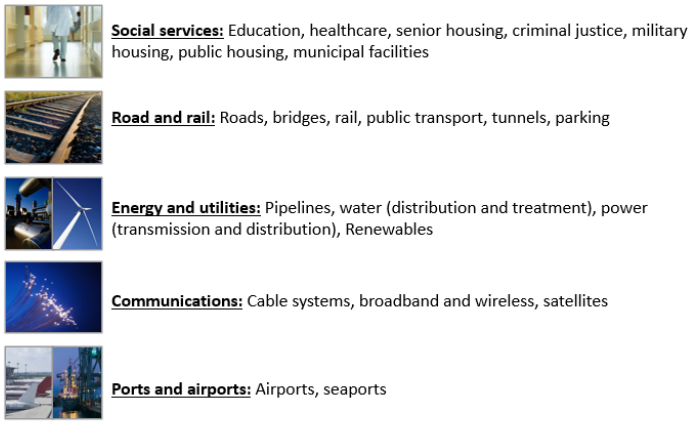
Chapter 22:
What is (and is Not) Project Finance

The more I work on projects, the more I teach classes in the foundations of project finance and the more I observe corporate finance in practice, the more I am convinced the students of finance and making efficient investments should begin with project finance and then, after understanding project finance, move to corporate finance. 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. Ultimately, my argument is that finance theory must answer the question of whether investments should be made and what are the costs and benefits of an investment. Examples of project financed investment are shown on the accompanying picture where projects are financed by private who incur carefully selected risks to promote efficiency (I do not necessarily agree that private prisons are a good idea). 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.



When I ask participants in my course 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.

This chapter begins with a definition of project finance and a summary of three central problems of corporate finance that are resolved by project finance (why I think project finance is so important in defining investments that make sense for society). Then I move to the essence of project finance and why having a third party tell you about risks on a standalone basis verifies the efficacy of an investment. I explain how having this third party – debt providers – assess risk on a more sensible basis than the way risk is measured in other areas of finance. I later suggest analysis of the value a project financed investment is interesting because risk and value changes dramatically over the life of a project. Studying project finance involves understanding the manner in which risk changes and a project moves from something like a venture capital investment 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. The final section demonstrates how project finance therefore means you have to understand how to assess and value investments ranging from venture capital to bond type cash flows.

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

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 just considered a form of debt, problems with financial theory such as assuming the amount of debt raised is independent of value; un-levering and re-levering betas; assuming that WACC and risks remain constant; believing that risks can be quantified with beta; 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. To see what I mean, I list a couple of examples of how project finance is typically defined (taken from Investopedia and Harvard business School Materials).

Let's look at some definitions to see what I mean. The first definition by Finnerty refers to nonrecourse debt (which I define later as the lack of ability to send an email to your parents and ask form money) and cash flow (contrasted to earnings per share that are affected by depreciation, impairment charges other accounting adjustments) that are important concepts in project finance. But the definition misses the essential idea that project finance is a tool to

demonstrate the financial viability of long-term investments that have reasonably stable cash flow over long time periods.

> *… 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.*[1]

Other definitions that I list below only mention the debt aspects of project finance and incorrectly emphasize the idea that collateral is important in assessing the viability of a project financed investment.

> *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.*[2]

> *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.*

With due respect to the authors who wrote the above definitions, the real essence of project finance is a whole lot more than a different kind of debt instrument. It is about having the ability to make essential infrastructure, energy, resource extraction and other long-term investments that would be very difficult to assess with standard financing approached (not always). With project finance, assessing investments, not just issuing debt, is not desirable without the stamp of approval of a lending institution and without some mitigation of risk by the government and other entities. Ultimately by demonstrating reasonable risk when raising funds, project financed investments can ultimately achieve a low cost of capital resulting in reasonable prices to people in a society.

To better understand project finance and how it is part of enabling investment in long-term assets, it is instructive to survey some key characteristics of long-term investments that have been able to achieve project financing. Because of the manner in which risks are assessed and the overwhelming capital that is provided by a financial institution (often more than 80%), a more objective cost of capital estimate can be made, and this 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

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

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; (5) the debt roughly targets BBB or BBB- bonds (barley investment grade); (6) as the risk of projects generally declines over time, equity investors can receive upside from re-financing and/or selling the project to entities that have an appetite for low-risk equity investments.

Given these important characteristics of project finance, a more appropriate definition may be the following:

> *… finding money from a bank (not associated with your company) 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 can meet debt service and provide a reasonable growth rate (IRR) in cash flow to investors and low cost for consumers.*

Stamp of Approval by Lender Defines Whether the Investment will be Made

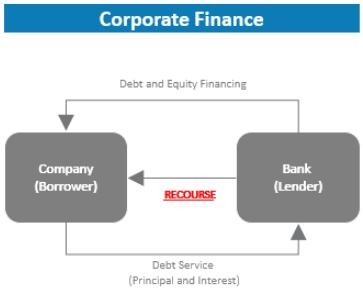
If I have not made it clear already, a central advantage of project finance involves having an independent institution – the bank – assess the risks and make the vast majority of investment. To see how this works, I make an imaginary case when one person makes a beautiful power point presentation to the board of directors on the construction of a large investment in a new battery giga factory. The presentation by this person include 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.

I then ask people to imagine a second presentation of the same project. In this case there is no power point slide presentation. The person making the presentation comes late to the board meeting because she has was at a meeting with a large bank that had made loans to many similar projects. 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 person also has other commitments regarding how the some of the risks will be accepted by third parties to the project. The second picture is supposed to represent this rather silly and hypothetical example.

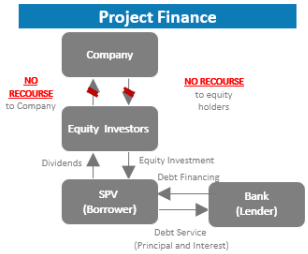
At the end of a course in France after we had worked through many nuanced, technical and legal issues associated with project finance, we sat around a table and pondered the benefits of project finance, and some suggested the big reason for using project finance is to keep debt off of the balance sheet. I come back to the fact that an entity that is not your company has done a lot of analysis with their own data and put an incredible stamp of approval on your project by putting in their own money – something like 80% of the money you need to invest. On top of that, the bank has worked on structuring of contracts that get to the heart of debates in economics involving the promotion of efficiency.

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

I used to just discuss the concept of a nonrecourse loan and think of it as a fancy word that means debt is pretty risky because the lender is limited to only accessing cash flow from a single project. Then you could sound really sophisticated by discussing limited recourse debt. The adjacent diagrams that are intended to illustrate the meaning of nonrecourse debt show how a normal loan 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). As a side note, this can be an advantage when a company – ENRON – cannot pay its corporate debt, but it does have subsidiary companies that are working fine.



As with the definition of project finance which miss the essence of what it is all about, the diagrams of nonrecourse debt miss the crucial aspect of what it is all about. I think of nonrecourse as having no support from your parents. Your parents may be rich and nice to you, or you may have a parent who is absent from your life. If you have run out of money temporarily, the nice parent will 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. Now think about how cool 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.

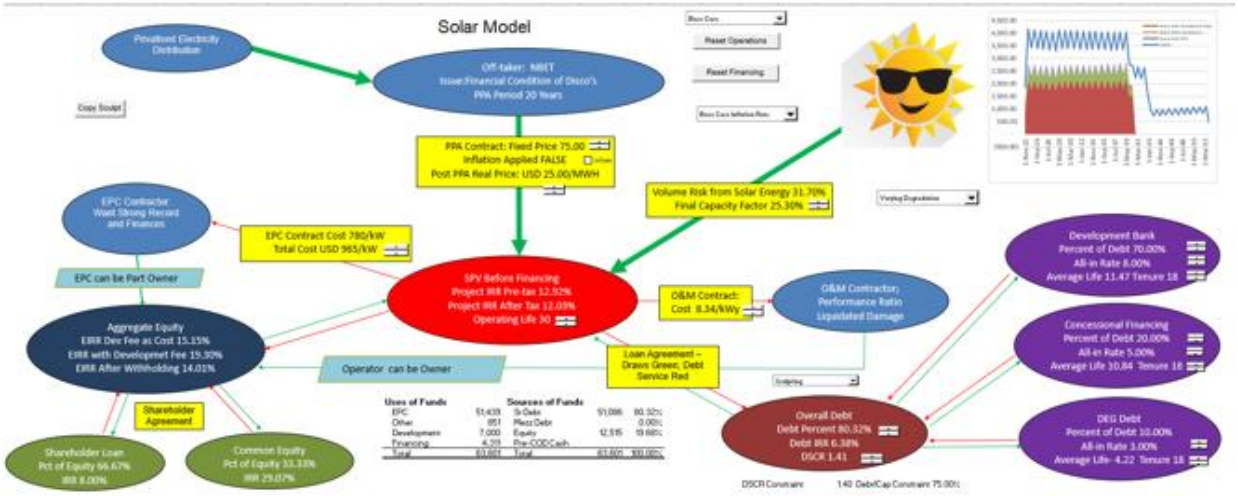
Risks of Changing in Fashion and/or Obsolescence Cannot be Accepted in Project Finance

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.

Use of Contracts with Incentives to Accept Controllable Risks to Allow Long-term Financing of Crucial Infrastructure Projects

An important part of project finance is use of contracts for capital expenditures (EPC), operation and maintenance (O&M) and revenue contracts that may assure prices, volumes, both prices and volumes or neither prices nor volumes. The contracts that are used in project finance can design incentives and penalties that ultimately transfers risk away from lenders and equity investors and thereby lower the cost of capital which again is so important for investments that combat climate change. This transfer of risk can be expensive and, worse yet it 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). Analysis of whether the contracts are sustainable (for example if the prices are reasonable) and whether

the counterparties to the contracts will be around is a big part of project finance analysis. The accompanying diagram illustrates how contract risks can be considered through drawing a diagram of the cash flows for the project. In this diagram, there is no contract for volumes which is represented by the sun and the DSCR is shown along with IRRs for the project.



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.

Chapter 24:

Comparing Corporate Finance Versus Project Finance in the Investment Process

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

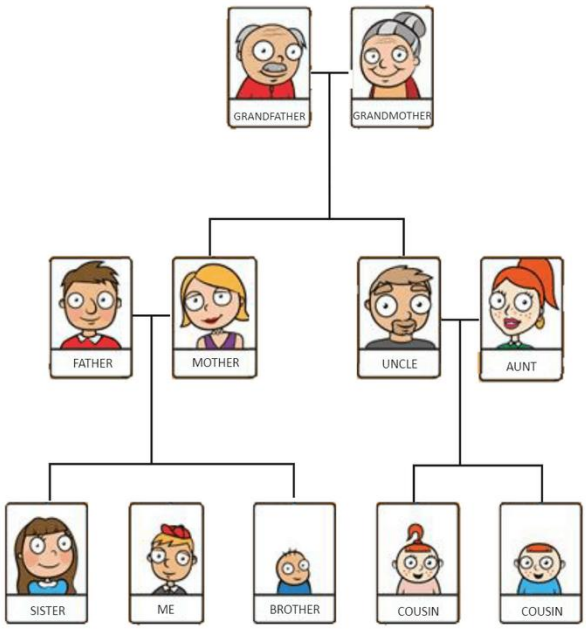
After defining project finance the discussion typically turns to a comparison of project finance and corporate finance. A two-column table is often presented like t he adjacent table where various features of project finance and corporate finance are compared. There is certainly nothing wrong with tables 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.



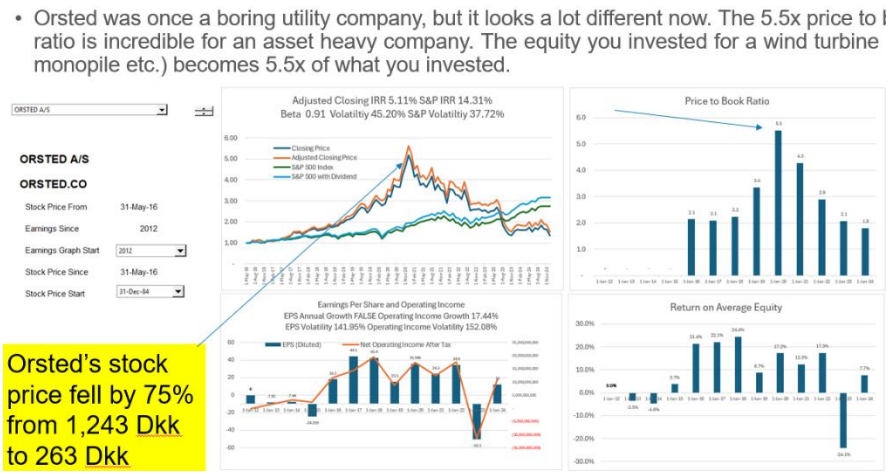
If you had tried to compute the value of this family by some kind of accounting statement that adds up the revenues earned, the costs incurred and the investments made in education and other personal development, the numbers would not be very useful in establishing the value that the grandmother asked 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 potion. 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 These 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.

Chapter 23:
Two Ratios in Project Finance – IRR and DSCR and Why These Ratios Are Better than Others for Measuring Value and Risk

Two Ratios that Define Value and Risk in Project Finance

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 the models and presentations is the IRR 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.

"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 really make me think hard. One example is when a lawyer from Malaysia asked me "what is all of this business about IRR anyway." She seemed to be wondering why the management of her company was so focused on this number. I now regularly ask a variant of this question to participants in my courses –

why would executives in corporations be obsessed with this statistic when making 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.[3] 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.[4]

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

[3] 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.

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

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

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 bec ome 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.[5] This just proves something that most will now, namely that the IRR is the

[5] 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).

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 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.