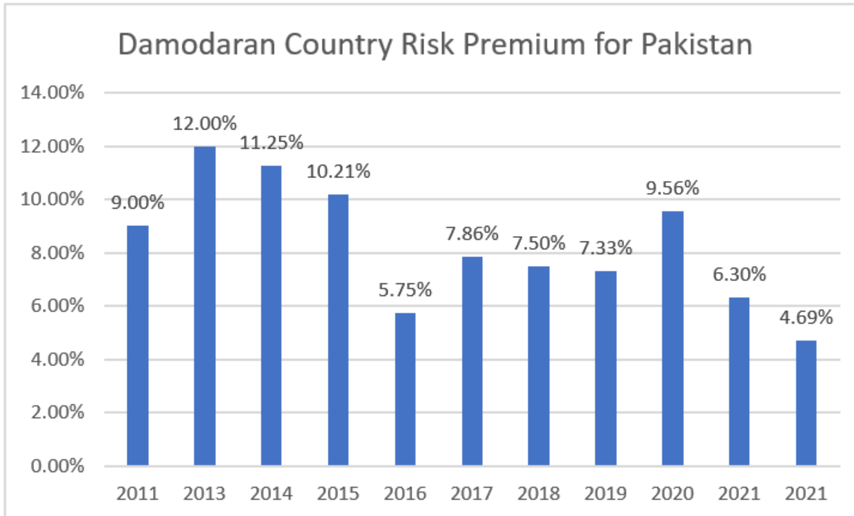
The lower interest rate for Pakistani IPP's could be explained in a few ways as elaborated below:

1. The interest rate on the Pakistani sovereign bonds issued in USD have had a bond yield that does not reflect the true risk of default for Pakistan because of the manner in which bond rating agencies such as Moody's and S&P evaluate bonds and irrational risk perceptions. This position is that the sovereign bond markets are not efficient in terms of measuring the probability of default.

2. The interest rates for the IPP's are influenced by NEPRA regulation that mandates allowable credit spreads. This rational is difficult because it assumes that local banks will accept credit spreads that do not cover their risk adjusted cost. If you take this argument to the extreme, one could for example make an argument that if NEPRA mandated negative credit spreads, that local banks would still make loans.

3. The interest rates for local banks consider the relatively low debt to capital ratios of the Pakistani IPP's (documented below). This could mean that if the government of Pakistan defaults on sovereign debt and also on the PPA contracts, there is enough equity buffer to protect against a default on the local debt.

As the financial statements of Pakistani IPP's are affected by accounting for delayed or lost cost recovery, use of financial data to estimate value is distorted and more work is necessary. One alternative to measuring the implicit cost of capital for Pakistani IPP's is to evaluate the cost of capital for other



companies in Pakistan. Figure 7 demonstrates trends in the return on equity and the price to book ratio for one company, Serle Co. Ltd. The fact that the price to book ratio is above 1.0 and that the return is about 16% demonstrates that the company is earning more than the cost of capital.

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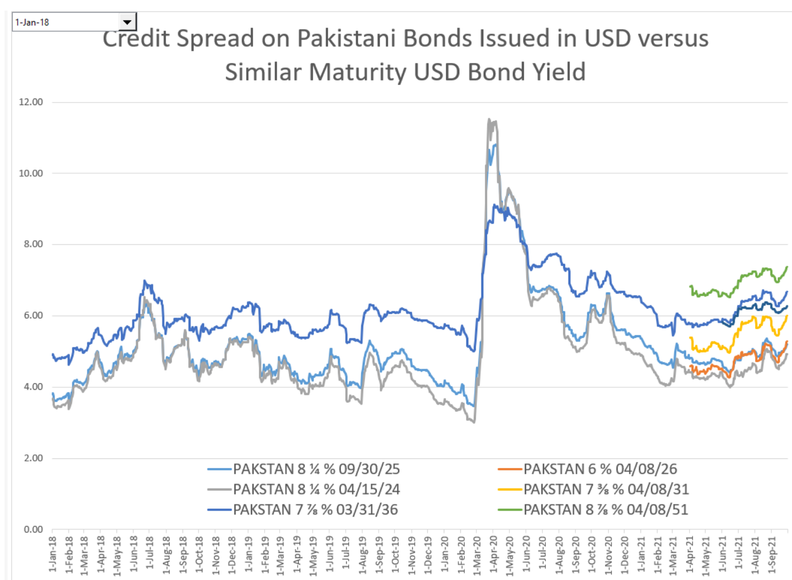
1. The interest rate on the Pakistani sovereign bonds issued in USD have had a bond yield that does not reflect the true risk of default for Pakistan because of the manner in which bond rating agencies such as Moody's and S&P evaluate bonds and irrational risk perceptions. This position is that the sovereign bond markets are not efficient in terms of measuring the probability of default.



2. The interest rates for the IPP's are i nfluenced by NEPRA regulation that mandates allowable credit spreads. This rational is difficult because it assumes that local banks will accept credit spreads that do not cover their risk adjusted cost. If you take this argument to the extreme, one could for example make an argument that if NEPRA mandated negative credit spreads, that local banks would still make loans.

3. The interest rates for local banks consider the relatively low debt to capital ratios of the Pakistani IPP's (documented below). This could mean that if the government of Pakistan defaults on sovereign debt and also on the PPA contracts, there is enough equity buffer to protect against a default on the local debt.

In estimating the cost of capital for companies in Pakistan and other countries with relatively low credit ratings it is traditional to add a country risk premium to the CAPM estimate. Country risk premium theory comes from the notion added risk arises from government actions that will lead to declines in cash flow that are not part of expected cash flow. When the cost of capital is applied as a discount rate is applied in valuation, there is generally not an explicit recognition of the probability of country default. This means that the cash flow estimate does not include a downside case with a government default as well as an assessment of the probability of this default happening. The country risk premium is and should be a controversial item in valuation and cost of capital because it has dramatic effects on PPA prices, particularly for capital intensive technologies like solar and hydro.
To illustrate the controversy of adding country risk premiums to the cost of capital, take the example of selling toothpaste in Pakistan and in the U.S. The country risk premium would suggest that the cost of capital for a little shop selling toothpaste in Pakistan would have to sell toothpaste for a higher price than a similar company selling toothpaste in the U.S. simply because the shop is operating in Pakistan rather than in the U.S. This is because the capital deployed for inventory, selling equipment, buildings and other equipment associated with selling toothpaste supposedly has much higher risk in Pakistan than in the U.S. While I disagree with the whole concept of country risk premium for many industries such as this example of toothpaste, my opinion is not a conventional point of view when computing cost of capital. In this section I present evidence on the country risk premium that is largely derived from the interest rates on Pakistani bonds where the repayment is in USD.

Credit Spread and Premium on Pakistani Sovereign Bonds Issued in USD
When a government issues bonds, denominated in a foreign currency, the interest rate on the bond can be compared to a rate on a riskless investment in that currency to get a market measure of the default spread for that country. In estimating the country risk premium, NEPRA has used a method where the premium on Pakistani government bonds issued in USD is measured relative to bonds with similar maturities. This premium or spread on government bonds is essentially the same as the credit spread on a corporate bond and it is also the came as the credit default swap for Pakistani bonds. Using the NEPRA approach, this credit spread that has been presented in Figures 5 and 12 on Pakistani bonds versus USD bonds with the equivalent maturity is added as the country risk premium. As the premium is measured for debt investors, the NEPRA approach uses an additional premium for equity which is supposed to be riskier than debt (in general one should be careful in comparing debt and equity returns because debt only has downside and equity has upside). This NEPRA adjustment to equity is computed using a standard deviation ratio. If you believe that the yield on Pakistani bonds with debt service paid in USD reflects the probability of default and the loss given default and also that the default on Pakistani bonds would probably mean that the Pakistani government would

default on PPA agreements would occur with a Pakistani default on the USD bonds, then the country risk premium derived from USD default spreads makes sense.

The method used by NEPRA appears reasonable as if there is a serious currency problem in Pakistan and the government debt in USD cannot be paid, it seems reasonable that if the PPA is indexed to the USD, that PPA would also not be paid. Further, the risk for equity holders as reflected in the CAPM should be similar premium on government bonds. If the lenders lose money because the PPA is not paid, then the equity holders will also lose money. Further, if currency crisis results in lenders not being paid, it is possible that the lenders will lose some of their money and the equity holders will lose all of their money. Before working through the mathematics of the probability of default and how it should be incorporated into the cost of capital, I note the average interest rate experienced by the nine IPP's conflicts with the whole concept of the country risk premium.

To understand what the yields on the Pakistani bonds issued in USD mean, the first step to is to understand that the fundamental formula for measuring the cost of capital on debt securities that only have downside risk and no upside other than earning the risk premium itself. This formula is a simple one that defines the credit spread or the premium on debt as a function of the probability that the loan defaults and, if the loan does default, what will be the final loss. The first factor is called the probability of default. The second factor is called the loss given default. The theoretical premium on a bond or any loan is given by the simple formula:

Premium on Bond Percent = Probability of Default x Loss, Given Default

The nice thing about this formula is that if you know the premium on a bond, you can back into the implied probability of default (if you make an assumption about the loss, given default). Table 9 shows the premium on Pakistani bonds that are issued in USD with different maturities. It is not surprising that the longer maturities have a higher premium as there is a higher probability of default the longer the bond is outstanding.

	Years to Maturity from November 2021	Basis vs USD Bond in Percent
PAKSTAN 8 ¼ % 09/30/25	4.00	5.19
PAKSTAN 6 % 04/08/26	4.84	5.29
PAKSTAN 8 ¼ % 04/15/24	2.54	4.92
PAKSTAN 7 ⅜ % 04/08/31	9.84	6.00
PAKSTAN 7 ⅞ % 03/31/36	7.38	6.68
PAKSTAN 8 ⅞ % 04/08/51	29.84	7.38
PAKWNP 7 ½ % 06/04/31	9.52	6.26

Table 9 - Basis USD Pakistani Bonds and Maturity

Computing the Implied Probability of Default on Pakistani Bonds

In this section I compute the implied probability of default given the Pakistani bond premium relative to the USD yield. I have tried to make the analysis of the implied probability as simple as possible by using a short maturity. I have used the closest maturity (the 8 ¼ maturing in 2024) for this exercise. This bond yield to maturity is 5.23% while the equivalent yield on US bonds is only .3%. This means the premium on the yield to maturity is 4.92%. Note that the coupon rate is 8.25% for the bond, meaning the investor would earn a return of higher than the 5.23% if the price of the bond was the par value of the bond. But as the bond has a higher price than the par value the effective interest rate is lower and that is essentially what the yield to maturity represents. In sum, if an investor wants to realise 5.23% while earning the 8.25% coupon, the investor would be willing to pay more than the par value of the bond. A summary of the bond is shown in Table 10.

Table 11 illustrates how you can derive the implied probability of default on the bond. This table assumes that the loss given default is 50%, meaning that if the Pakistani does miss an interest payment, the bond investor will be assumed to lose 50% of the final maturity payment. Many of the defaults on government bonds (generally in Latin America) did ultimately pay the principal meaning that the loss given default was not 100%. Table 11 shows the amount the bond over a three-year period with the principal payment and the final maturity payment. This bond is valued assuming that the bond will default in year 2 and that no coupon payment will be received. In addition, the final maturity payment is assumed to generate only 50% of the final payment. Table 11 demonstrates that if the default scenario is assumed to have a 24% chance of occurring, then the Pakistani bond will ultimately result in the same value to investors as the USD bond. In Table 11 the final two lines show the difference in cash flow from the expected value of the Pakistani bond as compared to the USD bond. The last line on the table demonstrates that the 24% probability of default does result in the same value to investors as the USD bond.

Maturity	3.00
Yield Spread	4.92%
Yield to Maturity	5.23%
Coupon Payment	8.25%
USD Yield	0.30%

Table 11 - Implied Probability of Default

The implied probability of default on the bond is affected by the assumed loss given default and the date at which the default occurs. Table 12 shows implied probability of default with different assumptions for these two parameters. The lowest probability of default in the next three years is 12.54% while the highest probability of default is 55.41%.

		Total	1	2	3
Default	2		FALSE	TRUE	TRUE
Bond Amount			1,000.00	1,000.00	1,000.00
Coupon Interest	8.25%		82.50	82.50	82.50
Total Payment			82.50	82.50	1,082.50
PV at Yield	5.23%	1,081.89			
	Probabilty	Loss, Given Default			
If No Default	76%		82.50	82.50	1,082.50
If Default	24%	0.5	82.50	0.00	500.00
Expected Return			82.50	63.09	945.45
Return from USD Bond			1,081.89	1,081.89	1,081.89
Coupon Plus Maturity	0.30%		3.27	3.27	1,085.16
PAK Bond vs US Bond			79.23	59.82	-139.71
NPV of Cash Flow	0.30%	0.00			

Table 12 - Alternative Probability of Default with Different Parameters

Direct Assessment of PPA Cash Flow to Derive Country Risk Premium

Some of the literature on the country risk premium suggests that it is better to make direct assessments about the cash flow loss from country risk rather than making an arbitrary premium adjustment. Unfortunately, these assessments are often made using vague statements rather than an illustration of how the analysis would work. I have created a simple example of how a direct assessment of cash flow can be used derive the implied country risk premium.

Table 13 illustrates that you could set-up a cash flow table and include scenarios where country policies result in lower cash flow. The first case has no default and a probability of 85.54%. The second case has a default in the third year and an assigned probability 14.46%. The weighted average cash flow from the probability is shown below. The implied IRR increases from 5% to 7.55% if the probability and the default are accounted for. The example shows that if you put a probability on the loss of cash flow, you can compute the IRR that is realised and evaluate back into the country risk premium.

		Loss Given Default				
		20%	25%	50%	75%	100%
Year of Default	1	34.92%	31.41%	20.92%	15.68%	12.54%
	2	42.85%	37.69%	23.53%	17.10%	13.43%
	3	55.41%	47.07%	26.87%	18.80%	14.46%

Table 13 demonstrates in a hypothetical example, that if you make an assumption about the probability that cash flows will be reduced and also the time period of the reduction, that you can back into the country risk premium. The issue with this method is that NEPRA would have to make an assessment that defaults occur because of its own actions.

Effective Interest Rate in USD = (1 + Euro Interest Rate)/(1 + Forward Exchange Change) – 1

Or, as the exchange rate change is 1.14/1.1285 = .9899

Effective interest rate = .52% = (1-.5%)/(.9899) = 1.005 and 1.005 – 1 = .5%

The general idea of this formula can be used to evaluate interest rates in Rs relative to interest rates in USD. But the forward exchange rate is not liquid. This means instead of using the forward exchange rate you can use the expected inflation rate using the PPP concepts discussed above. If the inflation rate in Pakistan is greater than the inflation rate in the U.S., then the devaluation percent can be used to adjust the interest rates stated in Rs to the equivalent USD amount.

Table 18 shows the historic change in exchange rate for Rs to USD. If the PPP idea would apply, the percentages shown in the table would reflect the Pakistani inflation rate relative to the USD inflation rate. For example, at the bottom of the table, a single year devaluation is shown. If the USD inflation rate was 2%, the implied inflation rate from the change in the exchange rate would be (1+6.8%) x (1 + 2%) = 1 or 8.93%. The equation is:

Implied Inflation in Pakistan = (1+ Exchange Rate Change) x (1+USD Inflation) – 1

Table 18 shows the average interest rates for the Pakistani IPP's as computed using Rs and also converted to USD. The conversion is made using the changes in exchange rates from Table 18. The formula for converting interest rates in Rs to USD involves computing the USD divided by the Rs rather than the Rs to USD. This results in an appreciation in exchange rates when expressed with USD in the numerator. The appreciation in the exchange rate can be used with the following formulas to express the interest costs for the Pakistani IPP's into USD rates.

Step 1: Appreciation in USD/PAK

Step 2: Appreciation Percent in USD/PAK

Step 3: USD Rate = (1+Pak Interest Rate) / (1 + Appreciation Percent) –

Table 13 - Direct Calculation of Country Risk

Mystery of Interest Rates Paid by IPP's versus USD Premiums

If an international institution is providing USD funds to Pakistan and assess the default probability of the bonds, there is no reason in theory to expect that local financial entities who lend money in Rs should have a different outlook for default probabilities. If there is a currency crisis and the IPP companies are indexed to the USD or earn PPA prices subject to local inflation, exactly the same risks of the government not being able to pay the PPA prices apply to the local banks. Local financial institutions evaluate loans with assessments of the probability of default and the loss given default in precisely the same way as international investors assess the risk of Pakistani government bonds. If the default on an PPA contract has similar characteristics as the overall government default risk, the risk premium should be at least as high for the loans made to the Pakistani IPP's as for the government debt. But the effective interest rate in the same currency for loans to the Pakistani IPP's is much lower than the USD based Pakistani loans. This is shown in the next section. Possible explanations for this are that the loans are much shorter tenure of the loans or big difference in the assessment of country and political risk as between international investors and local investors.

There is little argument to make that the interest rates charged by local banks are not relevant in the assessment of the country risk. Figure 21 illustrates the average interest rate Saif Power and includes calculations on an annual basis and on a quarterly basis. The calculations use interest expense for the year, or the quarter divided by the average debt balance. For the quarterly periods, the average interest expense is multiplied by 4. Figure 21 shows that the annual interest rate in Rs has been between 5 and 10% over the last year.

PPA Analysis			1	2	3
PPA Cash Flow to Equity w/o Default	85.54%		500.00	500.00	500.00
Default Case	14.46%		500.00	500.00	-
Expected Value			500.00	500.00	427.70
Cost of Capital w/o CRP	5.00%	1,299.17			
		-1,299.17	500.00	500.00	500.00
Implied Cost of Capital from IRR	7.55%				
Country Risk Premium	2.43%				

A final issue with respect to country risk is the question of whether the beta or the EMRP includes some or all risks for serious currency and other problems that could lead to country defaults. For example, assume investors in the Pakistani IPP's are very worried about not getting paid when there is a currency crisis in the country. In this case, every time there is some kind of worry about the country of Pakistan and the KSE declines, then the stock price of the IPP will react strongly. If the beta is computed against the KSE index, the beta will be relatively high. This may be an issue if the beta is measured against the KSE index. If the index includes general country risks and if the IPP stocks react to that risk, this non-diversifiable risk should be reflected in the beta.

Damodaran Country Risk Premium

If you search for country risk premium on the internet, you will probably arrive at estimates of the country risk made by Damodaran. Even if the estimates made by Damodaran are questionable and incomplete, the fact that many use these estimates make the Damodaran estimated relevant to understand. I suggest the Damodaran method and explanation have may problems. For example, by not evaluating the implicit probability of default and the loss given default in the estimates and by ignoring things like the loss given default in the write-up of how the country risk works, there are no checks if the method works relative to financial ratios.

The Damodaran method is illustrated in Table 14 and Table 15 below. Table 14 is the most recent estimate of the Pakistani risk premium from Damodaran. The risk premium comes from the 4.28% credit default spread over US treasuries or alternatively the 5.75% premium that is derived from the general credit spread on bonds with a B- rating. In the case of using the 4.28% premium, a factor of .41% is added to arrive at the country risk premium. When the bond spread is used, the factor added to the credit spread is .55%.

Country	Pakistan
Moody's sovereign rating	B3
S&P sovereign rating	B-
CDS spread	4.51%
Excess CDS spread (over US CDS)	4.28%
Country Default Spread (based on ra	5.75%
Country Risk Premium (Rating)	6.30%
Equity Risk Premium (Rating)	11.02%
Country Risk Premium (CDS)	4.69%
Equity Risk Premium (CDS)	9.41%

Damodaran explains that he uses the sovereign rating (from Moody's: www.moodys.com) and then estimates the default spread for that rating. This is based upon traded country bonds in general over a default free government bond rate. He also explains that if a CDS spread is available he uses those. This results in the two different methods shown in Table 14. It is unclear what tenure of debt is used for measuring the CDS spread for the country default spread.

Table 15 shows how Damodaran's estimates of the risk premium have changed over the past decade. The Pakistani country risk premium has moved from a high of 12% in 2013 to 4.69% as of the most recent report. Part of the reason for this change in the Pakistani country risk premium is the change in the default spread on the Pakistani bonds paid in USD shown in the second column of Table 15. Another reason for the change in the risk premium is the difference between the default spread and the country risk premium shown in the right-hand column. This difference has moved from a high of 3% to a recent value of .41%. The calculations for this added premium are opaque, but the adder can be applied to different calculations of the bond premium.

Table 15 - Factors Causing Changes in Damodaran Risk Premium

Figure 23 - Credit Spread on Pakistani Bonds and Tenure

Recommended Country Risk Premium

In recognition of general concerns about investing on Pakistan I recommend using the 6% as the country risk premium to avoid controversy. The 6% is higher than the Damodaran risk premium as I used a longer maturity as shown in Figure 23. The numbers for the basis spread by maturity shown in Figure 23 are for the most recent yields available. As the default risk increases over time, the spreads are higher for the longer maturities. The same kind of argument for using a longer USD treasury bond for the risk free rate can be made for application of the credit spread. I also add 1% to the default spread to recognize the increased cost of equity relative to debt.

	Country Risk Premium	Default Spread	Total Risk Premium	Equity Risk Premium	Country Risk vs Spread
2011	9.00%	6.00%	14.00%	5.00%	3.00%
2013	12.00%		17.75%	5.75%	
2014	11.25%		17.75%	6.50%	
2015	10.21%	7.29%	16.46%	6.25%	2.92%
2016	5.75%		11.02%	5.27%	
2017	7.86%		12.99%	5.13%	
2018	7.50%		12.99%	5.49%	
2019	7.33%	6.03%	13.00%	5.67%	1.30%
2020	9.56%	7.63%	14.79%	5.23%	1.93%
2021	6.30%	5.75%	11.02%	4.72%	0.55%
2021	4.69%	4.28%	9.41%	4.72%	0.41%

In recommending the 6% country risk premium I come back to the idea that the true cost of capital is the minimum return that investors accept given the level of risk. If this minimum return is not met, important electricity investments will not be constructed in Pakistan. Unfortunately, this country risk can be the perceived risk rather than the risk computed on an objective basis, or it can result from a careful mathematical analysis of risk. In discussion the country risk for Pakistan, I have heard comments something general comments about the high risk of investing Pakistan.

Chapter 33: Measurement of Beta and Mean Reversion

Mean Reversion of Beta and Article from the 1970's

I have testified many times on the cost of capital in cases where a government agency sets prices for electricity and gas companies. You write long report that nobody reads. You go through some theory about the cost of capital. You come up with a number by fiddling around with different samples of comparable companies. If you represent the utility company, you suggest a high number and argue that regulated companies are really risky, that the overall risk for stocks are much higher than for government debt instruments by something like 8% (the EMRP). You then look around for ways to get high values for beta. You may present data from Value Line of MarketWatch that shows the beta for these companies is high. You don't make your own beta calculation and you don't explain why the beta calculated by Yahoo finance is so different from the beta presented by Value line and Marketwatch (see Figure xxx). You use a 30 year treasury bond rate to represent the risk free rate and you come up with a number above 10%.

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BETAS AND THEIR REGRESSION TENDENCIES

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I. INTRODUCTION

A PREVIOUS STUDY [3] showed that estimated beta coefficients, at least in the context of a portfolio of a large number of securities, were relatively stationary over time. Nonetheless, there was a consistent tendency for a portfolio with either an extremely low or high estimated beta in one period to have a less extreme beta as estimated in the next period. In other words, estimated betas exhibited in that article a tendency to regress towards the grand mean of all betas, namely one. This study will examine in further detail this regression tendency.[1]

The next section presents evidence showing the existence of this regression tendency and reviews the conventional reasons given in explanation [1], [4], [5]. The following section develops a formal model of this regression tendency and finds that the conventional analysis of this tendency is, if not incorrect, certainly misleading. Accompanying this theoretical analysis are some new empirical results which show that a major reason for the observed regression is real non-stationarities in the underlying values of beta and that the so-called ''order bias'' is not of dominant importance.

Another way to measure the cost of capital is to look around for companies that have a market price that is about equal to the cost of capital. When the amount of money invested is equal to the market value, the company has not wasted its shareholders money nor has it took their money and magnified it.

Disproving the cost of capital estimates

The reason that the beta statistics are so different is because of a formula used by Value line where beta computed from the stock price variance – the raw beta – is adjusted by an arbitrary 33.33% to push the beta towards the mean. This means that companies with raw betas of below 1.0 are adjusted upwards and companies with betas of below 1.0 have betas that are adjusted downwards.

$$\text{Adjusted Beta} = \text{Raw Beta } (0.67) + 1.00\ (0.33)$$

If you look a ConEd in Figure XXX, you can see that the yahoo beta is .19 using Yahoo Finance and it is .50 using MarketWatch. Using the "fancy" formula above, .19 x .67 + .33 (I did not multiply by 1.0) gives you .46 or about the value of MarketWatch. For ConEd you can go back to the 1960's and in minutes compute the beta for different time periods. When you do this you will not see any mean reversion (If you read on to the next chapter you can see this). The truly remarkable point about this so called mean reversion adjustment is that it comes from a paper written in 1975 by somebody named Marshall Blume. With due respect to the Dr. Blume, when you read the paper you see there is not much there. We can give Dr. Blume the benefit of the doubt because acquiring data was difficult in 1975. But these days you can in minutes compute the beta over different periods. If you want to see how much crap there is in cost of capital estimation, you can stop here. I am shaking when thinking about this.

Company	Yahoo Beta	Market Watch Beta
NEXTERA ENERGY	0.26	0.71
DOMINION ENERGY	0.40	0.68
DUKE ENERGY CORPORATION	0.29	0.66
SOUTHERN COMPANY	0.46	0.71
AMERICAN ELECTRIC POWER COMPANY	0.32	0.53
EXELON CORPORATION	0.47	0.91
SEMPRA ENERGY	0.65	0.82
XCEL ENERGY	0.35	0.64
CONSOLIDATED EDISON	0.19	0.50
PUBLIC SERVICE ENTERPRISE GROUP	0.58	0.69
WEC ENERGY GROUP	0.21	0.55
AMEREN CORPORATION	0.32	0.69
AVANGRID	0.31	0.62
OTTER TAIL POWER	0.42	1.06
ALLIANT ENERGY CORPORATION	0.37	0.60
NISOURCE	0.31	0.74
CONSUMERS ENERGY COMPANY	0.21	0.57
OGE ENERGY	0.67	0.74
MGE ENERGY	0.61	0.88
IDACORP	0.50	0.69
HAWAIIAN ELECTRIC INDUSTRIES	0.25	0.60
PORTLAND GENERAL ELECTRIC COMPANY	0.43	0.80
BLACK HILLS CORPORATION	0.43	0.92
PNM RESOURCES	0.50	0.87
Average	0.40	0.72
Median	0.39	0.69

What if we Knew the Cost of Capital

Define the cost of capital as the minimum return acceptable for taking the risk. Or, the minimum target IRR. Cannot read this anywhere like interest rates. Strong incentives to make this number high and not unbiased in many circumstances. Regulatory, justify monopoly profits … But we do not know the number. If we did, we could compute the PV of ROIC and solve the IRR problem. We could compute terminal value in a sensible way.

Basic Problem with Cost of Equity Capital – You Cannot See It

The question of what kind of growth rate you need to compensate for risk is at the centre of all finance. It drives project finance, the WACC in corporate finance.

The most basic problem with estimation of the cost of capital is that nobody can observe the number. There are no contracts between investors and a company that write down the percentage cost of equity number such as 6.5% for the cost of equity capital; you cannot track cost of capital changes in the same way that you can see changes in stock prices, interest rates, gold prices, exchange rates and other things. These days you can easily find data for things like earnings per share, operating income, cash flow, price to earnings ratios and so forth for companies on the internet; but you cannot find a number for the cost of equity anywhere. Furthermore, measuring the cost of equity is different from measuring the cost of debt. Components of the cost of debt are written in loan contracts where parts of the interest rate such as the base interest rate and the credit spread are explicitly written down in loan agreements. These credit spreads are collected in databases.

As the cost of equity cannot be directly observed, different methods have been created to implicitly derive and estimate the cost of equity. But all of the methods require estimation of variables that are subjective. These subjective variables include the market risk premium; the beta; the expected growth rate; the expected return, and the expected market risk premium. This difficulty in measuring the cost of capital should be a backdrop for all of the seemingly sophisticated economic equations that are used for variables like beta, country risk premia, expected growth rates and other items.

Coming up with a cost of capital number can be frustrating from both a theoretical and a practical data standpoint, particularly when working with the CAPM. Indeed, working through the details of cost of capital illustrates a panoply of flaws in financial theory. Some of the difficult technical questions include: if long-term bonds include inflation risk can this be called the risk free rate; is there a risk premium for stocks versus risk free bonds (the EMRP) that is stable; for non-US companies, should betas be computed on the basis of an international index or the local index; should betas be measured on the basis of daily, weekly or monthly returns; how should betas be un-levered and re-levered; how should the country risk be computed when local companies borrow at a lower rate than the government; can a good alternative to the CAPM be developed from implied cost of capital inside cash flow forecasts. I emphasise in this chapter that pretending that the cost of capital can be precisely estimated is misleading.

Cost of Capital is the Minimum Return You Need Before You Walk Away

Given the difficulty in measuring the cost of capital, I begin with a definition of the cost of capital, which is not as simple as one may think. The cost of capital is not simply the rate of return that is desired by an investor. Rather, it is the minimum return that is acceptable for to compensate for taking risk. The key word here is minimum. It is not the expected return; it is not the return that other people get on investments. For example, when an investor complains that the rate of return is too low to invest in a hydro plant, the investor is correctly interpreting the meaning of the cost of equity. But if the investor would continue build the hydro plant even if the return was lower, this return for which the investor would not walk away is not equal to the cost of capital as defined by the minimum acceptable return.

The only way to really find the cost of capital is to ask industry participants what return they need in order to invest in real projects (i.e., before they will walk away from an investment or before they will not purchase a stock assuming they have some kind of good forecast of cash flow). Even if participants have estimates that appear to not conform with data on betas, market premiums or other factors that may seem irrational in the context of financial theory, it is the point at which investors will not make investments that we are looking for when we measure cost of capital. I do emphasise that caution should be taken in these industry participants as the most fundamental objective of any business is to earn a return above the cost of capital and they have a strong incentive to overstate their hurdle rate.

You can think of the cost of capital in a bidding context. In a highly competitive bid for a project that does not have some kind of provisions that give one company an advantage over another company (e.g., a solar plant bid in Dubai). You want to win a bid and offer a low price. Your manager wants a pretty high return. If you are to have any chance of winning the bid, you negotiate with you manager to push down the acceptable return to win the bid until you arrive at the minimum acceptable return. This minimum return must compensate for the risk you take if you win the bid. You can imagine how difficult it is to come up with a true number.

One can think of any cost of capital – the debt cost of capital; the equity cost of capital; the weighted average cost of capital; the cost of capital on mezzanine debt -- as the build-up of a real interest rate, inflation and a risk premium. A general formula for the cost of capital in Pakistan includes a real interest rate, the expected rate of inflation, a general risk premium for investing in equity, a company or industry specific risk premium and finally, a country risk premium. This simple equation is consistent with the CAPM can be represented by the formula below:

Cost of Capital = Real Interest Rate + Expected USD Inflation + General Risk Premium +/- Company Risk Adjustment + Country Risk Premium

Big Points

1. History of earnings power and market values and capital gains
2. Equity returns from stock markets and debt returns
3. CAPM Problems
4. EMRP and Economic Growth
5. Beta and Time Period
6. What is Risk Free Rate
7. When the Debt Cost is Greater than Equity Cost

Crazy Cost of Equity Capital in Harvard Case Studies

Table xxx shows estimates of the cost of capital in an HBS case. This was published in ___.

The CAPM market risk premium is obtained from historical data, with allowance made for the judgment of the analyst. For purposes of this calculation, we will assume that it is 7%. LBO Note

Attempts to Find the Cost of Equity Capital from Projects

Another general source of cost of capital/return on equity estimates is data presented by Bloomberg when developing reports on the levelised cost of electricity for different technologies. Table xxx presents comparative data for 2019 when the Bloomberg used feed-in tariff with data from a Bloomberg report presented for the first half of 2021. Data in the table is supposed to reflect project costs and investment in USD, but there is some confusion with respect to currency adjustments. For example, when discussing returns in China, the Bloomberg report states that "we estimate that some projects can go ahead with a 6.5% nominal equity return." It is not clear whether this is a local return in Yuan or a return that is in USD. In Table xx there is also some question as to whether the numbers represent the cost of equity which is the minimum acceptable return or alternatively whether the data is the hoped-for return. I believe low values for return on equity in the table (for example, Solar Low 2021) are the best representations of the cost of capital defined as the minimum return that is acceptable for the given level of risk. The return on equity data for Germany and Japan are notable and demonstrate that the international cost of capital for wind projects in 2021 can fall below 5% (as stated above, the return on equity represents a maximum cost of capital estimate and the true cost of capital can be lower).

Bloomberg Return of Equity/Cost of Equity

Countries	Wind Onshore 2018	Solar Low 2019	Solar High 2019	Solar Low 2021	Solar High 2021	Wind Low 2021	Wind High 2021
India	12.00%	11.50%	13.30%	11.00%	12.80%	10.80%	13.00%
Australia	9.00%	7.50%	11.00%	6.50%	11.50%	6.50%	11.50%
China	10.00%	8.00%	10.00%	6.50%	8.00%	8.00%	8.00%
Philippines	10.00%						
Vietnam	12.00%						
Thailand	10.00%						
South Korea	9.00%						
Indonesia	12.00%						
Japan	8.00%	6.00%	7.00%	5.00%	6.00%	4.50%	5.50%
Malaysia	10.00%						
Germany	5.00%	5.00%	5.00%	5.00%	5.00%	4.00%	5.00%
UK	8.00%	7.00%	8.00%	6.50%	7.00%	7.00%	8.00%
US	9.00%	7.00%	7.00%	8.00%	8.00%	8.80%	8.80%

Can We Just Ask People What is Their Minimum Required Return

One can argue that this is a psychological/philosophical number that reflects investors minimum requirements can only really be determined by asking investors about their minimum expected returns. In the next chapter, I suggest that estimates of the general EMRP of more than 5-6% cannot be theoretically reasonable in the context of an economy that grows at 2-3% on a real basis because returns are growth rates. But if market participants have irrational requirements for the EMRP numbers, one could accept a higher number than the 2-3%. I emphasise that the EMRP estimated from the value of a stock index less the risk-free interest rate is completely distorted by capital gains caused by the change in the cost of capital itself. For example, if the value of stocks increases by 10% because of a decline in the cost of capital, this change in the value does not reflect earned returns of companies and should not be included in the risk premium.

Equity Risk Premiums of Above 4% are Not Plausible in a Developed Economy

The term equity market risk premium (EMRP) is supposed to represent the amount by which the market is expected to outperform the risk-free asset. It is the centre piece of the CAPM; it is a real number (without inflation); surveys of what people use do not matter; it can only be estimated through measuring implied returns. In practice, Rm is approximated by the return on a broad stock market index like the S&P 500, and Rf is measured as the promised return on a long-term U.S. government bond. According to a Harvard case study publication, "(t)he market risk premium has historically been about 7.5%, on average, although academic estimates of the ex ante premium range from 0.5% to 12%." 2 Valuation

If somebody wants to criticize the CAPM, they could point to the uncertainty and variation in measurements of the EMRP. The following quote illustrates the problem: "While users of risk and return models may have developed a consensus that historical premium is, in fact, the best estimate of the risk premium looking forward, there are surprisingly large differences in the actual premiums we observe being used in practice. For instance, the risk premium estimated in the U.S. markets by different investment banks, consultants and corporations range from 4% at the lower end to 12% at the upper end." With this kind of range in the equity market premium, the CAPM becomes useless. The range in the EMRP is the primary argument for deriving the implicit cost of capital from cash flow forecasts.

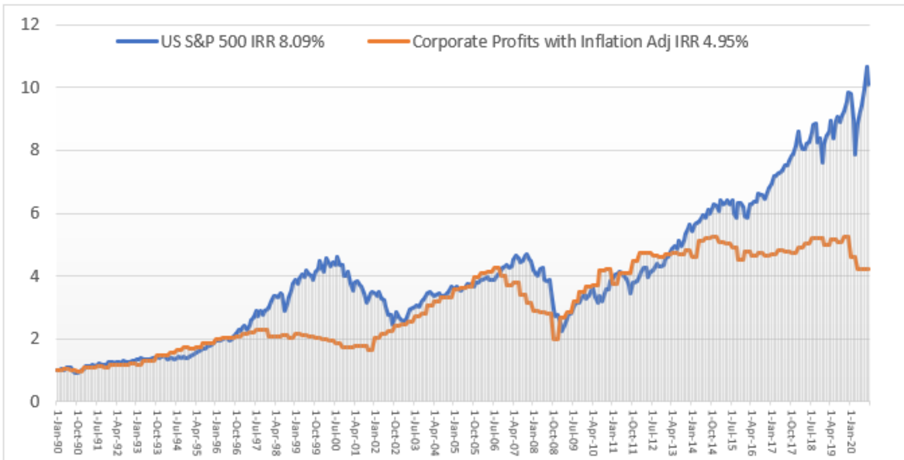
Estimates of the market risk premium can vary by a wide margin and some analysts have used estimates have been more than 7% in the past. If you go back to the fundamental definition of the cost of capital, the risk premium is minimum return that investors will accept relative to the risk-free rate.

An example of the main things that I question, that the equity market risk premium is anywhere near 6%, is illustrated on Figure xxxx. In teaching my classes I sometimes ask students how fast your money would have grown if you invested in the overall equity market (I will show you that it is best to define the IRR as a growth rate). My students seem to have been taught somewhere along the line that 8% is about what you could have earned if you invested in the stock market.

Perhaps this comes from the S&P 500 time series in yahoo. Finance website which for me has been revolutionary. With this website you can scrape data and then compute returns for most stocks in the world. Better yet, you can combine it with data from the Federal Reserve Economic Database (FRED) and then evaluate real and nominal returns, compare stocks to economic series, adjust for exchange rates, and evaluate stock performance relative to commodity price movements. Perhaps the 8% comes from an equity market risk premium of about 6% with a risk-free rate of about 6%. When you look at this more carefully,

Market Returns and Cost of Capital

At the bottom of all things in finance, the value of an investment or anything else is driven by two things. The first is the level of cash flow and the second is the risk associated with the cash flow. The second item, the risk associated with the cash flow, is represented by the cost of capital. Keeping this basic idea about cash flow and risk in mind allows some interpretation and understanding of financial markets. First, if stock prices increase, it does not necessarily mean that companies are earning a higher return. Instead, if stock prices have gone up but the cash flow has not, you can surmise that the cost of capital has declined. To illustrate this, consider valuation of a perpetual cash flow stream (with a perpetual cash flow stream, the value is the constant cash flow divided by the cost of capital). Assume that the investment made for the stream is 1,000 and the return is 100. If the cost of capital is 10%, then the value is the same as the investment and the cost of capital is the same as the return. This is illustrated below:



Value = 100/10% and Return = 100/1000 = 10% and,
Value/Investment = 1.0 and Value/Earnings = 10

Now assume that the cost of capital declines to 9% while the return remains at 10%. In this case the value increases to 1,111 while the return earned from the company remains at 10%. The investor has experienced a capital gain, but the capital gain is not from the investment earning a higher return. If NEPRA would interpret the return to be 11.1%, and set the return on this basis, it would not be setting the return to the cost of capital which would be 9%. This confirms that NEPRA cannot apply returns from increasing market indices when computing cost of capital.

This example illustrates the trap of assuming applying a stock price index increase either directly or indirectly applies to return measurement. This simple idea also implies that the change in a stock index cannot be used as the basis for computing the EMRP in the CAPM. Figure 10 graphs the U.S. S&P 500 Index and Corporate Profits published by the US government. It data is nominal and the inflation adjustment relates to adjustments made to depreciation for inflation. The graph demonstrates the idea that increases in stock prices over the past few years are the result of declines in the cost of capital rather than increases in earned returns and profits of the underlying companies.

Cost of Capital and Philosophy of Capitalism

The most influential economists ranging from Adam Smith to Ricardo to Marx have been philosophers and I will argue that thinking a little more deeply about risk and return without computing a regression analysis of stock prices will produce more sensible results.

In applying the equity market risk premium or EMRP in the CAPM estimates, I first note how difficult it is to get your head around what this mysterious number is. If you could somehow pretend there was some kind of marginal investor who is the person or institution who is buying or selling shares, the equity market risk premium would be the minimum extra expected return that theoretical investor would need to take his money out of risk-free investments and invest in a portfolio of shares. Just writing these words can make your head spin.

Historically the volatility of US stocks has been about 20%, while long-term bonds have a volatility of 7.6% and short-term bonds have a volatility of 3%.

In my opinion, the equity market risk premium is somewhere between a psychological concept and a philosophical idea. But note a couple of things. First, the EMRP is about future returns and not about past experience, it is about expectations. I have written that the EMRP is affected by changes in the cost of capital itself and that returns earned from making an investment should not be distorted by changes in the cost of capital itself. Second, as the EMRP reflects the returns or rates of growth to a group people in the economy, if the returns and the EMRP is greater than the real growth in the economy, then investors as a group will always get richer at the expense of everybody else. I leave it to the reader to contemplate whether this is sustainable in the long-run.

Third, any discussion about using geometric versus average returns should have been resolved ages ago. Returns are measured on a compound basis. Fourth, the portfolio of stocks that evaluate the return on stocks relative to risk free bonds should not be limited to a particular geographic location. For example, there is no reason to expect an investor in Pakistan who can invest in stocks all around the world to have a different minimum required criteria for taking equity risk versus bond risk than any other investor in the world. Both investors can invest in the same portfolio.

When thinking about the risk premium without getting trapped by technical discussions of items such as the geometric mean versus the arithmetic mean you can think of some very basic economic analysis of the supply and demand for capital supplied by people who what to invest in the market rather than in risk free securities that are earning almost nothing. You can think of pension funds or insurance companies for example. As the supply of capital increases and the alternatives of investing in bonds produce low returns, the mysterious risk premium which is the minimum acceptable return will decrease. This indeed is just about the only way to explain increases in market indices.

A few things that should be considered in evaluating the EMRP include:

If the EMRP is higher than the real (not the nominal) growth rate in the economy, investors as a group will continue to get richer while the rest of the economy will become poorer. This means that assuming an EMRP much higher than the real growth in the economy is a very questionable idea.

As money grows in an exponential manner with increasing returns, the amount of money that you generate from the risk premium produces a dramatic number relative to the risk-free rate.

If there were no changes in the cost of capital and investor supply and demand for risk did not change -- two completely unrealistic assumptions -- then the historic difference between the market portfolio and the risk-free rate could represent an equilibrium payment for risk. If the return was lower on stocks, then investors would move out of stocks and the return would increase. The problem is that the cost of capital changes as well as the supply and demand for risk capital.

Changes in the cost of capital produce capital gains or losses that are measured in the market index but do not have anything to do with the earning power of a company. For decades, declines in the cost of capital have led to increases in market indices.

In comparing the EMRP with credit spreads on risky bonds, it is not appropriate to assert that bonds have lower risk than equity. Bonds with a rating such as B or BB have downside risk but no upside potential other than the credit spread. Stocks have expected returns with both upside potential and downside risk with an expected return equal to the EMRP. The EMRP compensates for upside and downside volatility while the credit spread deals with only with downside risk.

Biases and Vested Interests in Measuring the Cost of Capital

I have testified on what is the appropriate cost of capital for utility companies since the 1980's and I recognize the controversy, biases, difficulties and uncertainties in the process. Cost of capital is used to set the rate of return and the prices of utility service and as such is one of the most important functions of not the most important function of a regulatory commission. Unfortunately, the cost of capital determination in regulatory agencies as well as business school programs and practiced in the finance profession is subject to important bias and confusion resulting from vested interests. Examples of biases, vested interests with important implications for understanding why cost of capital include:

1. In estimating the cost of capital for utility companies, regulatory agencies are under great pressure from financial interests not to deviate from norms in the industry. In the U.S., utility companies are clearly earning far more than the cost of capital as evidenced by price to book ratios well in excess of 1.0. Lowering rates or return to the cost of capital would cause heavy political pressure on the regulatory agencies from vast financial interests.

2. Country risk premiums applied to increasing returns for Pakistan and other countries allow foreign investors to extract higher profits from a country and allow local investors to increase prices. There is heavy financial pressure from vested interests to promote methods of analysis that result in high country risk premiums as justification for the increased tariffs and financial returns.

3. The notion that the premium earned on stocks relative to the nominal cost of government debt (the market risk premium) is greater than the real growth rate in an economy implies that investors as a group will continue to have their wealth expand relative to labour and other economic groups. The whole finance industry with natural interests to have stock values to increase at a faster rate than the overall economy has an incentive to argue for a high equity market risk premium (EMRP). The unrealistic and high market premiums have crept into all sorts of financial theory.

4. The risk of inflation rates changing from what is expected in the future is a very big when investing in long-term bonds that have a fixed nominal interest rate. Despite this fact that can easily make investing in long-term bonds riskier than investing in equities, the financial profession maintains that the equity is always riskier than debt which again justifies higher earned returns and higher tariffs.

Chapter 31
Overall Cost of Capital for Equity and Equity Market Risk Premium

The Real Problem with CAPM is Measurement of Inputs and Not Some Vague Proofs of Whether Beta Measures Risk

The CAPM is commonly used for estimating the cost of capital, but inputs for the model are subjective and the model has theoretical problems. The CAPM is difficult to implement and problematic not because of some academic study that questions whether beta is the only relevant measure of risk. The real problems with the CAPM comes about because of difficulties in measuring the risk-free rate, the beta and most of all the equity market premium.

The Capital Asset Pricing Model (CAPM). CAPM was first developed by William Sharpe and John Lintner for which William Sharpe was given the Nobel Prize in 1990. There are now big questions surrounding the CAPM both in terms of whether the model is even theoretically valid in measuring the cost of capital and in terms of the appropriate inputs to the model. But the CAPM is the most used model in computing the cost of capital. For example, a recent academic article stated: “The Capital Asset Pricing Model (CAPM) is the predominant model of risk and return taught by academics in universities and business schools in undergraduate, MBA, and executive education programs.

The CAPM is also widely used in practice, in particular, to estimate the cost of (equity) capital for a firm. However, it is well known that the CAPM does not fit the data.” While some academics suggest that the cost of capital can be estimated with more esoteric methods using the Arbitrage Pricing Model, the real alternative to the CAPM is deriving the cost of capital from valuations and estimates of cash flow. Given uncertainties associated with CAPM inputs it is frustrating to read academic studies that attempt to test the CAPM when the real problem is that the inputs are so difficult to measure.

A simple representation of the CAPM model is the following formula below. This formula is intuitive as you begin with a risk-free rate and add a risk premium as you would add a risk premium for a bond.

Cost of Equity = Risk Free Rate + Beta x Equity Market Risk Premium + Country Risk

As stated above, the only place where inflation comes into the picture is the risk-free rate. However, in using an implicit long-term inflation rate from a long-term bond, the inflation risk is introduced, and it is not appropriate to assume the long-term bond rate is risk free. The other data including the equity market risk premium and the country risk does not include inflation.

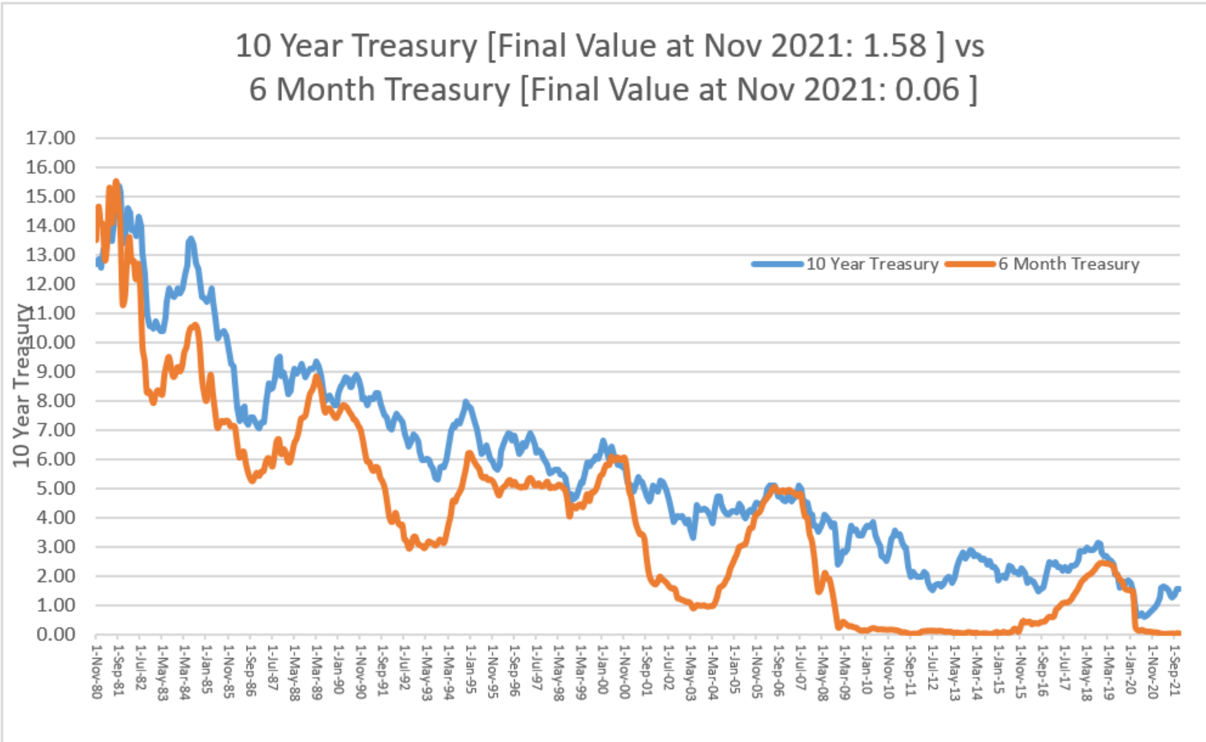
A 10-year Bond is not Risk Free

Estimation of the cost of capital for investments that directly or indirectly receive returns in USD begins with an estimate of the risk-free rate represented by USD long-term treasury bond yields. The treasury bond yield is the only element in the traditional CAPM analysis that includes expected inflation. In theory, the period of inflation implicit in the cost of capital should correspond to the duration of the cash flow.

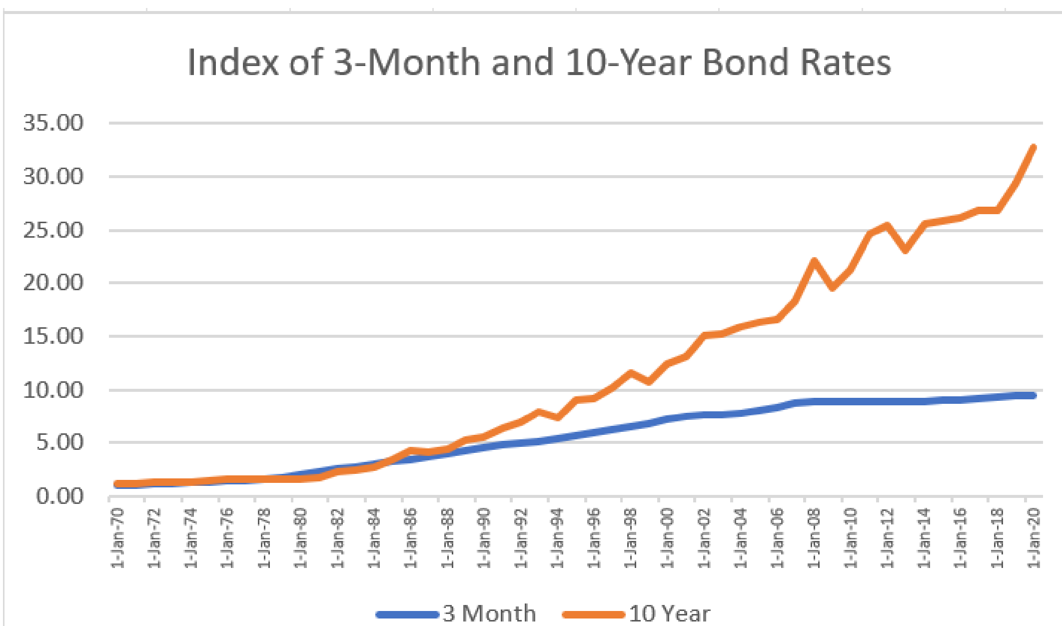
The 10-year bond yield overstates the risk-free rate because long-term bond yields include USD inflation risk. This is because when and investor buys a 10-year bond, the return is in fact not at all risk free in real terms even if the investor holds the bond to maturity. If the inflation rate turns out to be higher than the rate implied when the bond is purchased, the investor loses real purchasing power.

The real interest rate plus the expected inflation is represented by the nominal yield on treasury bonds. If the bonds are realised in USD, the purchasing power realised return is after USD inflation. There is some debate as to whether a short-term interest rate or a 5-year interest rate or a 10-year interest rate should be used in the cost of capital formula. Say investors in bonds are expecting different inflation rates over a 1-year, 5-year and 10-year period. The tenure of the bonds should reflect the USD inflation rates over the forecast period. To illustrate the relation between the PPA period, the inflation rate and the length of debt, assume a hypothetical two-year PPA agreement. If there are two zero coupon bonds, one with a maturity of one year and a second with a maturity of two years, the inflation rate will be hedged.

Treasury bonds using USD yields are generally used as a benchmark for a nominal risk-free rate that includes USD inflation and the real interest rate. Figure xxx shows recent trends in yields of USD treasury bonds with 5-year and 10-year maturities. The graph demonstrates rates were very low at the beginning of the pandemic and have increased. But the rates are below the Treasury Bond rates from 2019.



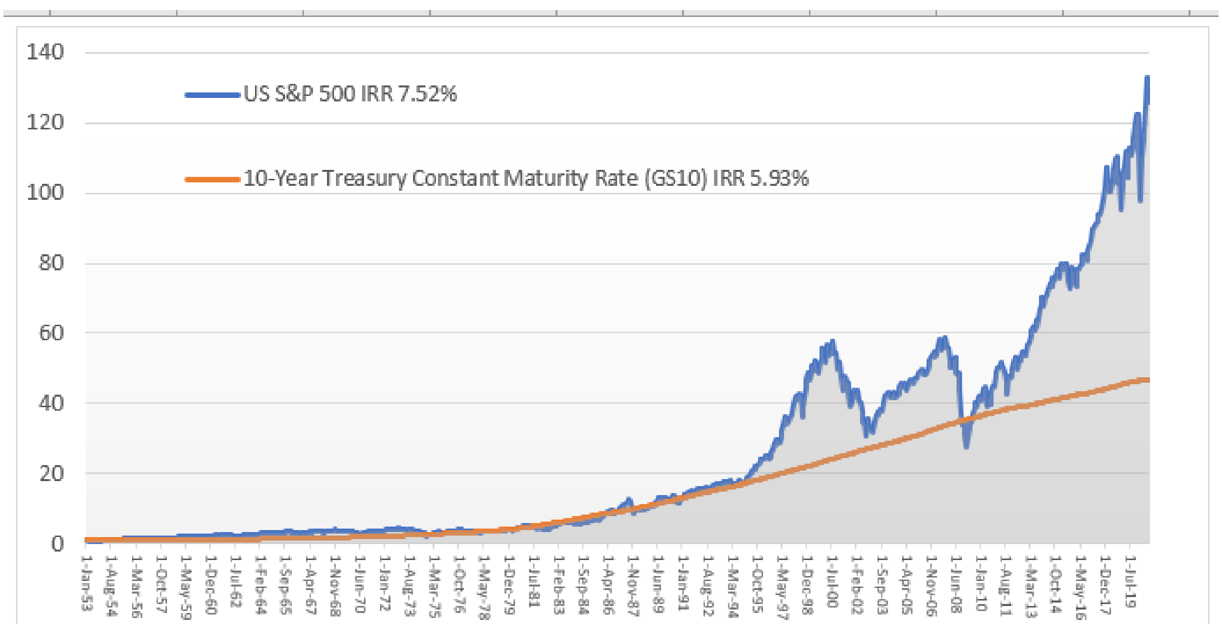
The variation in returns for long-term bonds as compared to short-term bonds is illustrated in Figure xxx. The source of this data is the Ibbotson data that was published by Damodoran.



Equity Market Risk Premium, Capital Gains and Income Distribution

The intuitive part of the CAPM is that the method begins with a risk-free rate and then adds a premium for risk. The risk premium (without country risk) consists of two parts, both of which are controversial. The first is an overall estimate of the return required for stocks in general called the equity market risk premium (EMRP). The second is the company specific factor measured with beta. The overall risk for investing in stocks relative to long-term risk-free bonds – the EMRP -- is a mysterious number that supposedly reflects risk and volatility of stocks in general relative to safe and stable bonds. The mysterious risk premium that drives much of the CAPM analysis is often the most controversial and difficult part of the CAPM is measuring the EMRP except for the country risk premium.

Figure xxx shows the measured equity market risk premium for the U.S. using earned returns on stocks versus the treasury bond rates since data is available for 10-year Treasury Bonds in 1953 which is easily available from the internet. The premium depends on the start date of the index and the end date, and the selected date produces a differential of 7.52% minus 5.93% or only 1.59%. This data is from the geometric average (the growth rate) and derived from S&P 500 data published by Yahoo Finance. The returns on the S&P 500 are somewhat lower than the Ibbotson returns used by Damodaran. The alternative stock indices will be documented in an appendix to be developed with NEPRA staff. In recent years, the graph shows a dramatic increase in the earned returns on equities relative to the 10-year bond yield which could lead to an incorrect assertion that the EMRP has increased. I elaborate on this below that the increase in the measured premium has more to do with the decline in the cost of capital as shown in Figure xxx than the return earned by stocks and greatly distorts any measure of EMRP from differential returns between stocks and bonds.



A related example is the idea that academics think they are doing something useful by taking surveys of CFO's as what kind of cost of capital assumptions that they use. These and other surveys mean almost nothing as finance executives have an implicit inventive to exaggerate the cost of capital estimates in their quest to achieve higher returns. Academics who study the cost of capital typically do not even mention the most realistic way to assess the cost of capital which is deriving the cost of capital from stock prices and expected cash flow.[64]

In Part VI I address problems with the CAPM, some of the most important of which have a lot more to do with measurement of variables than with the question of whether beta in theory is the one and only way to measure risk. For example, there have been many attempts to prove or disprove the CAPM where the question is whether the beta statistic is the only measure of risk that investors are paid for. The excerpt below is just one equation (of many) from a study where stock price changes after merger announcements was evaluated.[65] I suggest that you do not need to work through equations like this to understand problems with many of the foundations of finance.

$\gamma \times \mu$ for some $\gamma \in [0, 1]$, so that the cumulative abnormal return of the bidder's stock in response to the bid announcement is given by[24]

$$CAR_t^{Bidder} = \rho \times \frac{\pi \times FCF_{t+1}}{E_t^{Bidder}} \times \left[\frac{1}{r_f + (\gamma \times \beta_A + 1 - \gamma) \times \mu - g} - \frac{1}{r_f + \beta_A \times \mu - g} \right]. \qquad (15)$$

With respect, equations such as this do little to address the real world problems of whether beta should be mean reverted; whether daily, weekly or monthly stock prices should be used in computing beta; whether

As I wrote earlier, I am not an academic and I do not write articles and then submit them to be peer reviewed. But in the course of writing this book I have tested my ideas on the cost of capital and other subjects using a process which produces much more rigorous critique. I have testified for decades in contested litigation on valuation, cost of capital and project finance. This involves long written reports, rebuttal testimony, legal briefs and detailed information requests and is a painful and unrewarding thing to do. But I thought that if I

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[64] I find that one of the best sources for discussion of stock returns and the EMRP is a compilation of articles in
[65] DESSAINT, Olivier; OLIVIER, Jacques; OTTO, Clemens A.; and THESMAR, David. CAPM-based company (mis)valuations. (2018). 1-68. Research Collection Lee Kong Chian School of Business. Available at: https://ink.library.smu.edu.sg/lkcsb_research/5925

accepted another project that assessed the appropriate cost of equity capital for a boring and low-risk utility company that I could present the theory and practice of applying the CAPM in a more interesting way.

No excuse for this and not doing the data by yourself.

we start with the proposition that we want to measure return, then we see how limited accounting information is. Consider goodwill. Accountants decide that should be stuck on the balance sheet. If we measure return with goodwill, we get a lower number. Measure return with and without goodwill.

Imagine living your life as an accountant. You would get excited about things like the calculation of deferred taxes or LIFO versus FIFO inventory. You may be proud of calculating comprehensive income that uses the calculation of the fair value of derivatives in valuing assets. You may want even to go further and ponder how your numbers are used in the valuation of businesses. This more exciting activity is called financial statement analysis. In performing financial statement analysis, you could demonstrate how smart financial markets are because the stock price does not increase when a company changes from LIFO to FIFO accounting (please don't worry about this if you have not had a stimulating accounting class and studied this issue). You may even be able to sell a course with a fancy title suggesting that you have an innovative way to analyse accounting data to the Amsterdam Institute of Finance.

All of this excitement about accounting makes me think of Monty Python skits about accountants from the 1970's that were called "Stamp Out Chartered Accountancy".[66] In this chapter you will see that when you study numbers that are developed by arguably necessary bureaucratic accounting rules, all of the numbers created by accountants give a distorted picture of what we really want, namely the earned return earned on investment that drives value. The issue of measuring return is not with comprehensive income, deferred taxes or LIFO inventory that may be interesting to accountants. The real problem is that you cannot get a reasonable historic series of the return on investment from accounting data. You then cannot do the most basic thing in statistics, which is to use historic data in assessing the future. This problem with measurement of return arises from how the capital assets are accounted over time and how this affects the rate of return statistic. capital assets, depreciation, impairment, goodwill and understanding what investment is needed to earn EBITDA.

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[66] https://www.youtube.com/watch?v=NAOQH4xEyhM&t=10s

	Years ended		
	September 26, 2015	September 27, 2014	September 28, 2013
Net sales	233,715	182,795	170,910
Cost of sales	140,089	112,258	106,606
Gross margin	93,626	70,537	64,304
Operating expenses:			
Research and development	8,067	6,041	4,475
Selling, general and administrative	14,329	11,993	10,830
Total operating expenses	22,396	18,034	15,305
Operating income	71,230	52,503	48,999
Other income/(expense), net	1,285	980	1,156
Income before provision for income taxes	72,515	53,483	50,155
Provision for income taxes	19,121	13,973	13,118
Net income	53,394	39,510	37,037
Tax Rate	26.37%	26.13%	26.15%
NOPAT	52,448	38,786	36,183
Cash Income Net of Tax	946	724	854

Figure 1 - Apple Income Statement with Research and Development and Simple Layout

	September 26, 2015	September 27, 2014	Operating	Financing
ASSETS:				
Current assets:				
Cash and cash equivalents	21,120	13,844	1	
Short-term marketable securities	20,481	11,233		-1
Accounts receivable, less allowances of $82 and $86	16,849	17,460	1	
Inventories	2,349	2,111	1	
Deferred tax assets	5,546	4,318	1	
Vendor non-trade receivables	13,494	9,759	1	
Other current assets	9,539	9,806	1	
Total current assets	89,378	68,531		
Long-term marketable securities	164,065	130,162		-1
Property, plant and equipment, net	22,471	20,624	1	
Goodwill	5,116	4,616	1	
Acquired intangible assets, net	3,893	4,142	1	
Other assets	5,556	3,764	1	
Total assets	290,479	231,839		
LIABILITIES AND SHAREHOLDERS' EQUITY:				
Current liabilities:				
Accounts payable	35,490	30,196	-1	
Accrued expenses	25,181	18,453	-1	
Deferred revenue	8,940	8,491	-1	
Commercial paper	8,499	6,308		1
Current portion of long-term debt	2,500	0		1
Total current liabilities	80,610	63,448		
Deferred revenue, non-current	3,624	3,031	-1	
Long-term debt	53,463	28,987		1
Other non-current liabilities	33,427	24,826		1
Total liabilities	171,124	120,292		
Total shareholders' equity	119,355	111,547		1
Total liabilities and shareholders' equity	290,479	231,839		
Operating	32,698	30,273		
Financing	32,698	30,273		
Average Invested Capital	31,486			
ROIC	166.58%			
Cash net of Debt	86,657	81,274		
Average Cash Less Debt	83,966			
Cash Return	1.13%			

Figure 2 - Apple Return on Invested Capital Calculation with Separation of Non-Operating Assets and Operating Assets

To illustrate some issues associated with computing return on invested capital as well as other related valuation let's look at a balance sheet look at look at the figure below to either the cash on the balance sheet for Apple. This time I need to go back a few years to get the historic data long-term historical data can be done by going to the web. I went out Apple have this kind of cash on the balance sheet its earnings on the cash itself were very low but that doesn't reflect that earnings on the cash obviously does not work the overall earnings on the Core Business earnings and making iPhones and getting people to iTunes whatever they do. That cash on the balance sheet therefore if you want to evaluate the return on invested capital and this is a good example of where return on invested Capital. This time we are looking at why ROIC and not ROE. For Apple you would be investing in a lot of cash before and now you would just be investing in the pure company. would be very different than return on Equity you would that Surplus cash you would want to understand just how much cash we needed to run its business.

Now after the tax law changed Apple issue dividends and the cash went down dramatically. This fact that the cash went down dramatically would have increased ROE. If then if you would have left this on in the invested capital in the denominator of our return on invested capital I would have given you a lower denominator and a big increase in the in the return on invested capital of course that's what we don't want. the points and this illustrates the real point of the return on invested capital and that is to compute return from the core earnings that's what we're looking for that's why we harp on return on invested capital and not return on equity.

GE and Amazon Return on Invested Capital

These days you do not need a proprietary database from McKinsey to compute the return on invested capital. I have wasted a whole lot of time over the years in developing files that go to MarketWatch and Yahoo websites to grab data and compute things like the return on invested capital. As an old man I am amazed how you can grab data for companies in Pakistan and Nigeria as well as GE and Amazon. The good thing about getting your own data in excel is that you can make your own adjustments for things like goodwill and non-operating assets. Figure xxx illustrates the Return on Investment for Amazon and GE from my totally non-proprietary database. How can get the data instead of proprietary database with goodwill adjustment and no idea what is there.

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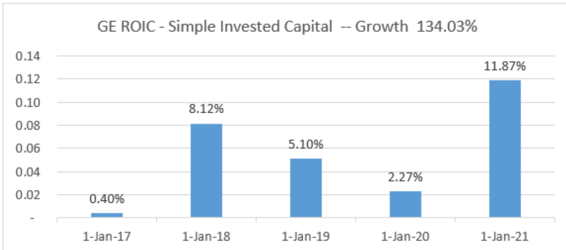

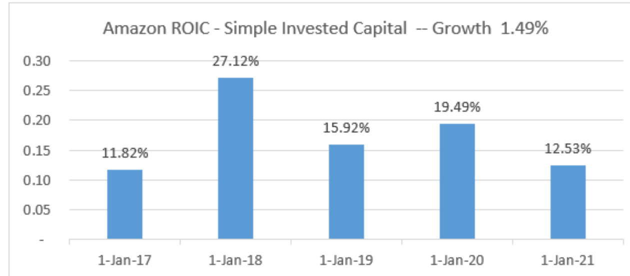

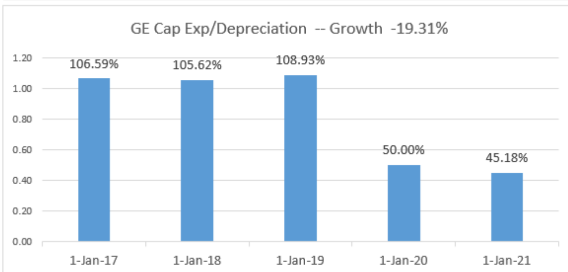

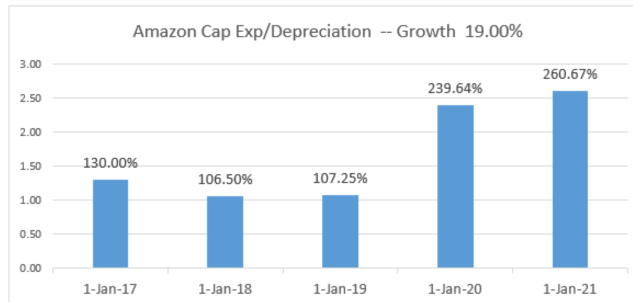

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		2014	2015	2016	2017	2018	2019	2020	2021
Historic	2016	TRUE	TRUE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
Terminal Period		FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
Valuation Period	2017	FALSE	FALSE	FALSE	TRUE	FALSE	FALSE	FALSE	FALSE
Financial Statistics									
Credit Line		4,580.00	4,580.00	4,580.00	4,580.00	4,580.00	4,580.00	4,580.00	4,580.00
Closing Short-term Debt		3,020.00	3,880.00	4,580.00	5,022.59	5,214.06	4,915.47	4,452.42	3,911.55
Credit Line Exceeded		FALSE	FALSE	FALSE	TRUE	TRUE	TRUE	FALSE	FALSE
Cash to Sales		4.41%	3.22%	3.27%					
Operating Cash		190.1	233.8	279.0	345.9	401.3	433.4	459.4	486.9
Surplus Cash		89.6	17.5	25.3	0.0	0.0	0.0	0.0	0.0
Return on Invested Capital									
EBIT		623.55	684.35	853.62	1,231.45	1,428.48	1,525.42	1,598.57	1,694.49
NOPAT		405.31	444.83	554.85	800.44	928.51	991.52	1,039.07	1,101.42
Working Capital		2,287.6	2,876.1	3,403.3	4,185.5	4,855.2	5,243.6	5,558.3	5,891.7
Plus Net PPE		3,874.0	4,293.3	4,654.1	4,847.8	4,938.8	4,875.2	4,789.5	4,698.6
Less Deferred Taxes		351.9	360.7	406.2	539.1	603.0	636.2	669.6	713.9
Add: Operating		190.1	233.8	279.0	345.9	401.3	433.4	459.4	486.9
Total		5,999.8	7,042.6	7,930.2	8,840.2	9,592.3	9,916.1	10,137.5	10,363.4
Debt		5,150.0	5,860.0	6,410.0	6,702.6	6,744.1	6,295.5	5,682.4	4,991.5
Equity		939.4	1,200.1	1,545.5	2,137.6	2,848.3	3,620.6	4,455.1	5,371.8
Less: Surplus		89.6	17.5	25.3	0.0	0.0	0.0	0.0	0.0
Total		5,999.8	7,042.6	7,930.2	8,840.2	9,592.3	9,916.1	10,137.5	10,363.4
Average Invested Capital		5,999.84	6,521.24	7,486.41	8,385.18	9,216.25	9,754.20	10,026.78	10,250.43
14 ROIC		6.76%	6.82%	7.41%	9.55%	10.07%	10.17%	10.36%	10.75%

Figure 3 - Return on Invested Capital Calculation for Amazon with Balance Sheet Reconciliation

The historic ROIC is also important for companies that are expected to experience changes in the rate of return. If you are evaluating a start-up company, you may want to assess the issue of whether the company can really experience very high monopoly profits over the long-run or whether it will be subject to competitive pressure. If the company is currently earning a high return, you need to assess what will be a reasonable industry return and how long will it take for the company to realize that return. Of course ,these are extremely difficult questions at the heart of valuation, and I am not suggesting any rule to or any statistical method to evaluate the long-term ROIC. But I do emphasize that if you want to make a presentation of the value of a company, you should first consider the rate of return without biases and you should also make an explicit presentation of your ROIC assumptions relative to historic levels.

If you are reviewing a company that is expected to change its return on capital can think of ROIC as you would think about other statistical data. If you want to ultimately make a projection of the time series, the place to start is to evaluate what happened in the past and then make some adjustments (such as correlation to some other variable). You can then add some judgment using economic or behavioural analysis to adjust your forecast. When you have a time series statistic like the oil prices, or GDP per capita you could examine reasons for underlying trends; evaluate mean reversion and cyclical trends; relate the statistic to other variables; gauge forecasts of the statistic relative to historic data and so forth. I suggest that this is what you are attempting to do in valuation analysis through predicting trends in ROIC. For example, if you believe a company will move to Box 2 -- the “throwing money away” box – from

Box 1 because of surplus capacity with long-term investments, then value quantification will depend on how far the ROIC falls and for how long.

It sounds like this other than trying to explain some formula now let's get back so what do we do with Amazon and GE. The graph below the tour the table below shows the Amazon return on invested capital assume that all of its cash on the balance sheet is Surplus cash an alternative case when we assume none of the cash on the balance sheet. is so close cash and. The point of this is to illustrate that just this assumption about gives you a very different run and this is without even scratching the surface the other thing we and it's relates to uncertainty about Surplus cash is we have to decide for example do with deferred taxes.

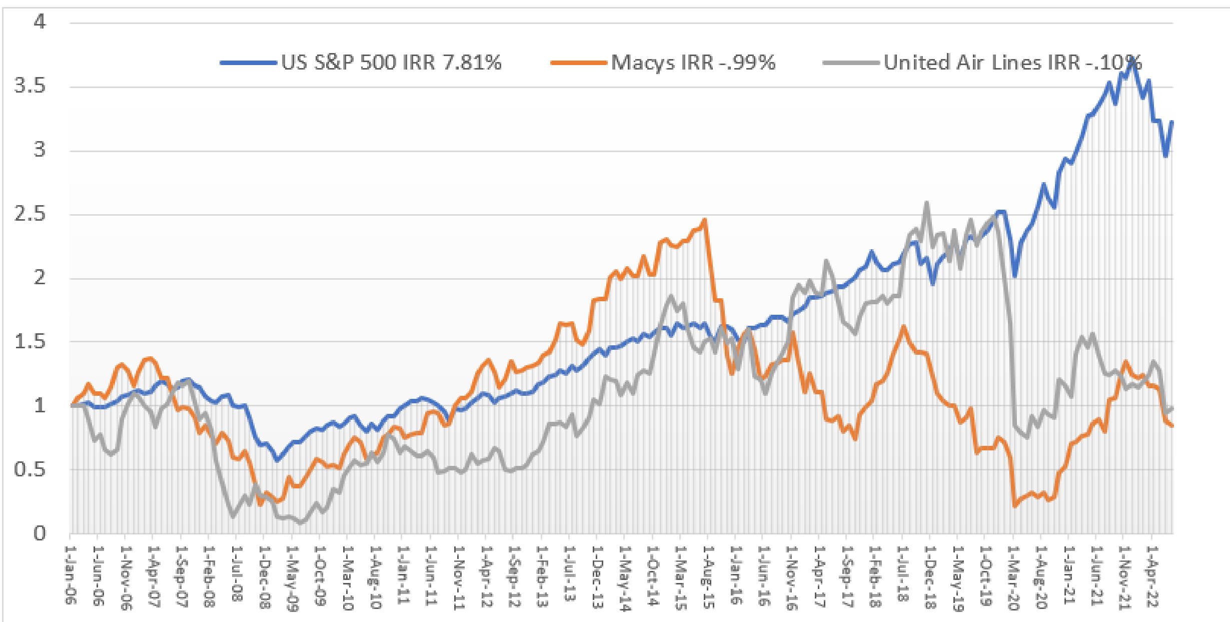

Figure 4 – Macy's Adjusted Stock Price and COVID

Macy's, Inc.
Return on Invested Capital (ROIC)
($ in millions)

	Trailing Four Quarters February 1, 2020		Trailing Four Quarters February 2, 2019
Most Comparable GAAP Ratio:			
Net Income	$ 564		$ 1,098
Property and equipment - net	$ 6,633		$ 6,637
	8.5%		16.5%
Non-GAAP Ratio:			
Net Income	$ 564		$ 1,098
Add back interest expense, net	185		236
Add back loss on early retirement of debt	30		33
Add back federal, state and local tax expense	164		322
Earnings before interest and taxes (EBIT)	$ 943		$ 1,689
Add back restructuring, impairments, store closing and other costs	354		136
Add back settlement charges	58		88
Add back depreciation and amortization	981		962
Add back benefit plan income, net	(31)	a	
Add back rent expense			
Real estate	335		327
Personal property	8		9
Deferred rent amortization	-		14
EBIT, excluding impact of restructuring, impairments, store closing and other costs, settlement charges, depreciation and amortization, benefit plan income, net and rent expense	$ 2,648		$ 3,225
Property and equipment - net	$ 6,628		$ 6,655
Add back accumulated depreciation and amortization	4,438		4,553
Add capitalized value of non-capitalized leases	-		2,800
Add capitalized value of variable rent	114		-
Add lease right of use assets	2,241		-
Add (deduct) selected balance sheet components:			
Receivables	265		273
Merchandise inventories	5,743		5,664
Prepaid expenses and other current assets	551	b	608
Other assets	675	c	803
Merchandise accounts payable	(2,183)		(2,219)
Accounts payable and accrued liabilities	(2,609)	d	(2,917)
Other long-term liabilities	(371)	e	-
Total Average Invested Capital	$ 15,492		$ 16,220
	17.1%		19.9%

Management believes that return on invested capital (ROIC), as defined as EBIT, excluding the impact of restructuring, impairments, store closing and other costs and settlement charges, depreciation and amortization and rent expense, as a percentage to its average invested capital is a useful measure in evaluating how efficiently the Company employs its capital. As computed above, the total average invested capital is comprised of an annual two-point (i.e., end of the previous year and the immediately preceding year) average of gross property and equipment, a capitalized value of non-capitalized leases equal to periodic annual reported net rent expense multiplied by a factor of eight or the right of use assets and a four-point (i.e., end of each quarter within the period presented) average of other selected assets and liabilities. The calculation of the capitalized value of non-capitalized leases is consistent with industry and credit rating agency practice and the specified assets are subject to a four-point average to compensate for seasonal fluctuations.

Figure 5 – Excerpt from Macy's Financial Presentations Showing that the Company Supposedly Earned 17.1% ROIC in 2020, the COVID Year

The stock price trends in Figure xxx demonstrate, not surprisingly, that Macy's has had problems that arose before COVID from competition from on-line sales. The return has been below the overall market and the company's adjusted stock price has not returned to pre-COVID levels. But Figure yyy suggests that Macy's has a very high return on invested capital. Figure zzz (from another tool in edbodmer.com – footnote) demonstrates the return on invested capital computed in a simpler way. The whole idea of this little discussion is the real world problems in computing return on invested capital. If you really believed that Macy's was earning a very good return, you would expect the company to try to grow and to have a very high price to book ratio. But if you look at some details, you can get hints about why this statistic is so bad. Specifically the comment "Management believes that return on invested capital (ROIC), as defined as EBIT, excluding the impact of restructuring, impairments, store closing and other costs and settlement charges, depreciation and amortization and rent expense, as a percentage to its average invested capital is a useful measure in evaluating how efficiently the Company employs its capital" you can see that ROIC is affected by restructuring, impairment and other factors that make the denominator of the ratio lower. These factors as well as the fact that the company has not been replacing its assets render the statistic meaningless.

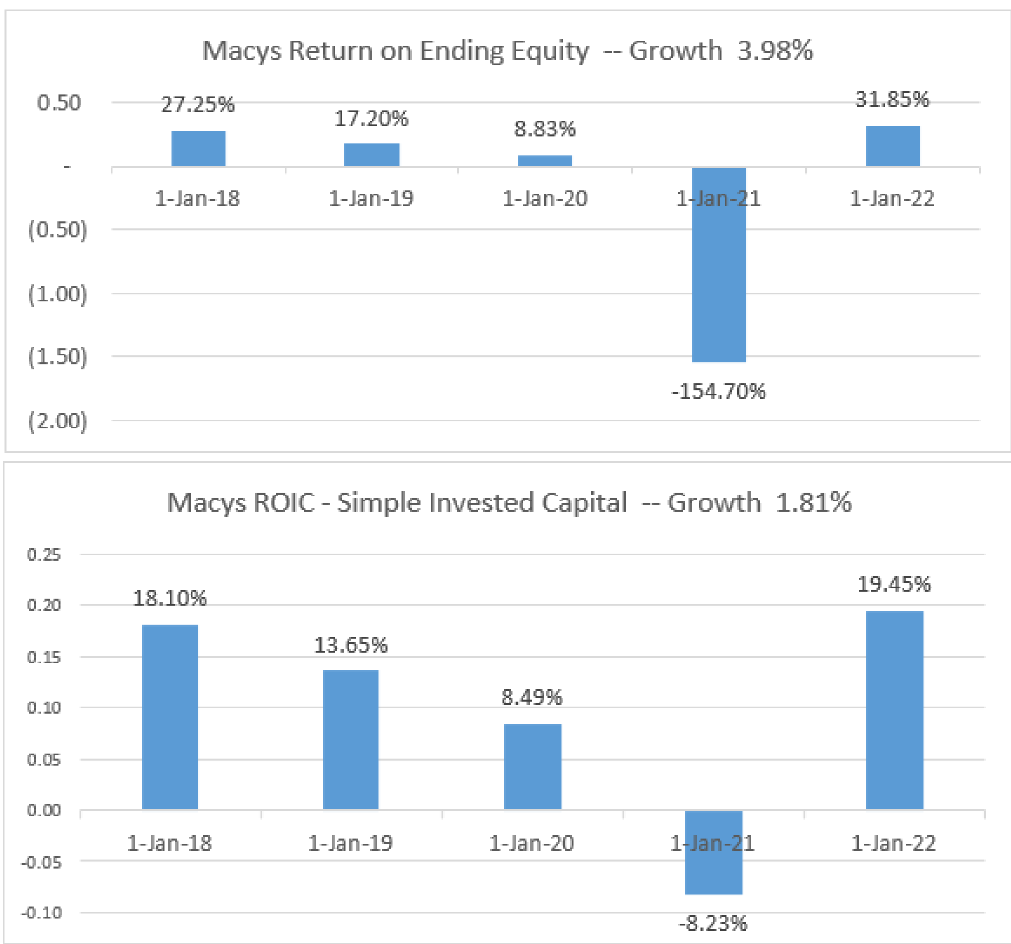

Figure 6 – Macy's Return on Equity and Return on Invested Capital After Write-off Demonstrating Rebound After Negative Returns

If you think that there is some kind of standard formula, or an exact formula to Computing the return on invested Capital, you would be wrong. This is why the next section the next section let's talk about let's talk about the who just a minute continuing there is no standard for me.

By scanning the graphs above you can see that Macy's had a "kitchen sink" quarter in2020 with the negative 119% return on equity. After the denominator of the return on equity is reduced – net income/equity – the future return statistics are much higher. If you think this new return with the lower denominator can be any kind of indicator of future return statistics, good luck to you. Financial statement analysis should be about using financial statement data to predict the future. Any suggestion that this fundamental aspect of financial analysis can be resolved is gone. Current and historic return data now has absolutely nothing to do with what kind of return can be earned on new assets. As the rate of return on investment drives value along with growth, we have lost the ability to use historic data in making projections and we have almost no ability to judge what the return on new assets could be. Further, if you would go to the database tool and select other companies in the Dow 30 index, you would find that most have some kind of kitchen sink quarter or other impairment adjustment in the balance sheet that limits any potential for using the balance sheet to predict returns.

Now let's say you want to make a forecast of the net cash flow for Macy's. You could just make a forecast of EBITDA (or EBITDA less working capital changes). You would have to then assess the potential for growth in EBITDA and use this as the starting point for you valuation analysis. But as I have tried to point out, this growth depends directly or indirectly on making capital or other investments (inventory, research, software, education) of some sort. If you had an idea of the return the company could earn on new investments, you could then back-out the investment number. But with the kitchen sink quarter in 2020, the return statistics are now meaningless. We cannot look backwards and get any idea of the potential for returns – you have no historic data to use as a basis for a forecast.

Alternatively, when making a valuation you could perhaps just allow EBITDA to diminish as the stores age (like Sears or Montgomery Wards) and not make new investments. But then you better keep the EBITDA diminution consistent with the capital expenditure assumption. When making your terminal value analysis you would still have to consider capital expenditures. Maybe you could assume that capital expenditures are consistent with historic growth but the real issue is that you do not have a real basis for making a forecast. In contrast, imagine if you had a good idea of what the return on investment really is. You could then use the return in computing the value formula Value = Net Operating Profit x (1-ROIC/Growth)/(WACC-Growth). Perhaps the return is below a reasonable estimate of the cost of capital or the growth is slow.

GE and Amazon Return on Invested Capital

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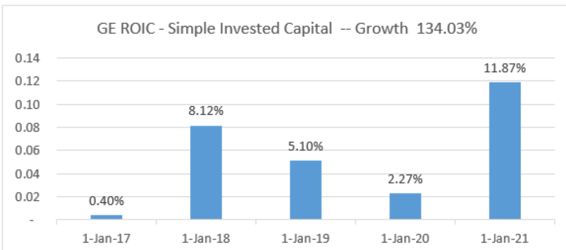

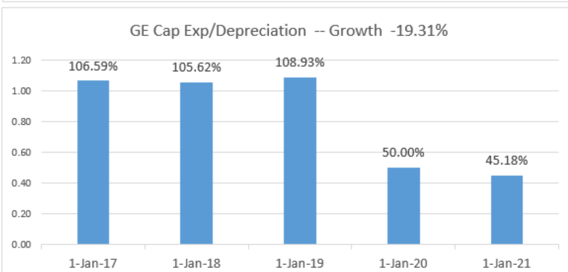

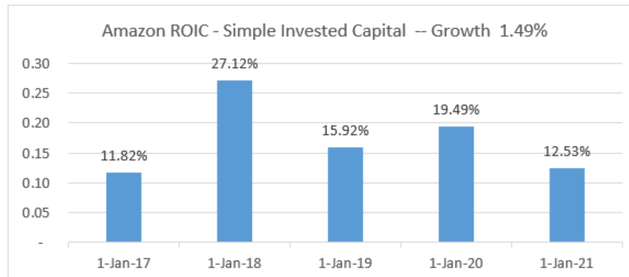

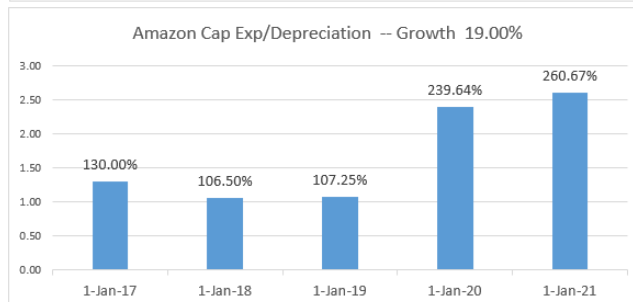

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		2014	2015	2016	2017	2018	2019	2020	2021
Historic	2016	TRUE	TRUE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
Terminal Period		FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
Valuation Period	2017	FALSE	FALSE	FALSE	TRUE	FALSE	FALSE	FALSE	FALSE
Financial Statistics									
Credit Line		4,580.00	4,580.00	4,580.00	4,580.00	4,580.00	4,580.00	4,580.00	4,580.00
Closing Short-term Debt		3,020.00	3,880.00	4,580.00	5,022.59	5,214.06	4,915.47	4,452.42	3,911.55
Credit Line Exceeded		FALSE	FALSE	FALSE	TRUE	TRUE	TRUE	FALSE	FALSE
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Surplus Cash		89.6	17.5	25.3	0.0	0.0	0.0	0.0	0.0
Return on Invested Capital									
EBIT		623.55	684.35	853.62	1,231.45	1,428.48	1,525.42	1,598.57	1,694.49
NOPAT		405.31	444.83	554.85	800.44	928.51	991.52	1,039.07	1,101.42
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Plus Net PPE		3,874.0	4,293.3	4,654.1	4,847.8	4,938.8	4,875.2	4,789.5	4,698.6
Less Deferred Taxes		351.9	360.7	406.2	539.1	603.0	636.2	669.6	713.9
Add: Operating		190.1	233.8	279.0	345.9	401.3	433.4	459.4	486.9
Total		5,999.8	7,042.6	7,930.2	8,840.2	9,592.3	9,916.1	10,137.5	10,363.4
Debt		5,150.0	5,860.0	6,410.0	6,702.6	6,744.1	6,295.5	5,682.4	4,991.5
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Less: Surplus		89.6	17.5	25.3	0.0	0.0	0.0	0.0	0.0
Total		5,999.8	7,042.6	7,930.2	8,840.2	9,592.3	9,916.1	10,137.5	10,363.4
Average Invested Capital		5,999.84	6,521.24	7,486.41	8,385.18	9,216.25	9,754.20	10,026.78	10,250.43
14 ROIC		6.76%	6.82%	7.41%	9.55%	10.07%	10.17%	10.36%	10.75%

Figure 7 - Return on Invested Capital Calculation for Amazon with Balance Sheet Reconciliation

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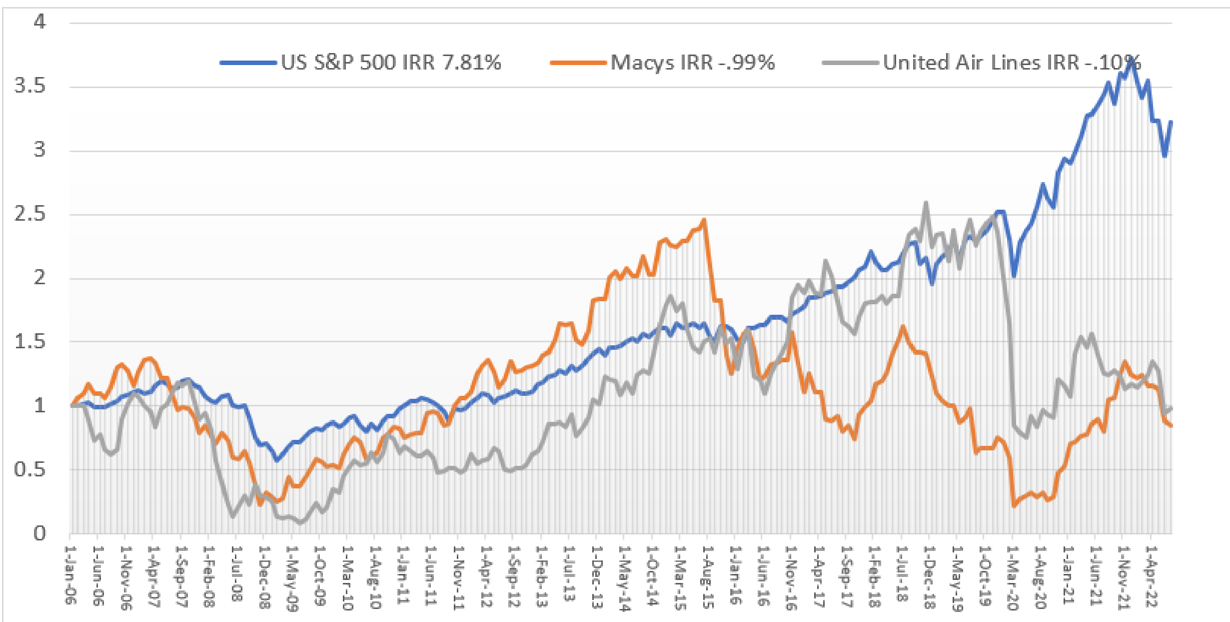

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Add back federal, state and local tax expense	164		322
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Add back restructuring, impairments, store closing and other costs	354		136
Add back settlement charges	58		88
Add back depreciation and amortization	981		962
Add back benefit plan income, net	(31)	a	
Add back rent expense			
Real estate	335		327
Personal property	8		9
Deferred rent amortization	-		14
EBIT, excluding impact of restructuring, impairments, store closing and other costs, settlement charges, depreciation and amortization, benefit plan income, net and rent expense	$ 2,648		$ 3,225
Property and equipment - net	$ 6,628		$ 6,655
Add back accumulated depreciation and amortization	4,438		4,553
Add capitalized value of non-capitalized leases	-		2,800
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Add (deduct) selected balance sheet components:			
Receivables	265		273
Merchandise inventories	5,743		5,664
Prepaid expenses and other current assets	551	b	608
Other assets	675	c	803
Merchandise accounts payable	(2,183)		(2,219)
Accounts payable and accrued liabilities	(2,609)	d	(2,917)
Other long-term liabilities	(371)	e	-
Total Average Invested Capital	$ 15,492		$ 16,220
	17.1%		19.9%

Management believes that return on invested capital (ROIC), as defined as EBIT, excluding the impact of restructuring, impairments, store closing and other costs and settlement charges, depreciation and amortization and rent expense, as a percentage to its average invested capital is a useful measure in evaluating how efficiently the Company employs its capital. As computed above, the total average invested capital is comprised of an annual two-point (i.e., end of the previous year and the immediately preceding year) average of gross property and equipment, a capitalized value of non-capitalized leases equal to periodic annual reported net rent expense multiplied by a factor of eight or the right of use assets and a four-point (i.e., end of each quarter within the period presented) average of other selected assets and liabilities. The calculation of the capitalized value of non-capitalized leases is consistent with industry and credit rating agency practice and the specified assets are subject to a four-point average to compensate for seasonal fluctuations.

Figure 9 – Excerpt from Macy's Financial Presentations Showing that the Company Supposedly Earned 17.1% ROIC in 2020, the COVID Year

The stock price trends in Figure xxx demonstrate, not surprisingly, that Macy's has had problems that arose before COVID from competition from on-line sales. The return has been below the overall market and the company's adjusted stock price has not returned to pre-COVID levels. But Figure yyy suggests that Macy's has a very high return on invested capital. Figure zzz (from another tool in edbodmer.com – footnote) demonstrates the return on invested capital computed in a simpler way. The whole idea of this little discussion is the real world problems in computing return on invested capital. If you really believed that Macy's was earning a very good return, you would expect the company to try to grow and to have a very high price to book ratio. But if you look at some details, you can get hints about why this statistic is so bad. Specifically the comment "Management believes that return on invested capital (ROIC), as defined as EBIT, excluding the impact of restructuring, impairments, store closing and other costs and settlement charges, depreciation and amortization and rent expense, as a percentage to its average invested capital is a useful measure in evaluating how efficiently the Company employs its capital" you can see that ROIC is affected by restructuring, impairment and other factors that make the denominator of the ratio lower. These factors as well as the fact that the company has not been replacing its assets render the statistic meaningless.

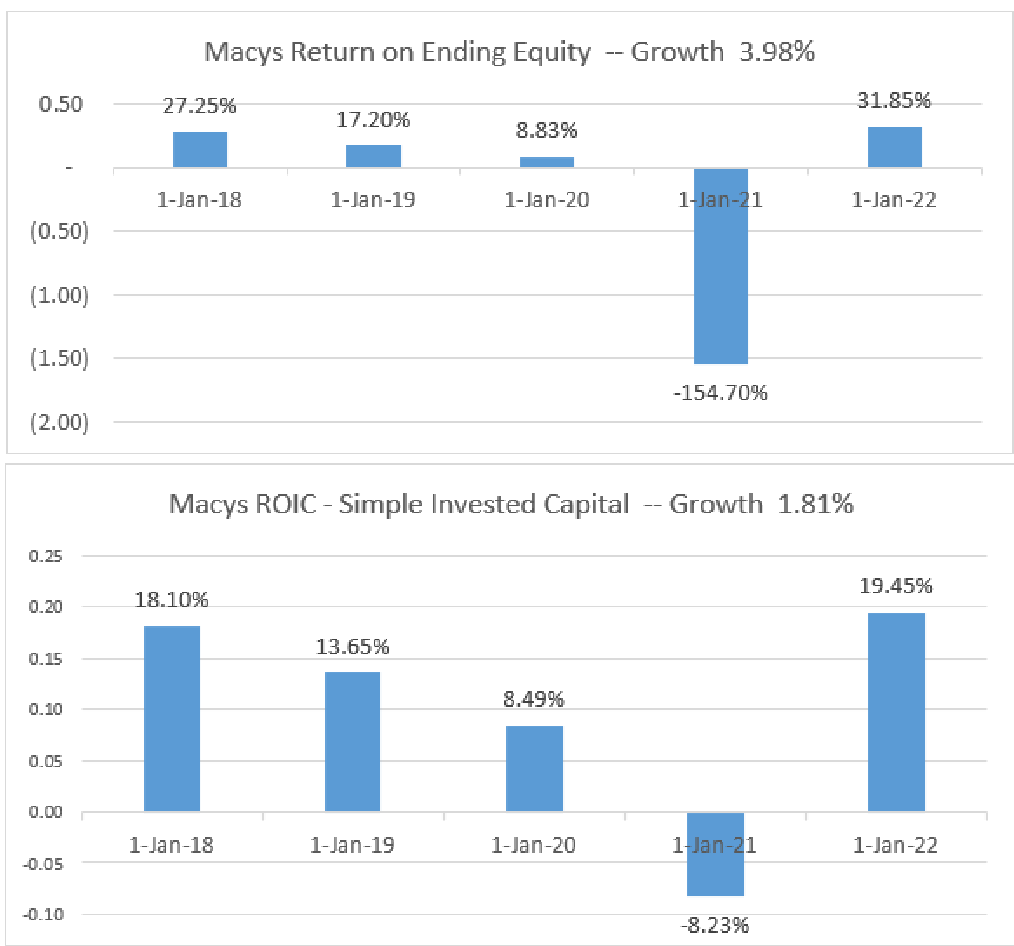


Figure 10 – Macy's Return on Equity and Return on Invested Capital After Write-off Demonstrating Rebound After Negative Returns

If you think that there is some kind of standard formula, or an exact formula to Computing the return on invested Capital, you would be wrong. This is why the next section the next section let's talk about let's talk about the who just a minute continuing there is no standard for me.

By scanning the graphs above you can see that Macy's had a "kitchen sink" quarter in2020 with the negative 119% return on equity. After the denominator of the return on equity is reduced – net income/equity – the future return statistics are much higher. If you think this new return with the lower denominator can be any kind of indicator of future return statistics, good luck to you. Financial statement analysis should be about using financial statement data to predict the future. Any suggestion that this fundamental aspect of financial analysis can be resolved is gone. Current and historic return data now has absolutely nothing to do with what kind of return can be earned on new assets. As the rate of return on investment drives value along with growth, we have lost the ability to use historic data in making projections and we have almost no ability to judge what the return on new assets could be. Further, if you would go to the database tool and select other companies in the Dow 30 index, you would find that most have some kind of kitchen sink quarter or other impairment adjustment in the balance sheet that limits any potential for using the balance sheet to predict returns.

Now let's say you want to make a forecast of the net cash flow for Macy's. You could just make a forecast of EBITDA (or EBITDA less working capital changes). You would have to then assess the potential for growth in EBITDA and use this as the starting point for you valuation analysis. But as I have tried to point out, this growth depends directly or indirectly on making capital or other investments (inventory, research, software, education) of some sort. If you had an idea of the return the company could earn on new investments, you could then back-out the investment number. But with the kitchen sink quarter in 2020, the return statistics are now meaningless. We cannot look backwards and get any idea of the potential for returns – you have no historic data to use as a basis for a forecast.

Alternatively, when making a valuation you could perhaps just allow EBITDA to diminish as the stores age (like Sears or Montgomery Wards) and not make new investments. But then you better keep the EBITDA diminution consistent with the capital expenditure assumption. When making your terminal value analysis you would still have to consider capital expenditures. Maybe you could assume that capital expenditures are consistent with historic growth but the real issue is that you do not have a real basis for making a forecast. In contrast, imagine if you had a good idea of what the return on investment really is. You could then use the return in computing the value formula Value = Net Operating Profit x (1-ROIC/Growth)/(WACC-Growth). Perhaps the return is below a reasonable estimate of the cost of capital or the growth is slow.

Parked – Chapter 2

Attacking HBS cases like this would have been fun, but I found that discussing all of the biases and mistakes in the analysis it would be difficult to keep focused and on track. I also thought about working through the McKinsey book chapter by chapter and showing where conventional ideas about finance are wrong. Instead, I have tried to keep the book more structured. After introducing how bad financial theory and practice has negative environmental impacts, I begin with some general corporate finance ideas in Chapter 4. I then move to project finance as a much more precise way to evaluate risk and return; towards the end of the book, I have written my comments about measuring the cost of capital. I do refer to selected cases that demonstrate how the ideas work in practise, but I do not work through the cases in a lot of detail.

But as with other finance sources such as the McKinsey valuation book, articles written by Dr Pietro Veronesi and material published by Dr Damodaran on his website (a few of my favourite targets in this book), biases and problems in finance become apparent. I hope you do not think I am taking pot shots like people do in fighting on social networks. Rather, I use these and other materials to make a reasoned questioning of key aspects of finance that are ultimately used to make essential investments.

Problems From Trying to Use Simplistic Valuation Formulas

At the opposite end of the spectrum from the seemingly sophisticated equations and confusing language, the people who practice finance often apply simplistic formulas, arbitrary benchmarks and crude use of financial statement information which can be an even bigger problem. One example of this simplicity is use of the constant growth formula below for terminal value without adjustments for the required associated investment (capital expenditures) to support the growth.

Terminal Value = Terminal Period Cash Flow x (1+Terminal Growth)/(WACC – Terminal Growth)

It does not take much deep thought to understand the very general idea that without making investments it is impossible to grow (this applies to a lot more than money and business). But the terminal growth formula applied to the terminal period cash flow does not make this fundamental connection because investments are buried in the terminal period cash flow, and it is not clear how much investment is made to support the terminal growth. It is shocking that people still use this formula without thinking about the level of returns that a business entity can earn in the long run.

A second example of simplistic analysis in finance is the way performance and prospective value is (or is not) assessed with calculation of return on investment (net profit after depreciation and taxes divided by the level of investment). If you continue reading this book you will book you will see that I harp on the fairly obvious point that value depends on estimating the prospective rate of return. It is not revolutionary to suggest that in evaluating the future rate of return, you would like to understand something about the historic return as a starting point -- this is no different than starting with history to make assessments of what can happen to other things in the future, ranging from the GDP per capita of a country, to divorce rates, to the profitability of an MBA degree, to the price of oil. But you will see that because of distortions from straight line depreciation, impairment write-offs and many other accounting conventions, finding the true economic rate of return is not possible using conventional financial statement analysis.

Discuss trying to boil down risk into a single statistic, the beta. Don't have to be so precise and can look around at the data. One of my points is on the ROE and the price to book ratio to measure the cost of capital.

PARKED – Chapter 4

Problem is that the horrible effort for making financial models is not used by academics or consultants like McKinsey (where you put together the models with financial theory. Maybe you do have big models but not step back and do things like economic depreciation, alternatives to IRR like risk premium measurement or consolidation to make project portfolio into a corporation). Also do not present financial statistics with returns including dividends or present the price to book ratio next door to the return on equity.

Chapter 4

Use of Analytical Tools to Demonstrate Problems in Finance and Valuation

Use of Financial Models in Demonstrating Problems in Finance Theory

The idea of this book is to prove various ideas about finance in an objective manner (rather than spouting off as I have done so far). I will demonstrate how my ideas work with financial models together with publicly available data to illustrate the biases and flaws using current methods. In this chapter I summarize some of key the models and analysis tools, describing how they are used later in the book. I also document where you can get access to the models and run the models with different inputs and assumptions. By presenting a quick summary of the models in this chapter, you can get a preview of the key themes of the rest of the book.

Some of the analytical techniques involve a lot of data collection and interpretation such as the tool to the second model is evaluation of corporate return and valuation statistics that is used to question cost of capital, valuation multiples and performance measurement; a third model is a project finance model that is applied to demonstrate resolution of biases from applying the IRR statistic, computation of economic depreciation and changing value over the life of a project from changes in risk; the fourth model includes reconciliation of project valuation with corporate valuation and is used to demonstrate upsides, nuanced returns calculations and performance evaluation of single assets; the fifth is a model that reconciles different valuation ratios with return, growth, cost of capital and other parameters.

Initial Model – Growth Rates (IRRs) on Different Stocks and Other Investments Compared to Economic Data

An initial analysis tool evaluates stock returns relative to economic variables in terms of the IRR and addresses some foundational issues such as what is the definition of an investment and what is the definition of finance. This tool deals with the question of why the IRR statistica has become so prominent in financial analysis. IRR is the central variable discussed by public policy, private equity, M&A and even indirectly by television commentaries. This is analysis is used to demonstrate that the IRR measures the growth rate in cash flow and can be compared with growth rates in economic variables leading to consideration of basic issues around economic growth. The analysis tool delves into the question of what constitutes a required rate of return and the cost of capital. The analysis introduces some of the difficulties in computing growth rates and rates of return when cash flows occur in intermediate periods.

The analysis of stock prices and economic variables is also used in the discussion of ambiguities in measuring beta such as the stunning practice of assuming arbitrary mean reversion of beta. Similarly, the data is used so that you can evaluate long-term premiums earned in different markets relative to government bonds. The tool is available on the website associated with this book.[67]

Financial Models of Single Investments and Project Finance Models in Illustrating the Importance of Distortions in Investments Created by Finance Theory

Introduction to case study. Capital Intensity and distortions of investment decisions. Finance used in public policy. Model is back-up for discussion of why a solar project in Chad had a price that is an order of magnitude seven times the price in Saudi Arabia (with similar sunlight). Model is used to demonstrate the distortions created in capital assets from accounting with straight line depreciation. Acknowledge that the book has a lot of project finance as project finance is an instrument that can be used to derive cost of capital and at the same time promote economic efficiency.

Project finance as way to understand all valuations as a project is a building block. How financiers define risk and value with detailed assessment of risk and importance of long-term investments. Importance of mean reversion in long-term investments.

Financial Analysis of Corporations as Valuation of a Corporation as a Consolidation of a Portfolio of Projects

In describing how investors can earn a growth rate which can also be termed the return on their investment, I cover both corporate and project finance. While project finance can be defined to cover detailed debt structuring elements, the general definition to begin is that project finance is a single investment (one Costa Coffee shop or one shoe factory or one solar

[67] The way the tool can be used to gather current data and to get different stock prices is documented https://edbodmer.com/database-analysis-vba/ where you can find videos on how to use the analysis tool.

power farm) whilst a corporation is the sum of the projects. To introduce the relationship between project and corporate finance I use the example of the value of a family. The value depends on the success of individuals as well as the value that has been built up from history. I do not get into issues of inheritance and issues of advantage. I insist that to understand issues of the value of the corporation – the increase in the value measured with compound growth -- need to understand the source of value. Need to connect the two areas of finance.

The biggest item of value in a corporate DCF analysis is the terminal value as a corporation is assumed to last indefinitely (forever).

- In the long-term future, all of the management will be replaced
- In the long-term future, all of the current products will be obsolete
- In the long-term, all existing assets (except land) will be retired
- Value in the long-term comes from the ability of management to earn returns above the cost of capital; why should we assume management can continually earn high returns on new projects

A really big problem in corporation is what WACC to use in valuation

- Assuming a constant WACC is crazy
- Everybody has different opinions about what the equity risk premium and the beta are, leading to dramatic differences in WACC
- There continue to be problems with valuing the tax shield from interest in WACC and debates about un-levering and re-levering Beta and adjusted net present value

Another big problem in corporate finance is interpreting EPS, ROE and ROIC along with P/E, EV/EBITDA and Price to Book Ratio

- When companies are growing fast, the ROE and ROIC will be lower than the equity or project IRR while when companies are not investing the reverse will be true
- The value impacts of this can be resolved with project finance analysis.

Value change is from what the individuals do. You can look at financial statements of the entire family and try to decipher. But the value comes from the individuals (maybe one person will be really successful or maybe another will be a disaster or maybe they will continue what their parents do). When looking at the value of the family and it is the same with the value of a corporation, the age of the assets (corporation) or the people (family) will have an effect on the value of the corporation. If the family is made up of teenagers who get into trouble and will have a big cost of education, the financial statements of the family will appear bad. It all sounds silly, but the fundamental difference of valuing a single asset versus a portfolio of assets in a corporation is a central theme of the book namely that you should start with the individual asset and understand the individual asset before you consolidate the assets to a corporation.

Value of individuals are measured by IRR or NPV. In project finance exclusively measure the value of each project (person) with the IRR.

Classic definition, which is correct, is that the IRR is the discount rate that makes the NPV zero. Probably comes from the teaching of NPV and the fact that you could not compute with your HP calculator. Now has taken over. When discuss return probably talking about the equity IRR. IRR can be defined as the growth rate in cash flows with a very big asterisk. This asterisk is that it is assumed that any dividends received are assumed to be re-invested in a similar asset with earns exactly the same return. So the next fundamental concept is that the IRR and the growth rate are the same.

First the general idea. Corporations. Discuss asset value or you could call it capital budgeting. Here discuss seemingly boring and obvious points about IRR and NPV. Models to illustrate value from cash flow and impact of cost of capital. Correct IRR mathematics. Ultimately move to Project Finance to derive risk and return. Discuss how not to use WACC. How risk changes. How not to un-leverage and re-leverage. How equity is like a convertible bond with an upside and silly it is to say equity always has higher cost than debt. Also compute financial ratios including returns and multiples with value.

Valuation of a Corporation and a Family

All corporations are made of collections of individual mature assets, new projects, start-up ventures, and many other investments. Similarly, families are made up of many individuals and countries are made up of separate villages, towns, cities, counties and states and …. To understand corporations, families, or countries, you really need delve into what makes up the individual elements. When you look at some kind of aggregate financial statements, you do not get a story of what is really happening to the organization, country, corporation or family. If a corporation is to achieve a high valuation, the rate of return as measured by the IRR on individual projects should be more than some measure of the risk of the projects and the corporation should have the opportunity to make a lot of the high valued projects. To evaluate the future cash flow of a corporation, you are essentially trying to evaluate the returns on existing projects as well as the returns on new projects.

To illustrate the reasons for understanding project finance, consider the family tree diagram in Figure xxx. Let's say the grandmother in Figure xxx for some crazy reason wants to know the value of the family. To really do this, each of the people in the family tree must be valued. But these people have different ages, different risks, different earnings potentials. For example, the one of the young people may be in the teenage development stage and you do not know whether she will have any value at all because she only follows around bad boys. Another boy in the family tree may show a lot of promise but he is just finishing his education and has not earned anything yet. Imagine that you make a spreadsheet for each family member (I have met people in my classes who may do this) and then put add up all of the current earnings as would be the case in financial statement analysis. I assume you are thinking that this would be useless. In valuing a corporation which is analogous to this family, we are using very crude financial statements to evaluate the value of the company.

Start with basic case of corporation which is built up from project that earn the same returns. Look at returns and the EPS. Understand the value with simple case. Show the distortions and provides basis for book.

For example, when evaluating a financial ratio such as Enterprise Value/Earnings Before Interest Depreciation and Amortisation ("EV/EBITDA") in valuation analysis, you can make a little financial model that proves how the economic life of investments, tax rates, investment age, working capital levels and other items affect the EV part of the equation on top but not the EBITDA at the bottom. Then you can clearly see that it is irrelevant to compare the EV/EBITDA of two companies that have assets with different economic operating lives, ages of assets, effective tax rates, working capital levels, rates of return on investment or expected growth from new investments. You can try to make adjustments for all of these things, but it will be clear that companies that appear very similar can in no way compared in terms of the ratio.

Another example of many is that when trying to measure the cost of capital and the equity market risk premium ("EMRP"), you can retrieve data on stock prices into an excel file and then understand how to test for mean reversion and compute the earned premium above government bond yields yourself. You can see the strong incentives in the system to bias the EMRP upwards with effects on all sorts of things including putting too much value on growth rather than innovation (arguably leading to so many environmental problems). After you get your hands dirty with financial models that can be quite simple, you will see that you arrive at very different numbers if you consider capital gains from changes in the cost of capital differently from the underlying earning power of corporations.

The text is structured according to the fundamental idea that valuation, assessment of management performance, evaluation of multiples and other finance issues come from the simple notion of earning a return above the cost of capital and smartly making investments to grow or, often more important, contract a business depending on whether you are generating real earnings. This business of realising a risk premium on your investment is used to evaluate how and when to make new investments; as the basis of computing terminal value; as a way to assess whether multiples like P/E ratios are reasonable; as the foundation of a way to get away from the CAPM; and as a way to evaluate investments in new developments. I do present my alternative for computing the cost of capital, but I put the cost of capital discussion at the end not at the beginning because of the general notion that financial analysts want to get away from depending on such a flimsy number.

The first analytical too is a computer program that extracts stock price, dividend and economic data from yahoo.finance.com and from the FRED database. The tool allows you to compute growth rates (IRRs) on different series. The first model I have created is a program where you have to open excel, define a set of tickers and compare series such as the S&P500 including dividends with GDP, corporate profits and median income. The series can be evaluated in real terms, and you can choose different start and end periods. You can compare the IRR for different time periods and different series.

The tool is used to introduce fundamental ideas about value, growth a. It is used as an introduction to what is a

Financial and valuation results of the two companies can be demonstrated by how much money you would have made if you invested made an investment and then held the stocks. This amount of money you make from an investment is the ultimate value that we want to measure with DCF, terminal value, WACC multiples and so forth. The value can be represented as the amount of money made relative to the amount invested or the IRR. Both are really the same and represent the growth rate. This type of analysis must pick some initial investment period and a holding period. If we make an investment at a certain data and then re-invest the dividends, we can measure the historic value created. The amount of money you get at the end of the holding period relative to the start can be measured with the compound growth rate which is exactly the same as the IRR. The IRR and the growth rate are the same because there are only two cash flows and nothing in between. The first outflow and then an inflow. The amount you have at the end is real money. The graphs below illustrate something called the adjusted stock prices that are published by finance yahoo.com.

In subsequent chapters I will show how if measure the difference in the results. You will see that if the return on investment is measured with the correct economic life, economic depreciation, and does not include write-offs, then you can start to think sensibly about valuation. With a reasonable measure of the prospective return, you can assess multiples in a better way; you can derive a better way of computing terminal value; you can assess historic performance and other issues.

Financial Model of Single Project with and without Project Financing to Illustrate Nuances with IRR Measurement, Performance Measurement, Financing Potential and Other Issues

Demonstration of IRR problems, performance measurement issues, evaluating projects with changing risk.

What is profit maximization.

Do not do this in typical modelling instruction.

Young people do not question IRR criteria.

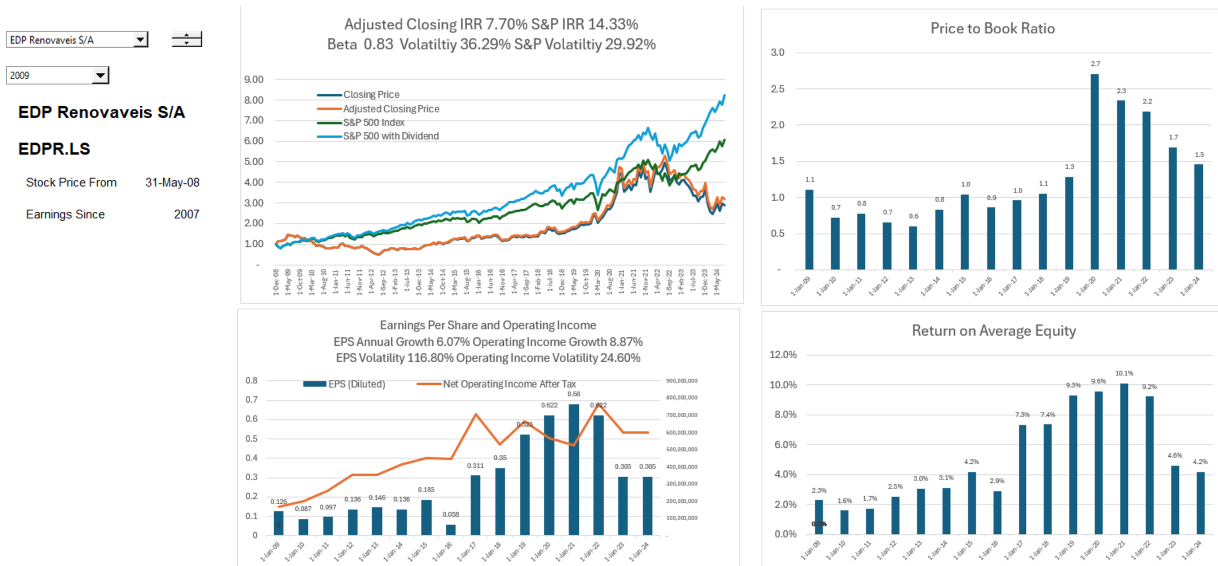
Over the years I have gained much more knowledge from general discussions with people who have endured the torture of attending my classes than by reading finance books and articles. Many times, the questions the students ask are very instructive. One example is when a lawyer from Malaysia asked me "what is all of this business about IRR anyway," se

Fourth Model – Simple Model of a Corporation from Returns, Growth and the Cost of Capital with Historical Trends and Terminal Value

Comes down to ROIC, cost of capital and growth. But must take care that if the growth rate is different, the depreciation will not equal capital expenditues.

Fifth Model – Analysis of Financial Statements for Different Companies to Evaluate Multiples, Cost of Capital and

Show the graph for EDP Renewables.



the value of a corporation. Will do this where we add up projects to portfolio.

Imagine a lot of investments. Could compute the value of each one then add them up and get

Also in this book cover corporate value. Many of critiques are related to corporate value. Corporate value is based on EPS typically and on Roic and pe ev to ebida and Roe etc. Fundamental idea of roic versus Wacc. Attack corporate valuation by building up from projects rather than standard financial statement analysis and dcf with terminal value. Look from perspective of building up portfolio. Begin with standard method of valuation and see the difference. See the mistakes in using financial statement analysis and terminalvalue. See the magic of comparing market to book value.

Concept 4: Corporate Performance versus Project Performance and ROIC versus Project IRR

Examples are the use of debt capacity in project finance to derive risks, required overall return and the economic viability of an investment; calculating the implied probability of default and country risk premia; flaws in un-levering and re-levering betas, simplistic ideas about the market risk premium, distortions in measuring return, fundamental problems in assessing how to measure expected changes in the risk of an asset over time.

Parked – Chapter 3

A Frenchman named Jean Mark Jancovici makes powerful arguments about climate change and emphasizes the technical efficiency of different technology. For example, he is a big critique of hydrogen because of the manner in which energy is lost in the process of creating hydrogen and then converting the hydrogen back to energy. Mr. Jancovici expresses the entire economy in terms of the amount of energy used to convert basic materials into things that we use and like rather than in terms of money. Not a bad idea at all. He demonstrates how painful it will be to reduce energy use as the standard of living must also decline. But Mr. Jancovici like so many others who study climate change and responses leave out any consideration about the cost of capital and the relative capital intensity and fuel intensity of investments. When thinking about capital-intensity I have tried to do something similar to Mr. Jancovici but where the trade-off between CO2 emitting fuel and capital is included. When capital is included in a simple model of the economy, the importance of the cost of capital to make an energy transition possible immediately becomes apparent.

that compares an economy with more capital-intensive investments with an economy that has more non-capital-intensive investments. This simulation demonstrates that it is not necessary to correlate fuel use with well-being and that the cost of capital comes down to how childish we are in wanting to consume things earlier rather than later.

a to to measure the choice between the fuel intensive option of collecting wood every day compared to the capital-intensive option where you spend a lot of time making the contraption. You would work on this system every day after finding food and it would take a long time. But after you finish it, you would have to spend less time on collecting wood for the fire and then making a fire.

The hot water system using the sunlight (solar power) is a capital-intensive option while the option of the collecting wood and then trying to make a fire is the fuel intensive options (I hope you do not worry too much about the specifics, it is the best I can think of). Also, note that I do not care about the efficiency of converting the two options from energy into hot water. The cost of capital can be thought of as the amount of leisure time that you lose during the period when you build the system relative to the amount of time you spend on collecting the wood. If the amount of time spent to make the contraptions is equal to the sum of hours spent in the future to collect and burn the wood, then the rate of return is zero. If you are satisfied with this result, the cost of capital is also zero. On the other hand, if you spend somewhat less time on building the system relative to the amount of time that you save, then the cost of capital is positive. You could compute the IRR on the number of leisure hours.

While the example is very stylized, it demonstrates how to think of various issues in evaluating the cost of capital and climate change. First, the cost of capital that matters is a real number and should not be affected by inflation – there is no money in this example. Second, while one of the first things you learn in finance is that people always would rather consume earlier than later, meaning that you a leisure hour now is worth more than a leisure hour later. This may or may not be true as you maybe you put just as much value on a leisure hour this year as a leisure hour in the future. Third, there may be more risks associated with the capital-intensive solar contraption not working or with the fuel intensive option from running out of wood in the nearby area to heat the bath water for your family. The leisure time trade-off should certainly account for these risks. But when evaluating the fundamental question of whether you should invest in one technology or another, things like country default risk, currency risk, inflation risk should not affect the fundamental decision. To combat climate change finance and contract structuring should not distort investment decisions away from the fundamentals. In this example risk certainly exists, but it is not distorted by estimates of the EMRP, Beta, Inflation or other things that seem scientific but just distort things. I am agnostic about different technologies.

Project Finance and IRR versus Return on Investment

In project finance, returns are measured with IRR's. The project return measures the profit – the growth rate over time with no financing (this can also be without tax). The project IRR that is pre-tax is analogous to return on invested capital where you divide the EBIT rather than NOPAT by invested capital. Then you can move to the growth rate after tax. In project finance, you then evaluate the equity IRR that is the driver of what investors care about. The equity IRR is dependent on the financing of the project. Illustration of very simple project finance analysis for one period and consistency with corporate analysis in one period model. Show the reconciliation. Show project finance model.

For a long time wanted to do this. But it is a little painful and would not typically do this. Find useful in explaining things. Contrasts with the articles in academics. Take the time to make a theoretical Simulation is much more useful at every level. This includes evaluation of IRR. It includes valuation of project with different risks. It includes understanding of value over time. It includes understanding risk from different perspective.