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Discount Rate for Investments: Some Basic Considerations in Selecting a Discount Rate

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Abstract

A discount rate is the interest rate used in discounting future values to present values. It is the opportunity cost of capital representing the minimum rate of return to justify the investment. The market rate of interest has three components: risk, inflation and real interest rate. There is not any single accepted procedure for determining the appropriate discount rate. Two comprehensive approaches are suggested: (1) Opportunity cost of capital approach, (2) Social rate of time preference approach. Theoretically opportunity cost of capital, weighted average discount rate, and the shadow price of capital are most commonly considered. Each approach has its advantages and disadvantage and practically difficult to apply. No single discount rate will be appropriate for all applications. A particular discount rate must be adjusted to particular times, locations, type of projects and methods of financing.

Since a small percentage change in the discount rate can have a drastic impact on a net present value, relatively an accurate approach in determining the discount rate is needed. A discount rate is the interest rate used in discounting future values to present values. Thus, the interest rate used for discounting is also called the discount rate. The choice of a discount rate is the same to a statement of an investor's preference for present consumption or future consumption. A lower discount rate means more resources will be made available to the future than with a higher discount rate. The discount rate is a difficult task to estimate. It is the opportunity cost of capital representing the minimum rate of return to justify the investment. If the suggested investment is not competent to earn this minimum, the capital should be invested in an alternative investment.

Adjustments for risk[1] and inflation[2] need to be considered in selecting a discount rate. Public and private investors are risk averse and should use risk-adjusted discount rates exceeding the risk-free rate (Hirshleifer). The market rate of interest has three components: risk, inflation and real interest rate[3]. The higher the risk of default on a loan, the higher the interest. In the United States, economists use the interest rate on long-term U.S. Treasury bonds as a proxy for the risk-free rate, as the chance of U.S. government defaulting on these obligations is close to zero (Kahn). To compensate for inflation some adjustments have to made to decide an appropriate discount rate. These adjustments are important for justification of the selected discount rate. To counterbalance for risk, a risk premium may be added to the discount rate. It is important to note that adding a premium to the discount rate does not eliminate risk. Therefore, why should investors add a risk premium to justify the discount rate?. A decision on discount rate to use in justifying investments has remained a controversial issue among economists. The main objective of this study is to determine a reliable procedure for selection of an appropriate discount rate to be used for investments. Theoretical background and practical point of view in selection of a discount are discussed.

There is not any single accepted procedure currently in practice for determining the appropriate discount rate at which projects are to be evaluated. Two comprehensive approaches are suggested which are relatively more appealing. (1) Opportunity cost of capital approach, (2) Social rate of time preference approach.

Weighted Average Discount Rate

To select a social discount rate, the opportunity-cost approach is the most objective and operational (Baumol). It measures the opportunity cost of capital in the private sector as a discount rate in the public sector. The discount rate according to this approach is based on the source from which investment funds are withdrawn. For example, when funds are obtained from increased savings, a net rate of return to savers (q) as a discount rate is theoretically justifiable. If funds are obtained from the reduced investment, then investment rate of return (i) is a proper discount rate. On the other hand, if some funds are obtained from the increased savings and the remainder is

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[1] Risk may be viewed as resulting in an additional cost to the firm, which must be met in achieving an optimal organization of the firm's activities. The firm will engage in a risky activity only if it is compensated for certain costs and risk costs. The effects of these added risk costs can then be evaluated and will alter the firm's choice of activities (Robinson and Barry).

[2] A rise, over time, in the average level of prices.

[3] Interest rates adjusted for the expected erosion of purchasing power resulting from inflation.

obtained from the reduced investment in private economy, then weighted average of i and q will be a proper discount rate. This positive weighted-average return represents what is forgone when public projects are undertaken, and is the *minimum* return required on projects of the public sector.

If a project in the private sector generates a 10 percent rate of return and by investing that amount of funds in the public sector generates 7 percent rate of return. This project in the public sector may not be approved on the basis of efficiency, as its rate of return is less than the private sector. The weighted average discount rate approach is not practical, because the information about relative proportion of displaced consumption and reduced investment in the economy is difficult to obtain. Or it is difficult to identify the relative weights for the two sources of funds used in a project.

Social Rate of Time Preference

This approach to select a discount rate places the emphasis exclusively upon *consumption* forgone (Marglin, and Hirschleifer). The social rate of time preference (SRTP) discount rate reflects the time preference consumers assign to consumption now as against consumption in the future. This approach accounts for intergenerational equity (fairness) concerns. The view is that government has an obligation to provide the welfare of unborn generations. Time preference in the approach is treated at a societal level. Essence of this approach is that individuals tend to value the present more than the future. Individuals' impatience or time preference arises from a psychological basis that how would a person consume a cake over time?. Therefore, a market rate reflecting the time preference of current generation is likely to be higher than the social rate reflecting intergenerational preferences. The SRTP represents the market rate adjusted for external effects or ethical considerations. The market rate of time preference (MRTP) represents the rate at which one is willing to trade present consumption for future consumption. The SRTP is the rate at which society is willing to trade off present for future consumption.

Although this may be correct theoretically, but it is impossible to apply, since the data it requires are not available. These adjustments may not be possible spatially when long-term horizon projects are involved. It is because the time preference of unborn is not observable. In other words future generations cannot be here to argue on their behalf, therefore we must be "fair" in distribution of benefits between generations. In discounting the single time dimension is important to compare the costs and future stream of benefits of a project.

Technological advances and innovations may take place any time in future and in this sense the welfare of future generation may be greater than the present generations or at least it may not be affected at all. For example, before the invention of the electronic fuel injector the consumption of gas was 10 miles per gallon, but after this invention the mileage increased from 10 miles per gallon of gas to 20 miles per gallon. It is just like the oil resources increased twofold. Consequently, the welfare of the generation increased after this invention compared to the past generations.

Discounting in Practice

Knowing what discount rate to use is quite an insightful practice, one that has taken the attention historically hundreds of economists over the past 50 years. In practice, it is very difficult to suggest a particular discount rate. The best approach is that the analyst should justify the use of a specific discount rate. For example, if society's saving rate is relatively low by world standards, then social rate of time preference (SRTP) likely will be a proper approach, particularly when the funds needed for a public project come at the expense of reduced consumption.

However, if the required funds crowed out (raising funds for public investments reduces the amount of private investment) other investment (private or public), then the cost of capital approach (market rate of return adjusted for possible market distortions) or shadow price[4] of capital approach may be appropriate. In a world of increasing capital mobility, the opportunity cost of funds to the public sector is unaffected by the crowding out argument (Lind 1990). The public sector should use the real cost of borrowing on the world market. For example, the U.S Congressional Budget Office used a real discount rate of 2 percent in 1986 (Hartman).

In general, some projects will offer such a high rate of return that they would appear desirable according to the benefit cost criteria regardless the discount rate employed, or some projects will offer such a low rate of return that they would not appear desirable according to the benefit cost criteria regardless the discount rate employed (assuming the discount rate used is in a reasonable range, like between 3 to 15 percent). However, appropriate discount rate value still required to investigate for other projects which appear efficient for some discount rates but inefficient for others. In such type of situations, a sensitivity analysis can be performed for detecting relatively a proper discount rate.

In case of public sector agencies, they use different procedure in selecting a discount rate. The Office of Management and Budget (OMB) adopts the shadow price of capital approach to capture the effects of government projects on resource allocation in private sector (Circular No. A-94). Moreover, the treasury's borrowing rates are

[4] Shadow price may be defined as the increase in social welfare resulting from any marginal change in the availability of commodities or factors of production. It may or may not be equal to the market price. (SP = change in social welfare/change in output of public investment). In this approach all future costs and benefit streams are converted into consumption equivalents and discounted these streams at the rate of time preference. Project's costs (C) are future stream of consumption benefits expected from displaced private investment. These benefits are discounted by the rate of time preference, and then compared to the projects benefits (B), which are also shown in consumption values and discounted by the rate of time preference.

also used as discount rates in some particular analyses, for example, internal government investment.

The General Accounting Office (GAO) uses a discount rate based on interest rate for marketable treasury debt with maturity comparable to the project being evaluated. The Congressional Budget Office (CBO) uses a discount rate based on the real yield of treasury debt. The appropriate discount rate is government-borrowing rate, since the nominal rate on government securities will include the risk premium (Hartman). Because, society as a whole is neutral towards risk. Society is able to pool their risk by means of sharing, that is a large number of beneficiaries share the risks (Arrow and Lind).

In spite of the current empirical studies in this area, the pretax rate of return to private capital and the federal government's borrowing rates as appropriate discount rates are still remain unimpeachable (Nas).

In fact, a search for the optimal discount rate as Baumol points out is, a wild goose chase. Although it may not be possible to find the optimal discount rate, but we must guard against arguments for high or low discount rates. Otherwise it may destroy the objective of the discount rate and the benefit-cost analysis. For example, the purpose of a generational discount rate choice is to determine the "economically optimal extinction" of a renewable resource (Burton).

Relatively, as the shadow pricing method is improving over time, one practical procedure may be to evaluate the present value of a project over a range of discount rates and to determine the upper and lower bound discount rates (sensitivity analysis). An appropriate discount rate also depends on special contexts of the policy problem (Lind). How, session chair of a debate "Discount Rates: Theory and Practice.", concluded with the opinion of other participants that: (i) no single discount rate will be appropriate for all applications. (ii) Shadow price of capital approach is the most defensible but difficult to apply and opens the possibilities for making manipulations. (iii) Discount rate must be adjusted to particular times, locations, type of projects and methods of financing. For example, in late 1980's a real rate about 2 percent was quite appropriate in the light of above-mentioned considerations. Once the discount rate selected the adjustments for inflation and risk may need to be considered.

Adjustment for Inflation

There are two procedures to adjust for inflation for computing the present value of a project and both arrive at the same thing. (1) Nominal terms, (2) Real terms. This discount rate can be expressed either as nominal discount rate (including inflation factor) or real discount rate (excluding inflation factor). The nominal discount rate (i) can be calculated with the information of real discount rate (r) and inflation rate (f):

$$1 \qquad PV = \frac{\sum [(B_t - C_t)(1+f')]}{[(1+r)^t (1+f')]}$$

$$2 \qquad PV = \frac{\sum (B_t - C_t)}{(1+r)^t}$$

$$3 \qquad PV = \frac{\sum (B_t - C_t)}{(1+r)^t}$$

$$4 \qquad i = [(1+r)(1+f)] - 1$$

$$5 \qquad i = r + f + rf$$

$$6 \qquad r = \frac{(1+i)}{(1+f)} - 1$$

Where i is the market interest rate, r is real interest rate, and f is inflation rate. Similarly knowing the market rate of interest and inflation rate, real interest rate can also be calculated:

Assuming that there is no inflation in the economy, the PV can be calculated by using Equation (4). Now let us assume that there is a certain amount of inflation (f) in the economy that can be incorporated in the Equation (5) both in the numerator and in the denominator. It is obvious that this inflation factor can be canceled from the Equation (5), which results again as Equation (4). Hence the evaluator can either use the real (noninflated) B's and C's and the real interest rate (noninflated) or nominal (inflated) values of B's and C's and nominal interest rate (inflated) obtaining the same results.

To avoid mistakes in practice, evaluators should not discount real net benefits by the nominal interest rates, and they should not discount nominal net benefits by the real interest rate. The U.S. government has been using benefits and costs in real terms, but discounted by actual nominal interest rate on long-term U.S. government bonds (Gramlich). In times of inflation, this nominal interest rate does increase. In case of long-term projects it becomes more critical because the benefits are realized more in the future than when the costs are borne, hence leading to over discounting the benefits.

Regardless of the approach adopted, the analyst encounters some problems. If the analyst assumes that there is no inflation, he has to make some judgement about the private opportunity cost of the capital in the absence of inflation. When inflation is anticipated, the nominal return to private investment (or consumption) contains an inflation premium that may be very difficult to estimate.

If the analysts want to incorporate the inflation component to calculate the present value, the analyst will be confronted with the problem of predicting the rate of inflation for many years in the future.. In practice, probably most analysts' estimates present value of future benefits and costs in constant prices and they practically ignore the inflation (Anderson and Russell).

Adjustment for Risk

The objective of benefit cost analysis is the identification and measurement of a project's benefits and costs occurring in different time periods. Naturally uncertainties or risks are involved in estimating precisely the future benefits and costs, and it may become more risky when analysis involves many years into the future. This is because over long period of time many changes may occur, such as change in size of population, population migration, changes in consumption patterns, technological improvement and innovations, and perhaps even weather changes. As the crop production is largely dependent on the weather, therefore the risk management in agriculture is of vital importance. In fact, the uncertainties about the future are an inherent aspect of life. The role of benefit cost analysis is to provide the precise estimates, when the analyst has less than perfect knowledge.

Discount Rate Adjustment

The adjustments generally mean increases in the rate used to discount benefits and decreases the discount rate applied to costs. It tends to reduce the magnitude of discounted benefits while increasing that of discounted costs (Anderson and Russell). Consequently, on fewer projects will be approved on the basis of economic efficiency. The analyst also required to decide that what should be the magnitude of the adjustments. The appropriate adjustment magnitudes can be determined by examining the rate of returns earned on similar investments in the private sector (Arrow and Lind). If a private project is yielding a 12 percent rate of return whereas the overall opportunity cost of capital is 9 percent, then the appropriate adjustment value would be 3 percent that is the difference between the two rates. Hence, in this example, 12 percent discount rate should be used to discount the benefits and costs of this specific public project. Society as a whole is neutral towards risk (Arrow and Lind). They argued that society is normally able to pool its risks effectively by means of large numbers of beneficiaries sharing the risks.

Reliable adjustments can be made only within the situation of a two-period model. It is important to note that generally, the risk premium is added to the projects only if the uncertainty increases over time. However, this may not be true in every situation. Especially when the public sector has distributional objectives there may be a negative covariance between public projects and the economy in the absence of such projects. Here it will be suitable to reduce the discount rate rather than to raise it (Brent). Robert Wilson also pointed out that risk premium is not added because of variation in the outcome of the project. It is added because the correlation of the project with other projects or other sources of national income. If this correlation is enough negative, then tax or charge for risk is negative. In this situation it would be appropriate to lower the discount rate rather than to increase.

Public sector and private sector risk adjustments will be different, because the public sector would undertake different projects from the private sector. Hence, the covariance would be different (covariance between a particular project and the state of economy in the absence of the project), and therefore different risk adjustment.

In either situation it is important to note that adding or deducting a premium to the discount rate does not eliminate the risk. It is simply a way to build in a margin for error.

Conclusion

Theoretically opportunity cost of capital, weighted average discount rate, and the shadow price of capital are most commonly considered. Each approach has its advantages and disadvantage and practically difficult to apply.

Practically, public sector agencies use different procedure in selecting a discount rate. The General Accounting Office (GAO) uses a discount rate based on interest rate for marketable treasury debt with maturity comparable to the project being evaluated. The Office of Management and Budget (OMB) uses the shadow price of capital approach and treasury's borrowing rates as discount rates. The Congressional Budget Office (CBO) uses a discount rate based on the real yield of treasury debt. The pretax rate of return to private capital and the federal government's borrowing rates are still the appropriate discount rates.

No single discount rate will be appropriate for all applications. A particular discount rate must be adjusted to particular times, locations, type of projects and methods of financing. Once a specific discount rate selected, inflation and risk adjustments may be required. In practice, present value of future benefits and costs is generally estimated in constant prices and practically the inflation is ignored. Adjustment for risk requires a higher discount rate for net benefit streams positively correlated over time with other projects or GNP and lower for negatively correlated net benefit streams.

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