Choosing a Discount Rate

The world's largest iron-ore producer [sold]$1 billion in investment grade bonds due in 2016 priced to yield 6.254%. Cia. Vale do Rio Doce, which last year became the first Brazilian corporation to win an investment grade rating, issued the debt to help fund its repurchase of $300 million of its 9% bonds due in 2013, thereby cutting the company's borrowing costs.

CVRD Issues Record Bond, LatinFinance, February 2006, p. 4

Introduction

The concept of equivalence is essential to evaluating infrastructure projects that require substantial investments before any benefits are obtained. Given a discount rate, it is possible to relate any arbitrary sequence of cash flows to an equivalent present worth or future worth or to an annuity that continues indefinitely or for a fixed number of periods. Given the projected costs and benefits, it is possible to calculate the net present value of a project, which can then easily be compared to the net present value for other projects. However, this extremely useful concept depends upon having a discount rate, and the selection of a discount rate is a complicated and ultimately quite subjective matter. The discount rate cannot be established by fiat, nor is there a methodology that can be used to determine the exact discount rate that someone should use in evaluating a project. Moreover, the various people and organizations considering a project are likely to use quite different discount rates in evaluating the same project. Since the discount rate determines the importance of future financial costs and benefits, it is necessary to give some thought to the choice of a discount rate.

The discount rate is similar, but not identical to the rate of return. The discount rate is a conceptual figure that is useful in establishing equivalence of cash flows, whereas the rate of return is an accounting term that is used in describing past or predicted financial performance of companies. Historically, rates of return have been higher for riskier investments, because investors discount future earnings more heavily for such investments. The greater the perceived risks associated with stocks or bonds, the lower the prices that they will command – and the higher the costs for the company or agency trying to raise capital for a project. The discount rate used to evaluate projects should be at least as high as the rate of return that could be obtained via other investments with similar risks. The **minimum attractive rate of return** for a company will be at least equal to its cost of capital – and perhaps much higher.

The concept of a discount rate may seem to be a rather arcane topic, but it has clear and important consequences for a company or a government agency. The quote at the beginning of this chapter describes how a company was able to reduce its interest costs from 9% to 6.254% because the financial community upgraded the company's credit rating. With lower interest on $300 million worth of bonds, the company saved approximately $8 million per year in interest from 2006 through 2013. How the financial community views the risks associated with a company can be extremely important to the profitability and even the survival of that company.

Profits and Rate of Return vs. Net Present Value

Companies and investors often think in terms of profits and return on investment as well as or instead of present worth or future worth. Profit and return on investment are both accounting terms. Profit is the difference between revenue and expense, while return on investment is the ratio of profit to the total amount invested. In the simplest case, an investment of I at time 0 results in annual profits of A/year over a very long time horizon. In this simple case, the annual return on investment would always be A/I. While this simple logic is fine for, say, buying bonds, it is insufficient for investments in infrastructure. The first problem is that the investment does not occur at time 0, but may in fact require years of effort. The second problem is that the revenues and expenses associated with the project are likely to vary over the life of the project. The third problem is that tax laws and accounting conventions determine what is called an expense and what is called an investment; the way that legislators and accountants consider financial matters may be quite different from the ways that entrepreneurs, companies and investors do their analysis.

The first two problems can be addressed by use of the concept of equivalence, assuming that an appropriate discount rate is given. The actual investments that take place over a period of months or years can be related to an equivalent total investment either at time 0 or at the time the project is completed and the operation begins. Likewise, the net benefits can be converted to an equivalent long-term annuity that begins either at time 0 or at the time that operation begins. The return on investment would then be the ratio of the equivalent annuity to the equivalent investment.

The problems related to accounting and taxes are trickier. Profit and return on investment are defined by legislation and accounting rules, and it is not possible to adjust the definitions of these terms to be consistent with some other view of the world, e.g. the emphasis on net present value of cash flows that is presented in this text and other texts on engineering economy, management science, and project evaluation. The generally accepted belief is that managers and investors will do better by focusing on the net present, future or annuity value of after-tax cash flows rather than focusing on profits as defined by accounting rules and government regulations.

It will eventually be necessary to consider how taxes and accounting rules affect cash flows and to understand how changes in tax laws and accounting can be used to promote different types of projects. For now, however, we keep our focus on cash flows without worrying about taxes. But we do have to worry about risk, and the easiest way to understand why is to consider the effect of borrowing money on the chances for a project's success, as demonstrated in the next section.

Leveraging and Risk

Borrowing the funds needed for an investment will reduce the initial investment required from the owner and potentially increase the expected return on the investment, but also increase the risk of the project. Because of the higher risk associated with the project, a higher discount rate will have to be used.

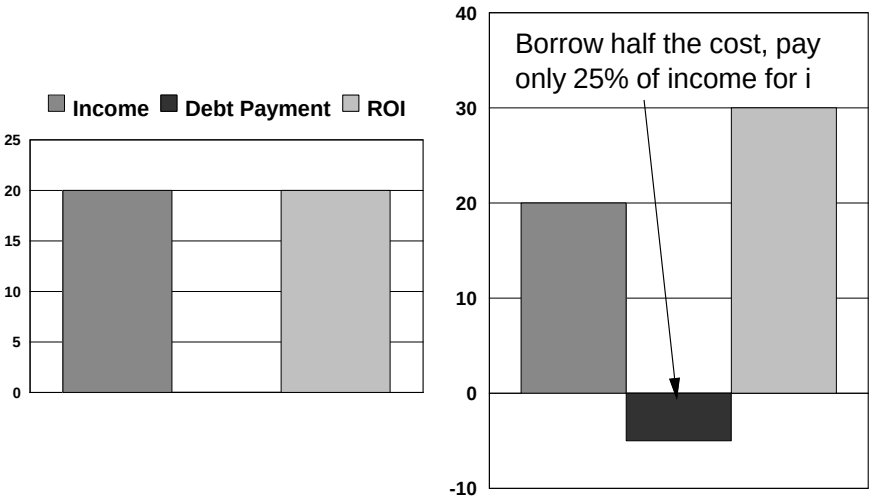
Consider the case from the previous section in which a project's cash flow has been transformed into the equivalent cash flows represented by an investment of I at time 0 and annual profits A that are received at the end of every year thereafter. If all the investment funds are provided by the owner of the project, then the owner's return on investment will be A/I. If the owner borrows a portion of the investment, then two things happen: the owner's investment declines by the amount borrowed, and the annual profit declines by the amount paid in interest. The owner's return on investment will now be:

(Eq. 1) Owner's ROI = (A – loan interest)/(I – loan principal)

Figure 1 illustrates what would happen in a situation where the initial annual return A is $20 million on an investment I of $100 million. The y-axis on this chart should be interpreted as millions of dollars for income and debt payments, but for ROI it should be read as the annual %. The chart on the left shows the initial situation in which all of the investment is provided by the owner; the annual income is $20 million, there is no interest payment on the debt, and the ROI is 20% (A/I = $20 million/$100 million).

The chart on the right shows what happens if the owner only provides half of the investment and borrows the other $50 million at an interest rate of 10%. In this case, the annual income remains unchanged at $20 million, but there is an interest payment of $5 million. The owner's ROI jumps to 30%, as the net income to the owner after paying the interest is $15 million, which is 30% of the owner's investment.

Debt Financing Increases the Expected Return of the Project if the Interest Rate is lower than the ROI

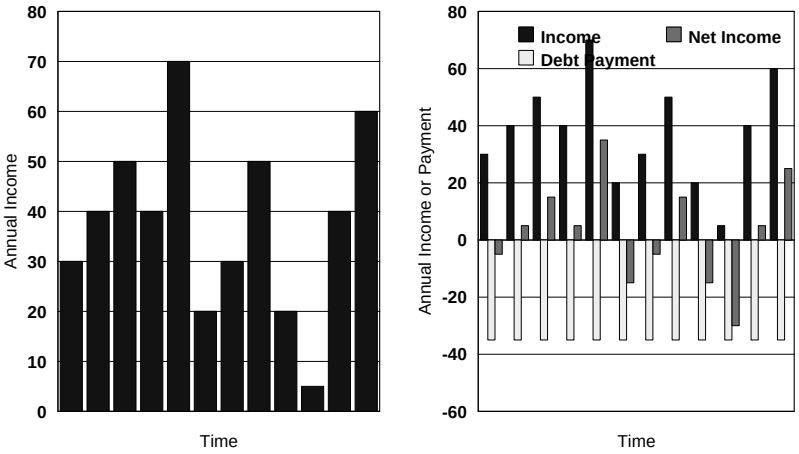


Borrowing money will increase the owner's ROI so long as the interest rate is lower than the return on the original project. The process of borrowing money in order to increase the amount that can be invested is called **leveraging**. Leveraging may increase or decrease the profitability of the project. Since infrastructure projects generally require very substantial investments, most such projects are highly leveraged. Minimizing interest costs becomes a major concern in such projects.

Whether leveraging is undertaken in order to increase ROI or simply to enable the project to be constructed, leveraging will increase risks because of the possibility of a default on interest payments. Figure 2 shows why this is so. As suggested by the chart on the left, cash flows may vary from year to year. In this situation, annual profits range between $5 million and $70 million. In the unleveraged situation, smaller annual profits simply reduce the profitability for that year, and the owner still enjoys positive cash flow. In the chart on the right, it is assumed that the project is very highly leveraged, requiring interest payments of $35 million per year. As a result, the cash flows in some years are insufficient to cover the interest payments, and the owner must use other sources of funds to make the interest payments and avoid bankruptcy.

The greater the uncertainty in predicting future cash flows, the greater the risks from leveraging. Leveraging works best in situations where there is a stable source of revenue, so that there is little risk that interest expenses will exceed actual cash flows. A project whose financing is heavily leveraged will be riskier than if it had little or no debt, and investors will therefore discount projected cash flows using a higher discount rate.

Debt Financing Increases Risks of a Projects, Because Principal & Interest Must be Paid When Due



Factors Affecting the Discount Rate

Minimum Attractive Rate of Return (MARR)

The discount rate reflects the time value of money to a particular individual or organization. Future cash flows must be discounted because of at least three factors.

- **Opportunity cost**: the opportunity cost represents the potential financial benefits that must be foregone once a decision is made to invest in a particular project. Instead of investing in a particular project, individuals and companies could invest in other projects, in stocks and bonds, in real estate or in other ventures. If they have borrowed money, they could pay off their debt. If they have sold stocks to the public, they could buy back some of the stocks.
- **Inflation**: inflation is likely to erode the purchasing power of money received in the future. As a result, the same amount of money would purchase less in the future than it would today.
- **Risk**: the money that is anticipated to be received sometime in the future may or may not materialize.

These factors overlap to some extent, as the opportunity cost depends to some extent on expectations concerning inflation and risk. Also, each of these factors will be treated differently by those promoting a project and those investing in a project. Nevertheless, both promoters and investors are likely to have a **minimum attractive rate of return (MARR)** as they contemplate undertaking or investing in a project. The MARR represents the rate of return that promoters or investors believe that they could achieve via other investments with similar perceived risks. Discounting cash flows using the MARR as the discount rate will indicate whether or not the proposed project is as attractive as pursuing the other options that are available. Promoters and potential investors have different investment options and they have different perceptions of the risks associated with a particular project. Therefore the MARR used by those proposing a project is likely to be different from the MARR used by those who are asked to invest in the project. The differences are worth discussing in further detail.

MARR for Investors

Potential investors have quite a different perspective from those proposing a project. They are not necessarily concerned very much or at all with the objectives of the project, as they are primarily interested in maximizing their financial returns. They probably do not understand nearly as much about the technologies, locations, opportunities, or possibilities as do the promoters of a project - and the investors are apt to be leery of promoters who perhaps have reasons to oversell their project proposals.

Investors have numerous investment opportunities, and they have access to many qualified investment analysts who rate the financial attractiveness of many of those investment opportunities. They are likely to have a very good understanding of the financial markets, and they will have their own track record with respect to investing in different sectors and in different types of securities.

In general, investors can seek higher returns by investing in riskier endeavors, as illustrated in Figure 3. Savings accounts insured by the U.S. government and bonds issued by the U.S. government may be viewed as a risk-free investment, and they may offer an interest rate of 5% or less. Riskier bonds will require higher interest rates in order to attract investors. The risk that a bond will default can be estimated by analyzing the finances of the company or government agency issuing the bonds. Companies such as Moody's rate bonds with respect to their credit-worthiness; the best bonds are rated as AAA, then AA, B, etc. Bonds with lower ratings require higher interest rates because the probability of default is greater; bonds with very low ratings may be deemed unsuitable as investments for some very conserv of interest paymer r the credit rating, t nmonly are sold in fy the sales price of

What is an Appropriate Discount Rate?
Risk vs. Expected Return

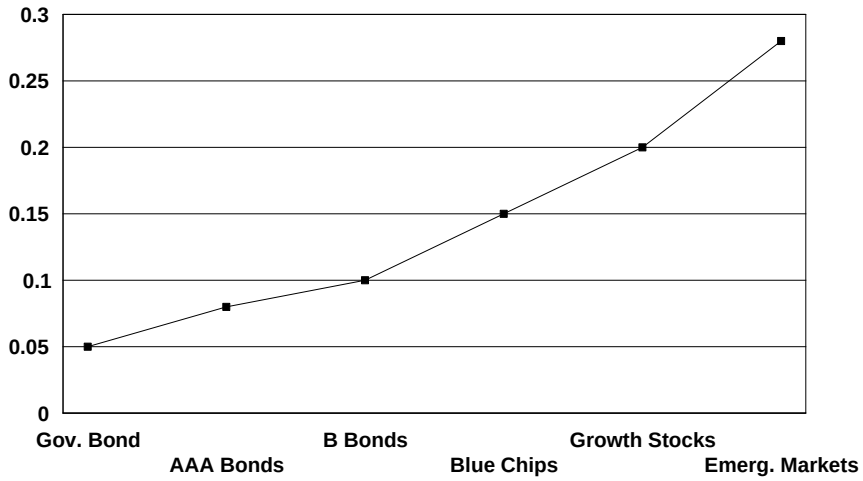


Figure 3 shows stocks as having a higher expected return than B-rated bonds. This makes sense, because the interest must be paid on the bonds before any cash is available to the stockholders. "Blue Chips" are stocks in the largest, most well-known, and very financially stable and attractive companies. Blue Chips have an excellent history of good financial performance, and they therefore are viewed as having relatively low risk. The value of Blue Chip stocks is largely dependent upon a continuation of past performance rather than anticipation of future improvement. Growth stocks are issued by companies that anticipate rapid growth in earnings; the value of the stocks is based more on hope

for the future rather than continuation of the past. Since the earnings are expected, not proven, investors discount future cash flows more heavily than they discount Blue Chip cash flows. Even higher discounts will be applied to cash flows projected by companies involved with new technologies or companies that do substantial business in regions of the world where financial markets are relatively undeveloped. The opportunities may well be much greater in such markets, but the risks are also much higher.

The risk-return curve plotted above in Figure 3 is determined by market forces and economic conditions. The shape of the curve is affected by the state of the economy, government policy concerning interest rates, government debt levels, the number of new offerings of stocks and bonds, political uncertainty in various regions around the world, public perceptions concerning new technologies, wars, and other factors. The discount rates implied by the risk-return curve can be interpreted as resulting from the sum of three factors:

- The real return available on risk-free investments
- The expected rate of inflation
- A risk premium that reflects investors' collective views concerning the riskiness of the company, including judgments concerning the company's financial situation, the outlook for the entire industry, and the social and political conditions in the country or countries where the company is located or where the company's products are sold.

Each of these factors is used to discount the current value of future earnings. For example, given the risk free return (rf), the annual risk premium, and the inflation rate (inf), the present worth of the cash flow CF in month N would be:

(Eq. 2) Present worth of $CF(N) = CF(N)/((1+rf)^N(1+risk)^N(1+inf)^N)$

If each of the three factors is small, then

(Eq. 3) Present worth of $CF(N) \sim CF(N)/(1 + rf + risk + inf)^N$

The discount rate, in this case, would be (rf + risk + inf).

It is important to understand what the chart in Figure 3 does show and what it does not show. It *does* show that investors will discount future cash flows much more severely if they believe that there is a lot of risk associated with a project. It does *not* show that investments in riskier projects will make more money. It *does* show that reducing risks allows a developer or a company to raise more money *today* based upon its projected cash flows for *tomorrow*.

It is even more important to understand that the above chart represents the market's evaluation of risks and investment opportunities. This is not the same as the owner's or developer's assessment of opportunities. Each individual and each company has their own Minimal Acceptable Rate of Return (MARR) and their own preferences for risk and return. Their MARR is based upon their opportunities, perceptions of their risks, and their preferences for risk and return. They will discount projections of future cash flows in their projects using their MARR for projects they deem to have similar risks. Because of their own experience or knowledge or ignorance, they may well believe that a project can be completed as planned and that it will indeed achieve the anticipated cash flows. Hence, they may see projects as being less risky (and therefore a better alternative) than the same projects would be viewed by the market. They will therefore go to rather great lengths to convince potential investors that the project is feasible and that the risks are not as great as the investors might fear.

MARR for Owners and Promoters

Project owners and promoters have a much different perspective than investors. The promoters may be a developer, a company, or an agency promoting a particular project; there may be a "champion" who has long been advocating the project and seeking political and financial support from many agencies, organizations, and companies. The promoters are seeking to achieve various benefits from the project, some of which may be financial, some of which

may be economic and quantifiable as monetary benefits, and some of which may be social or environmental or other benefits that are difficult to quantify. They understand that they need to finance the project, i.e. come up with the cash necessary to pay for the investment and the continuing expenses of the project. Presumably they believe that the project is worth doing, that it is a good way to achieve the benefits that are sought, and that it has a reasonable chance of success. They will have considered similar projects and perhaps they may have already completed similar projects. They likely have consulted experts regarding the feasibility of the construction, the demand for the project and the risks associated with the proposed project. They also have a good idea of their own opportunity costs, based upon their experience and their investment options. They presumably do not expect their next project to be their best project ever, but they do expect to achieve returns similar to what they have achieved in the past and to what they believe they could achieve in other projects.

If the promoters have sufficient funds to construct and operate the project, then they can do pretty much what they want to do. If they need to raise money for the project, then they have additional financial concerns. If they borrow money, they will worry about the interest rates they will have to pay. If they need to sell stock, they will worry about how what price their stock will command in the market and what proportion of the ownership must be transferred to the new stockholders. Their MARR must be greater than their cost of capital and it must be greater than what they earn in other endeavors.

The cost of capital is an important factor for companies. Many companies raise money by selling bonds or selling stock. The cost of capital is lower for bonds than for stocks, as described in the previous section. For bonds, the cost of capital is the interest rate that is paid. For stocks, the cost of capital can be estimated as the historical returns to the owners of the stock. The annual return for a stock can be calculated as follows:

(Eq. 4) Annual return = (Final Value – Initial Value + Dividends)/Initial Value

For example, consider a stock that was valued at \$100/share on January 1st, paid a \$2 dividend on December 31st and had a value of \$110 on January 1st of the following year. The stock increased in value by 10% and the dividend was 2% of the initial value, so the total return was 12%. The average historical returns for a stock can be used when estimating the cost of capital for that company.

A share of stock represents ownership in the company, which means that stockholders have "equity" in the company. The **weighted average cost of capital** depends on the relative amounts of debt and equity in the company and can be calculated as follows.

(Eq. 5) WACC = %D (average interest on debt) + % E (average return on equity)

Where

%D = Debt as percent of total value of debt plus stock

%E = Equity as percent of total value of debt plus stock

For example, we can calculate the weighted average cost of capital for a company whose ratio of debt to equity is 3::2, whose average interest rate on debt is 8%, and whose historical returns to equity have been 16%. Substituting these values in Equation 6 shows that the company's average cost of capital is 11.2%:

(Eq. 6) WACC = 60% debt (8% interest on debt) + 40% equity (16% return on equity)

= .6 (8%) + .4 (16%) = 4.8% +6.4% = 11.2%

As discussed above, a company may reduce its credit rating and increase the risk of bankruptcy if it increases its proportion of debt. If a company increases the ratio of debt to equity, it will eventually encounter higher interest rates

and difficulties in selling bonds. To maintain their credit ratings, many companies will endeavor to maintain a constant ratio of debt to equity. If this ratio is constant, then the WACC represents what it costs (or has cost) the company to raise capital for new projects. Over time, as the debt/equity ratio and market conditions change, the cost of capital will also change.

The analysis of the cost of capital can be made much more complicated. Instead of the weighted average cost of capital over the past year or past five years, a company will likely be interested in its current cost of capital. In regulatory affairs and legal cases, lawyers and experts will debate projected cash flows and discount rates. In Wall Street or other financial centers, analysts will be trying to figure out the true values of stock prices, which presumably reflect the projected cash flows for the company, the discount rate applied to those cash flows, and the number of shares outstanding. Company financial officers present their projections of cash flows to financial analysts, and the financial analysts make recommendations to their clients as to whether the stock should be bought, sold, or held. The financial analysts may make their own judgments regarding future cash flows of the company, and they may select a discount rate based upon their perceptions of risk. Their judgments will be critical in determining share prices as well as the interest rates the company will have to pay on future sales of bonds.

The benefit to a company in issuing stock instead of bonds is that there is no requirement to issue dividends, which is very helpful during unprofitable periods. If a company defaults on interest payments on bonds, it can be forced into bankruptcy, but if it decides not to issue dividends, there is no such risk. The negative aspect of selling stock is that the sales price may reflect investors' application of very high discount rates to the company's projection of future cash flows. As a result, the current owners may give up more of the company (and its future earnings) than they want to if they try to sell more shares of stock.

It is important to emphasize again and again that perceptions of risk and choices of discount rates will be different for the different parties involved in a project. For example, suppose a group of engineers and entrepreneurs has created a company that is trying to raise $100 million for constructing what they believe to be a very lucrative project in a developing country. The company has done extensive research concerning construction costs, operating cost, and potential revenues. While they recognize that there are some risks related to regional economic conditions, they are confident that their proposal can be constructed on time and on budget and that it will attract high demand almost immediately. They have prepared a prospectus in which they describe the project in great detail, and they anticipate annual profits to reach $20 million per year for at least 30 years. Using a discount rate of 10%, they estimated the net present value of the revenue stream to be $200 million as of the time the project begins operations, which is far greater than the construction cost. They will have no income for several years while the project is being constructed, so they hope to raise the $100 million from a combination of low-interest loans and sale of stock to get started. Almost immediately, they discover that they would have to pay 12% interest for a construction loan of no more than $20 million; by the time construction was completed, they estimated they would have to pay $5 million in interest. Then they approached several potential investors to see if would be feasible to sell stock in their company to raise the funds necessary to cover the remaining $80 million of construction costs plus the $5 million in interest. They indeed found investors interested in infrastructure projects in this country – but those investors were discounting cash flows by 25% or more when they evaluated such projects. Hence, for those investors, the cash flows of $20 million per year were worth only $80 million (estimated as the equivalent present value of an annuity for an indefinite period = $20 million per year/(0.25) = $80 million). Thus, to these investors, the returns from the proposed project were much less than their MARR, so that they would not be willing to pay enough for the stock for the developers to finance their project even if they purchased 100% of the company. The project therefore would likely collapse, because it would be impossible to raise sufficient funds to get started.

MARR for Large Companies

A large company's minimum attractive rate of return (MARR) will never be less than its weighted average cost of capital (WACC), because it can always buy back its stock and bonds if it has an excess of cash and no suitable investments. Since the WACC reflects market valuations of its stock and bonds, the WACC and therefore the MARR

will be affected by macro-economic factors such as inflation and recessions as well as by the market's perception of risks associated with the company and the industry.

The company's MARR must also take into consideration the company's opportunities for investments. Investments in the company may be desirable in order to expand capacity, increase efficiency, support moves into new types of business, or to improve safety. Company officials will have many competing internal requests for capital, and they will have (or should have) an excellent perspective concerning the potential benefits for these competing projects. A company may also consider broader investments. It can invest in the financial markets, just like any investor, or it could attempt to buy or merge with other companies.

In a completely predictable world, a company perhaps would be able to invest in any and all projects with a return greater than its WACC. After all, if a company can raise money by selling stocks and bonds at an average cost of, say 11%, then it can increase its profits by investing in all projects with an expected return greater than 11%. If so, then the MARR for this company would be the WACC.

In actual practice, however, the company is faced with many uncertainties. The projections of cash flows are based upon numerous assumptions, and there is in fact a potential distribution of cash flows associated with each project. The expected return may be greater than 11%, but there may be a good chance of earning less or even substantially less than 11%. The more highly leveraged the company becomes, the greater the potential that it will be unable to cover its interest payments. The company may not be willing to risk losing money, and therefore may not wish to invest in projects unless they are very sure that the projects will have a return greater and perhaps substantially greater than its WACC. This kind of financial discipline will be imposed at three levels:

- The Chief Financial Officer will scrutinize proposals and impose criteria for ranking and selecting projects, taking into account the need to maintain a debt/equity ratio that is acceptable to investors
- The Board of Directors may limit the total capital budget for the company in order to limit the overall risks associated with the company
- The capital markets may decide that a company is a credit risk, which means that someone will issue a report or a study or a credit ranking that reflects poorly on the company. Companies, countries or agencies with a poor credit rating will have to pay higher interest on any future bonds that they issue and they will probably see a reduction in their stock prices or more difficulty in raising money for their projects.

Thus, in practice, a company will typically be unable to invest in all of the potentially profitable projects. Instead, it is likely to invest in the most profitable projects, which means that it will set its MARR (often called a "hurdle rate") well above its average cost of capital.

MARR for State, Local, and Federal Governments

Governments are often able to sell bonds at very low interest rates, so it may appear that the cost of capital for a public agency is very low. However, the low rates reflect in part the ability of governments to raise money by taxation. The actual cost of capital reflects not only the interest costs on public bonds but also the opportunity cost associated with taxation. What could the public have otherwise done with the money they paid in taxes? When economists consider this question, they come up with a higher cost of capital and therefore a higher discount rate or MARR for public projects.

Consider a taxpayer who has a minimum acceptable rate of return of 12%. This individual or business would be unwilling to invest in a scheme that offered less than 12% profit. The taxpayer would not keep all of the profits, as any applicable federal, state, or local taxes would have to be paid. If those taxes amounted to a third of the profits, then the minimum acceptable after-tax profit for the taxpayer would be 8% of the investment. A taxpayer concerned with efficiency in government might feel that government funded projects should be subjected to the same kind of test: the government should not invest in projects unless they also provide an after-tax benefit of 8%. Since governments do not pay taxes, this taxpayer might conclude that the government should use a minimum acceptable

rate of return of 8% for projects funded by general tax revenues. The taxpayer might prefer projects to have a financial return of 8%, but perhaps would be willing to include clearly documented economic benefits received by society.

There is certainly some credibility to the argument that governments should not use tax revenues for projects with only modest benefits if the same money could have been better used by the taxpayers themselves. Deciding what rate of return is required is a matter of policy more than logic. In the United States, the General Accountability Office from time to time issues guidelines for the discount rates that should be used for public projects. These rates have recently been 7-8%, which is consistent with the logic expressed above. Given the many difficulties in measuring and monetarizing the public costs and benefits of a project, the choice of a discount rate is just one of many analytical assumptions that must be considered in evaluating a public project.

MARR for Special Government Agencies

Governments sometimes create special independent agencies that are authorized to raise money by selling bonds. These bonds are backed not by taxation, but by the financial credit of the agency. For these agencies, the cost of capital really is the interest rates that they must pay on their bonds. These agencies are therefore able to invest in projects with low financial returns – presumably justified by the broader socio-economic benefits provided by the agency. Examples would include port authorities, turnpike authorities, and housing authorities.

Choosing a Discount Rates: Examples

This section presents several examples that illustrate the logic behind the choice of a discount rate. Note that the choice is heavily dependent upon the perspective of the individual or organization that is making the choice. In some situations, there may be no clear answer, and there is usually no precise answer.

Determining the Interest Rate for Corporate Bonds

As the VP Finance for Acme Construction, you have been asked to estimate the interest rates on bonds that your company plans to sell in order to finance the construction of a new toll bridge. Long-term US Treasury Bonds currently pay just under 5% interest, and you know that investors usually consider these to be nearly risk-free investments. You expect that the rate of inflation (currently 2%) will increase to 3% by the time that your company is ready to sell the bonds. You expect that your company's bonds will continue to have a risk premium of 2% relative to US Treasury bonds. What interest rate should you plan to pay on these bonds?

This question addresses the interest rates that investors will require to invest in your project. From a financial analyst's perspective, the interest rate will be determined by the market. As seen in section 8.3, the market requires higher returns for riskier securities (see the figure that illustrates a risk/return curve). Discount rates for each type of security will equal the sum of three factors:

- the interest rate on a risk-free, inflation-free investment (i.e. the basic time value of money)
- the inflation rate
- a risk premium

Here, we have 5% interest on US Treasury bonds, which includes inflation, but is presumed to be risk free. We expect inflation to increase by 1%. And the risk premium will be 2%. Therefore we expect the rate to be 5%+1%+2% = 8%

Choosing a Discount Rate Based Upon a Firm's Cost of Capital

Brothers K, a construction firm specializing in prison security, borrows money at 6%; its stock is priced by the market to provide a 12% return. The company's debt/equity ratio is currently 2. What discount rate should the company use to evaluate new projects so as to at least cover its weighted average cost of capital?

We know that the company's MARR should be at least as great as the weighted average cost of capital. We are given no further information about the company, except that it is an established firm with prior projects and an ability to raise money by borrowing or by selling stock. The debt/equity ratio of 2 means that loans account for 2/3 of the market valuation of the company, while stocks account for 1/3 of the market valuation. The weighted average cost of capital will be 2/3(6%) plus 1/3(12%) = 8%. It would be possible to argue for a higher rate based upon the likelihood that the MARR will be above, or even significantly above the WACC.

Choosing a Discount Rate for a City

Cities must justify investment in infrastructure by comparing the present worth of net benefits over the life of the project to the present worth of the construction costs. Cities raise money through income tax, property tax, or the sale of bonds. Interest paid on municipal bonds is about 4%, which is lower than the interest rates that private companies pay on their bonds (about 6%) and much lower than the returns required to sell stock (10% or more). What discount rate should the city use in evaluating the present worth of their investments?

A city's discount rate must be greater than the interest it pays on bonds (4%) because it raises money from taxpayers – individuals and companies - who have other options. The cost of capital for taxpayers will reflect some mixture of debt and equity financing, i.e. about 8% if the Brothers K firm in the previous example is typical. As noted above, the General Accountability Office requires the U.S. federal government to use something like 7-8% for discounting related to public investments.

Choosing a Discount Rate Based Upon a Firm's Investment Options

Earp Enterprises is a developer in Arizona that specializes in building relatively inexpensive, but functional corrals which they call "OK Corrals". Because of the company's use of advanced planning techniques and standardized components, it has consistently been able to make a return of 14-18% on its projects. The company's weighted average cost of capital is 10%, and it is a highly profitable company. A recent PhD from MIT, Flora Holliday, would like Mr. Earp to invest in a second home development focused on a new marina at Lake Powell. She has prepared a business plan that shows the cash flows that she expects from this venture, which she calls "Holliday Docks". What discount rate should Earp Enterprises use to determine whether or not to shoot down this proposal?

Earp's MARR must be greater than or equal to his cost of capital, which is 10%. If capital is unlimited, then any project that earns the cost of capital will be acceptable. On the other hand, capital probably is not unlimited and the question certainly implies that Earp has done very well on his prior projects. Since Earp has won many financial victories at his OK Corrals, he seems to have opportunities to make 14-18% "consistently". Hence, his MARR should reflect the lucrative potential for continued investment in OK Corrals and be higher than the WACC, perhaps 14-15%.

Dividing Up the Cash Flows of a Major Project

It is important to understand that the various players involved in a major project will have markedly different cash flows, different risks to worry about, and different MARRs. Consider a case where a developer has secured a line of credit from Bank One for constructing a building. The bank will pay all the construction costs and charge the owner interest; no payments will be made on the loan until the project is completed, at which time loan payments will begin. The construction loan is likely to have a high interest rate, since there are risks related to the feasibility, time, and cost of construction. The owner plans to refinance the loan with Bank Two when the building is completed at the end of

year 3. Refinancing should provide a lower interest rate because the building will in fact be completed and there will (hopefully) be tenants who are paying on long-term leases. If all goes well, the new loan will cover the construction loan and the monthly loan payments plus operating costs will be less than the revenue from the tenants.

The cash flows for the three major players will be as follows:

- Bank One – pays all construction costs as they are incurred over the three years of construction; receives reimbursement plus interest when the loan is refinanced at the end of year 3.
- Bank Two – gives the owner an amount large enough to pay off the construction loan at the end of year 3; receives monthly payments of principal and interest for the life of the mortgage.
- Owner – pays nothing during construction period, since all of those costs are covered by Bank One; receives a large amount from Bank Two at the end of 3 years but immediately uses that money to pay off the loan from Bank One; collects lease payments, pays for operations, and makes loan payments to Bank Two over the life of the loan.

Bank One has completed its role by the end of year 3. Bank Two just starts its role at that time. The owner, if all goes well, doesn't have to put up his own money to construct the building, and then has sufficient cash flow to cover the mortgage payments. Bank One prefers to earn a high rate of interest rather than to hold on to its cash; the owner prefers to have the cash as needed. Bank Two is willing to accept lower interest, but is also creating a long-term annuity for itself. The owner would rather pay the interest on a long-term loan than pay for the building when it is constructed.

We could go into more detail and consider such things as the cash flow for the construction firms and suppliers or the possibility of selling the building upon completion. Each actor will have different perspectives on whether or not this is a good project, and each will have a different level of exposure to the risks that might be associated with the project.

Summary

Discounting is a mechanism for converting an arbitrary stream of cash flows into a present value, a future value, or an annuity. Three main factors must be considered in choosing a reasonable discount rate:

- Investment opportunities: what alternative opportunities are available for investment?
- Risk: is the proposed project more or less risky than the other options?
- Inflation: how much will inflation reduce the future purchasing power of of our money?

Discount rates and the notion of a "Minimum Acceptable Rate of Return" (MARR) are very important and potentially very confusing topics. The confusion results because of the differences in perspective among the various actors involved in designing, building, and financing a project.

Developers and entrepreneurs are generally in the position of raising money for constructing projects that they believe to be justifiable in terms of their future benefits. Since they lack the funds to build these projects, they must convince others to invest in them, possibly by citing the importance of the project, but more likely by demonstrating the potential profitability of the investment. Developers have various strategies for raising funds for their projects, including borrowing money from a bank, selling bonds, and selling stock.

Investors have a much different perspective than developers. Developers are thinking of receiving rents or tolls or operating profits, which they hope will be enough to cover the mortgage or interest payments or to justify a high price for their stock. For them, the cost of money is similar to the cost of energy or labor, and their main concern is about the long-term success of their projects. For the bankers and other investors, the nature of the project is much less relevant than the prospect of making money from mortgage payments, loan payments, bond-interest or rising values for the stock they have purchased.

Financial markets exist for stocks, bonds, mortgages, mutual funds, and other types of financial assets. The price of these financial assets depends upon the market, i.e. upon the price that a willing seller will accept from a buyer. The value of these assets (to an investor or a securities analyst) is based upon a projection of cash flows, an estimation of the risks associated with these cash flows, and the availability and price of other assets with similar levels of risks. Different potential investors may view the cash flows, the risks, and the alternative opportunities quite differently, which is part of the reason why securities are continuously bought and sold.

The different perspectives of financial analysts, governments, independent government agencies, and private companies result in different ways of determining their MARRs. Financial analysts are not particularly concerned about the merits of a company or a project; their job is to determine the risks associated with stocks, bonds or loans associated with a company or a project. A company with good credit can easily raise capital to invest in bad projects; a company with no past history may be unable to raise funds even for projects that may appear to the public to be highly desirable.

When local, state or federal government agencies discount the costs and benefits of proposed projects, their discount rate should reflect the average returns available to taxpayers, not the low interest rates on public bonds. However, if a special public agency raises money by selling bonds rather than through taxation, then it can use the interest rate on those bonds as its MARR.

For private companies, the MARR should be at least as great as their weighted average cost of capital, and it should be at least as high as the rate of return achievable on alternative projects or on investments in the financial markets. In practice, the financial risks associated with leveraging will generally result in an MARR well above the weighted average cost of capital.

In any situation, the discount rate is a rather fuzzy number, so it will be wise to consider a range of discount rates when evaluating a project.

In major projects, it is usually necessary to raise funds for construction from banks (loans) or financial markets (stocks and bonds). An entrepreneur or a company presents estimates of costs and benefits to banks and investors, who then evaluate the risks and choose discount rates consistent with their own MARRs. If a commitment is made to pay the banks before paying interest on bonds or dividends on stocks, then the banks' investments in the project are less risky than the investments made by those buying stocks and bonds. If the project is being undertaken by a government agency or a large company, it may be possible to get a low interest rate for loans based upon the agency's or company's credit rating rather than a rate based upon the riskiness of the project.

If you can reduce the perceived risks of your project, you can raise more money because investors will apply a lower discount rate to the same future benefits. In particular, a project that has been completed or that has very clear commitments for cash flows (leases for a building; approved tolls for a highway; approved public subsidies) will have lower risks than a new project with uncertain time to completion and no guaranteed source of income.

"Leveraging" is a term used when money is borrowed for your project and a pledge is made to a) repay the loan or b) turn the project over to the lender if loan payments are not made. Borrowing reduces the amount of their own money that the owners must put into the project and allows a chance for a greater return on their investment, but also creates greater financial risks.

Resource: Project Evaluation: Essays and Case Studies

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