Title: Sources or Risk in Capital Budgeting

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Abstract: My focus in this paper was the fact that one of the most important activities in any enterprise is that of capital resource allocation. Decision makers must have access to relevant and reliable information to select the "best" capital investment alternatives(s). However, this decision-making process is full of "risk" or "uncertainty" because future business, technological and political conditions can never be known with certainty.

SOURCES OR RISK IN CAPITAL BUDGETING

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INTRODUCTION

One of the most important activities in any enterprise is that of capital resource allocation. Decision makers must have access to relevant and reliable information to select the "best" capital investment alternative(s). However, this decision-making process is full of "risk" or "uncertainty" because future business, technological and political conditions can never be known for sure.[1]

The evaluation of capital projects involves estimating the benefits and costs that will result from undertaking these projects and then using these estimates to evaluate project desirability.[2] Of course, the resulting decision can only be as good as the information used to make the evaluation.

RISKS IN CAPITAL BUDGETING DECISIONS

Determining the profitability and risk of a capital investment is of utmost importance to management. The decision to accept or reject a project is often very difficult because the future cash flows generated by the investment can never be known with perfect certainty at the time of the initial outlay.

Generally, management selects those factors affecting cash flow whose uncertainty is to be quantified. Examples of factors which can affect cash flows include:

* cost of capital
* inflation
* capital investment amount
* capital expenditures
* sales price

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[1]Ouederni, Bechir N. and William G. Sullivan, "A Semi-Variance Model for Incorporating Risk into Capital Investment Analysis," The Engineering Economist, Vol. 36. No. 2, Winter 1991, p. 83.

[2]Quirin, G. David and Wiginton, John C., Analyzing Capital Expenditures: Private and Public Perspectives, Homewood, IL: Richard D. Irwin, Inc., 1981, p. 105.

* volume
* working capital
* salvage value/removal cost
* sales forecast
* manufacturing profit
* project life

Although all of the above factors can affect cash flows, judgment must be used in selecting only those factors that have significant effect on the project's future cash flow.[3] Otherwise, the interactions of the factors quickly make the analysis unwieldy. However, factors should not be dismissed without a proper consideration of their possible effects, since some of the effects may not be readily apparent or intuitive. The effects of many factors which affect capital budgeting decisions are discussed in this paper.

RISK DEFINED

Risk exists because we are unable to make perfect forecasts. Nearly all engineering economics problems require predicting such future events as the cost of a project, the demand for a given product, or the interest rate over the life of the project. Many problems contain important variables for which substantial uncertainty exists.

Some economic theorists have tried to distinguish between risk and uncertainty.[4] The usual basis for such a distinction is whether the probability distribution of outcomes is known or unknown. For the purposes of the following discussion, the term "risk" will refer to situations where some kind or probability

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[3]Singhvi, Surendra S., "The Capital Expenditure Evaluation Methods," Handbook of Budgeting, 2d ed. (Sweeney, H.W. Allen, and Rachlin, Robert, eds), New York: John Wiley & Sons, 1987, p. 394-398.

[4]Quirin and Wiginton, p. 345.

distribution, whether objective or subjective, can be generated. Thus, to the firm, risk is the possibility of unforeseen fluctuations in its cash flow. Under conditions of risk, the cash flows are generally regarded as being random variables.

METHODS OF ASSESSING RISK

Variability in the data is often modeled probabilistically to reflect its inherent "riskiness." When large amounts of money are involved, quantification of these deviations in terms of risk profiles is vital to decision makers who seek safe investments.[5] One commentator noted, "Risk, like beauty, lies in the eyes of the beholder."[6]

Future events are a priori random variables. Single-value estimates may adequately represent the expected value of the probability distribution of outcomes, but may also be systematically biased.[7] Thus, the relative dispersions of outcomes and the associated project risks usually differ, and must be taken into account in the decision-making process.

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[5]Ouederni and Sullivan, p. 85.

[6]Singhvi,"The Capital Expenditure Evaluation Methods," p. 392.

[7]Quirin and Wiginton, p. 41. The authors note that sufficient account of risk can not be taken by utilizing the expected values of the probability distributions and trusting these to work as actuarial equivalents to the rate of return of benefit-cost ratio in the certainty case. First, an attempt to maximize expected income under conditions of risk has long been recognized as capable of leading to ridiculous decisions, such as paying an infinite sum to play the notorious St. Petersburg game. (p. 350, citing Daniel Bernoulli, "Exposition of a New Theory on the Measurement of Risk," (1730), reprinted in Econometrica (1954), pp. 23-36). Second, it is contrary to observed behavior in that most firms hedge certain risks and insure against others at a cost which is in excess of the expected value of receipts from the contract. Finally, although limited liability relieves the stockholder from the possibility of losses in excess of the amount invested, lesser losses are transmitted to her either as reduced dividends or capital losses in the value of her stock. (pp. 349-50).

In practice, measurement of risk may prove quite difficult, and many practical businesspeople as well as economic theorists have argued against it.[8] The principal argument is that there are so many factors that must be considered in attempting to evaluate risk that it is either impossible, too time consuming, or too expensive to do so with enough accuracy to be of any use. However, ongoing theoretical developments in finance postulate how, in principle, the relevant dimensions of risk can be measured and used in decision making. Second, arguments based on the computational difficulties are no longer valid given the decreasing cost and increasing availability of sophisticated calculators and computers.[9]

Although risk appears difficult to accurately measure, reasonable quantitative or qualitative estimates of risk can be made in many cases. The general stages of the measurement process are the identification of possible outcomes, the conversion of these outcomes to money gains or losses (or nonmonetary gains and losses), and the assignment of probabilities.[10]

Statistical regression techniques can be useful in attempting to estimate many variables. However, the model often must depend, partially or exclusively, on the data provided by executives and others who are knowledgeable regarding the situation for which the model is being constructed.[11] A problem may be introduced through conscious or subconscious bias. That is, managers may "overshoot" in estimates (to gain a project's acceptance) or "undershoot" (to appear talented when

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[8]Quirin and Wiginton, p. 349.

[9]Quirin and Wiginton, p. 349.

[10]Levary, Reuven and Neil E. Seitz, Quantitative Methods for Capital Budgeting, Cincinnati, OH: South-Western Publishing Co., 1990, p. 5.

[11]Carter, E. Eugene, Portfolio Aspects of Corporate Capital Budgeting, Lexington, MA: Lexington Books, 1974, p. 44.

the project performs better than expected).[12]

Another way of quantifying risk is through the use of forecasts. However, forecasting is based on current costs and estimates of future cash flows and therefore will always possess some error. Usually the degree of error correlates with time: short-term forecasts are generally more accurate than long-term. Hence, the degree of risk inherent in an investment usually increases with the expected life of the investment.[13] Forecasts may also lose accuracy in periods of rapid changes.

In practice, managers must rely on their own knowledge and that of experts to estimate the expected cash flows and the variance-covariance matrix around the flows which are needed to measure potential forecast errors. This is not a trivial exercise: For a capital investment expected to last T periods, T expected values and (T/2)(T-1) individual variances and covariances must be estimated.[14]

Where quantitative data about the risk is not available, it may be possible to use qualitative data in the capital budgeting process. Buhler[15] examined the selection of single-risk capital budgeting projects under the assumption that management has some qualitative ideas about the future development of the business environment (affecting the investment decision), but not enough

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[12]Carter, p. 46.

[13]Pritchard, Robert E. and Hindelang, Thomas J., The Strategic Evaluation and Management of Capital Expenditures, New York: AMACOM, 1981, p. 18.

[14]Giacotto, Carmelo, "Cash Flow Modelling and Forecasting in Capital Budgeting Under Uncertainty," Decision Sciences, Vol. 21, no. 4, Fall 1990, p. 825.

[15]Buhler, Wolfgang, "Capital Budgeting Under Qualitative Data Information," Capital Budgeting under Conditions of Uncertainty, (Crum, Roy L. and Derkinderen, Frans G.J., eds.), Boston: Martinus Nijhoff Publishing, 1981, pp. 81-117.

information to define a probability distribution.[16] The decision process could then be defined using this qualitative information by assuming that the information available to the management about future development of uncertain data can be represented by a weak partial order of "not less probable than" for the various states of nature. Graph theory is then used to represent the partial orders as a directed graph where the nodes are identified with the states of nature. Linear programming techniques can then be used to determine the optimal projects using this qualitative information.[17]

METHODS OF DEALING WITH RISK

After looking at the sources and possible magnitudes of risks associated with the capital budgeting process, managers must be able to make some sort of decision. Various methods to

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[16]Examples of these types of situations include: (1) The economic life of a project depends heavily on technological process. An estimation of the probability distribution is most likely to be impossible. Management, however, might be able to make branch-conditioned ordinal estimates stating that, for example, a six-year economic life is more probable than a ten-year one. (2) The wages paid in the next years depends on future union contracts. The rate of increase of wages lies between 5% and 10% with certainty. In addition, because of the general economic climate and the specific situation in the line of business, it is more probable that the union contract leads to an increase of wages between 6.5 and 7% than between 8 and 9%, which again is more probable than a rate of increase between 5 and 6%. (3) Future sales opportunities are of central importance for a capital budgeting decision. Expectations on sales volume in a future period will depend on the sales volume in previous periods. In general, an estimation of the stochastic process of future sales volumes will not be possible. All the same, it might be possible to make a judgment of the following kind: "If in period t the sales volume results in an amount between 200,000 and 220,000 units, then it is more probable that in period $t + 1$ the sales volume ranges between 210,000 and 230,000 units than between 260,000 and 280,000 units, considering business environment and the individual advertising expenses." Buhler, p. 86.

[17]Buhler, p. 91.

account for the risk have been used in evaluating capital budgeting decisions.

Sensitivity analyses are commonly performed on variables such as throughput, project life, product price and interest rate. These types of variables are often dominant factors in determining the economic outcome of an investment. Any variable that is not fixed and that may alter the economic outcome is a potential candidate for sensitivity analysis.[18]

Linear, integer and goal-programming models for capital budgeting are generally based on the assumption that investment decisions are made under conditions of certainty. Under this assumption, all inputs to these models are deterministic; each is represented by a single numerical value. Although the numerical value characterizing a given input may vary with time, the variations are assumed to be known in advance.

In reality, however, capital budgeting decisions are made under conditions where the values of variables affecting the cash flows of the projects are not known with certainty. Computer simulation is a technique that can be used to study the uncertainty surrounding capital budgeting decisions. Simulation can also be used to analyze the risk consequences of various capital budgeting alternatives.[19]

An approach for dealing with risk using linear programming is to use the coefficient of variation, which is the ratio of the standard deviation of a variable to the mean value of that variable. Either the objective function can be set to minimize the sum of these coefficients over all projects for some variable (e.g., earnings per share or net present value (NPV)) or a constraint can be formulated in which the coefficient cannot exceed some base amount.[20]

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[18]Jones, Byron W., Inflation in Engineering Economic Analysis, New York: John Wiley & Sons, 1982, p. 132.

[19]Levary and Seitz, p. 221.

[20]Carter, p. 93-94.

Although the payback method has been widely criticized as a capital budgeting decision criteria, many firms retain payback as a supplementary criterion. Managers apparently feel that since forecasting for periods beyond the payback period is very difficult, payback will tend to protect them from excessive exposure to risk.[21] In the type of usually considered, payback is simply a comparison of expected after-tax cash flows for the first few years with initial outlays. However, this approach does not protect against unforeseen poor outcomes in the initial years. It entirely ignores the possibility of bad results subsequent to the payback period. Thus it may lead to acceptance of highly risky, but short-lived projects and the rejection of long-lived projects which are virtually risk free. It is difficult to imagine situations in which its use as a supplementary criterion could afford systematic protection against risk. In those situations in which it would be operative, it merely imposes constraints on the time shape of expected stream of cash flows, but none whatever on their variability.[22]

SOURCES OF UNCERTAINTY IN CAPITAL BUDGETING

As discussed above, the risks that accompany many of the cash flows in the capital budgeting decision processes must be carefully reviewed to determine whether the factor will have a significant influence on the decision. Some of the primary factors are discussed below, along with a discussion of the effects of these risks.

INFLATION

Inflation is generally defined as an increase in the prices paid for goods and services. The increase in prices can result

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[21]Quirin and Wiginton, p. 387.

[22]Quirin, and Wiginton, p. 388.

from either cost inflation or price inflation, or a combination of the two.[23] No one can foretell the exact future of inflation rates. Inflation thus adds an additional element of risk to the inherent commercial risks associated with capital expenditures. More precisely, the additional risk results from unforeseen deviations in the inflation rate from its expected values.[24]

One basis for evaluation of capital-expenditure projects in an inflationary context is to forecast cash flows in real, rather that nominal dollars, and to proceed with the analysis of NPV as if nothing else had changed. Doing so, however, involves the implicit assumptions that the cost of capital to be used in making the NPV calculations is itself unchanged as a result of the inflationary expectations. If, in fact, it has been changed and incorporates an allowance for inflation, such a procedure involves double counting -- taking out the effects of inflation twice -- and can easily lead to incorrect decisions.[25]

Even when inflation is not an explicit variable in a sensitivity analysis, often it may have to be considered. It is particularly important to consider inflation when the price of an input or a product is the variable of interest in a sensitivity analysis. The sensitivity analysis must differentiate between price changes due to inflation and relative price changes. A price increase due to inflation will generally affect the prices of all other items in a similar manner and certainly will not have the same effect as a relative price change that changes the price of only one item.[26]

Many engineering economic analyses are sensitive to the

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[23]Jones, p. 3. Cost inflation is the result of real cost increases to produce goods and services. Price inflation is caused by the fluctuations in the prices of goods and services when there has been no corresponding change in their real cost.

[24]Quirin and Wiginton, p. 336.

[25]Quirin and Wiginton, p. 314.

[26]Jones, p. 133.

inflation rate. However, those analyses that involve fixed dollar terms can be particularly sensitive to inflation.[27] Fixed terms may result from contractual agreements or any other arrangement that sets prices or cash flows over a period of time. If incomes or the prices of products are fixed in dollar terms and costs are not, expenses can rise as a result of inflation, and the fixed incomes may no longer be adequate to cover the cost of production. Such situations may lead not only to investments with poor returns if inflation is higher than expected, but also to unexpected cash flow problems.[28] The sensitivity to inflation becomes particularly acute when long periods of time are also involved.

COST OF CAPITAL

The calculation of the present value of an investment requires that the cash flows be discounted to the present a rate known as the "cost of capital."[29] The cash flows associated with a proposed project are an extremely important factor in capital budgeting decisions. If a project will require an immediate large outlay of funds, or if expenditures association with the project over its life occur at awkward times, the project may be rejected in favor of one with a lower return on investment. On the other hand, if a project promises to bring in cash at a time when it will be sorely needed, this will be a factor in its favor.[30]

Both the cash flows and the NPV of a project are influenced greatly by the cost of capital used for discounting. In the case of a combined conventional/nonconventional investment project, a

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[27]Jones, p. 134.

[28]Jones, p. 135.

[29]Murdick, Robert G. and Deming, Donald D., The Management of Capital Expenditures, New York: McGraw-Hill Book Company, 1968, p. 52.

[30]Murdick and Deming, p. 58.

higher rate of discount has the following consequences: Net revenues, discounted at the higher rate, are needed from more years than before to cover initial capital outlays; and net revenues, accumulated at this higher rate, are needed for fewer years to cover future decommissioning expenses. The opposite effects are found with a lower rate of discount. These effects have to be considered when choosing the appropriate discount rate.[31] Due to the strong impact that the discount rate has on the cash flows and the NPV of projects, sensitivity analyses are usually performed to determine the influence that different rates will have on the capital budgeting process.

A problem often encountered with inflation and rate of return analysis is that the real rate of return is less than the apparent rate of return by approximately the inflation rate. During periods of significant inflation an investment with a real rate of return of 5-10% may be attractive whereas an investment with an apparent rate of return with an apparent rate of return may be undesirable.[32] Thus, it is important to distinguish between discount rates that are real (based on constant dollar cash flows) or apparent (based on dollar cash flows).

INITIAL CASH OUTLAY

For most assets, the initial cost outlay consists of two parts: the purchase price and any associated costs of acquiring the asset, such as costs for transportation, installation and the like.[33] Although the purchase price is probably known with certainty, the associated costs are subject to uncertainty. This will particularly be the case in the acquisition of new

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[31]Asztély, Sandor, "Capital Budgeting Proposals with Negative Salvage Values," Risk, Capital Costs, and Project Financing Decisions, (Crum, Roy L. and Derkinderen, Frans G.J., eds.), Boston: Martinus Nijhoff Publishing, 1981, p. 191.

[32]Jones, p. 107.

[33]Pritchard and Hindelang, p. 57.

technology, since installation, debugging and test runs may consume more resources than forecasted. Additionally, as discussed above, inflation may have an impact on the initial cash outlay, especially if there are fixed payments for the project over an extended time frame.

OPERATING EXPENSES

Estimates of operating expenses are usually required for capital budgeting decisions. Operating costs include such things as direct labor, indirect labor. benefits, maintenance, tooling, materials and supplies, inspection, assembly, scrap and rework, down time, power, floor space, property tax and insurance, inventory, safety and flexibility. Data on the operating costs of equipment or facilities which are new to the company may be obtained from vendors or contractors, or from internal estimates.

Operating expenses can be influenced by the age of the machinery, throughput, labor rates, inflation, price of maintenance supplies, tax rates and unforeseen difficulties. Commentators have noted that maintenance and scrap costs are apt to be particularly difficult to estimate due to these uncertainties.[34]

WORKING CAPITAL

Working capital is well recognized as an important decision area within the firm. Commentators have argued that working capital ought to be viewed as an investment and that changes in working capital policies ought to be included in the capital budgeting process of the firm.[35]

There are some capital investment projects, such as

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[34]Murdick, and Deming, p. 47.

[35]Smith, Keith V., "On Working Capital as an Investment by the Firm," Risk, Capital Costs, and Project Financing Decisions, (Crum, Roy L. and Derkinderen, Frans G.J., eds.), Boston: Martinus Nijhoff Publishing, 1981, p. 167.

replacement, pollution control and cost reduction, that are not likely to require any additional working capital. On the other hand, there are projects such as expansion of existing product lines and new product lines that require investment in additional working capital. In some situations, it is also possible that a capital investment could reduce the present investment of working capital, such as by reducing maintenance reserves.[36]

Thus, the cash inflows and outlays should reflect working capital that is, both initial and subsequent cash outlays should include necessary investments in current assets while the final cash outflow should include recovery of working capital at the end of the project.[37] Working capital is also subject to many of the same uncertainties as other cash flows in the capital budgeting decision process, such as inflation, price increases and throughput.

TAX CONSEQUENCES

Governments have available many devices for encouraging or discouraging firms to undertake investments. Among the variables are the method of depreciation, the allowed life of assets, the treatment of salvage and investment tax credits or investment allowances.[38] Tax incentives, especially tax-rate reductions or accelerated depreciation, are often used to stimulate entrepreneurial investment and risk-taking.[39] Business and

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[36]Singhvi, Surendra S., "The Capital Investment Budgeting Process," Handbook of Budgeting, 2d ed. (Sweeney, H.W. Allen, and Rachlin, Robert, eds), New York: John Wiley & Sons, 1987, pp. 352-353.

[37]Smith, p. 171.

[38]Bierman, Harold Jr. and Smidt, Seymour, The Capital Budgeting Decision: Economic Analysis of Investment Projects, 6th ed., New York: Macmillan Publishing Co., 1984, p. 131.

[39]Schneider, Dieter, "The Influence of Tax Incentives on Capital Budgeting Decisions under Uncertainty," Capital Budgeting under Conditions of Uncertainty, (Crum, Roy L. and

engineering managers should be knowledgeable as to the nature of the current tax laws and sensitive to changes in the laws, especially where these changes can have an effect on the capital budgeting process.

Any measurement of benefits and costs in private firms must take account of the effects of taxes on property and incomes. The incremental effect on the tax bill resulting from proposed projects should be carefully calculated at the company's marginal tax rate and included in the cash flows. While depreciation must not be directly included in the cash flows. it affects tax liability by providing a tax shield which must be considered in the tax calculation.[40] Depreciation should not be charged against the income produced since provision for this is implicit in the procedure of comparing or equating the discounted benefit and cost streams. To deduct it again would involve counting the same cost twice.[41]

Where accelerated depreciation is available for one project but not another, this should be recognized in the evaluation. Where accelerated allowances are available in early years, the tax liability in later years is increased, relative to that which would be incurred in later years under normal depreciation practices. The net result is to increase the discounted NPV by shifting benefits to earlier years which are most heavily weighted under the discounting technique.[42]

The cash effect of an investment tax credit should also be included in the cash flow analysis of a capital budgeting decision. An investment tax credit that has been used several times in the United States allows most corporations to deduct 10% of the cost of qualified investments from their federal income

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Derkinderen, Frans G.J., eds.), Boston: Martinus Nijhoff Publishing, 1981, pp. 38-59.

[40]Quirin and Wiginton, p. 115.

[41]Quirin and Wiginton, p. 106.

[42]Quirin and Wiginton, p. 115.

taxes.[43]

Since the tax laws are a function of political pressures, the economy and similar factors, changes are difficult to predict. Tax rates change frequently, and the government sometimes provides tax incentives that are unavailable at other times. Thus, there is some uncertainty as to the effect that the tax laws and rates will have on future cash flows.

Another important feature of income taxes is that they are based on dollar profits and dollar income and are paid in dollars. No consideration is given to the effect that inflation has on the value of the dollar. Consequently, it is often necessary to first calculate taxes in dollar terms even though a particular engineering economics problem is to be solved in constant dollar terms.[44]

DEMAND FOR PRODUCTS

The demand for products is an important source of uncertainty in capital budgeting situations. Demand for products may be subject to consumer preferences, the general state of the economy, government regulations and similar factors. If the product is an existing one, reasonable forecasts may be prepared using historical data and trend information. For a new product, however, forecasts are much more subject to error. The decision maker should be particularly aware of overly optimistic marketing forecasts of future demand, especially when the forecast covers fairly long period of time, as discussed above.

PRICES

The prices of both raw materials and finished goods are subject to uncertainty. As discussed above with regard to inflation, the real prices of goods and services may rise due to

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[43]Quirin and Wiginton, p. 115.

[44]Jones, p. 118.

increases in the costs to produce these items. In the case of general inflation, the price level may rise relatively equally for all goods and services. In industries that are tied to only a few raw materials (for example, the lumber industry), unforeseen changes in prices can have a major impact on the correctness of capital budgeting decisions. Factors that influence prices include: inflation; competition (foreign and domestic); government intervention; general economic conditions; and technological improvements.

PROJECT LIFE

The economic life of a project depends heavily on technological process. However, the practice of evaluating capital budgeting projects on the basis of a discounted cash-flow analysis typically assumes that a project's life is constant, that is, known with certainty, whereas in reality it is stochastic. The stochastic nature of a project's life may be due to competitive technological advances, changes in consumer tastes and preferences, and the impact of complementary products.

The consequences of incorrectly assuming that the project life is a constant have been shown to bias the mean and variance of the NPV distribution.[45] In most instances, assuming that project life is constant underestimated the project variance. In one study, the average variance was under-estimated by more than 50% of the maximum possible amount.[46] The use of the expected life of a project instead of the life distribution of the project

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[45]Bey, Roger P., "The Impact of Stochastic Project Lives on Capital Budgeting Decisions" , Capital Budgeting under Conditions of Uncertainty, (Crum, Roy L. and Derkinderen, Frans G.J., eds.), Boston: Martinus Nijhoff Publishing, 1981, p. 63; Chen, Kevin C.W. and Manes, Rene P., "A Note on Bias in Capital Budgeting Introduced by Stochastic Life," The Engineering Economist, Vol. 31, No. 2, Winter 1986, pp. 165-174.

[46]Bey, p. 71.

can also bias the estimate of its expected net present value.[47] In most situations, the bias results in an overestimate of the expected net present value of the project. The bias from assuming a deterministic life is also affected by the discount rate, the cash flow patterns and income taxes.[48]

The resultant errors from assuming a constant project life may result in decision errors could be made by assuming that project life is constant. If a firm faced capital rationing and selected projects on the basis of the project NPVs, different ranking and different projects may be accepted due to the assumptions about project life.[49] A similar situation holds if the project variances are rank ordered.

TIME HORIZON

The choice of a time horizon refers merely to the selection of the time period which the decision maker will consider in evaluating benefits and costs. Some projects may be dependent on physical or legal circumstances and thus have a well-defined life. Others have indefinitely long lives and may still be yielding benefits 300 years from now. The most practical way of resolving the horizon problem is to let the discount rate take care of it.[50]

In practice, many firms impose a shorter limit on benefits and costs to be considered for many types of projects. The argument for this practice is that the future is uncertain, that forecasts beyond a certain length are unreliable, so that benefits beyond a certain point are largely conjectural. Thus, the short horizon is imposed as a crude limit on risk, much as

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[47]Chen and Manes, p. 165.

[48]Chen and Manes, pp. 168-173.

[49]Bey, pp. 71,75.

[50]Quirin and Wiginton, p. 126. As an example, at 8%, a dollar to be received in 25 years is worth only $0.15 today, one due in 50 years only $0.02.

payback is used as a (crude) limitation on risk.[51]

SALVAGE VALUE/REMOVAL COSTS

At the end of a project, there may be either a cash inflow due to the sale of the assets used for the project, or there may be a cost involved in removing the assets and returning the environment to its original state. Even though these cash flows may be fairly distant in time, they still have an effect on the capital budgeting decision process and must be considered in making such decisions.

As a practical simplification, salvage values in conventional investment proposals are often disregarded because of their highly uncertain character and their realization in a remote future, which means a substantial reduction of their discounted present value.[52] However, this is probably not a wise practice, especially if there may be removal costs later that need to be amortized over the life of the product as part of a sinking fund.

In inflationary times, the future market value of an asset could significantly exceed the best estimate for this value at the present time.[53] Higher salvage values make the acquisition of assets more attractive. Errors in estimating an asset's salvage value are partially offset by tax implications and the discounting process (since such cash flows occur several periods out in the future).[54] However, the net effect can still be significant and can swing the decision to a different alternative. Hence, the impact of changes in the salvage value should be considered in capital budgeting decisions.

As a consequence of increasingly stringent requirements

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[51]Quirin and Wiginton, p. 127.

[52]Asztély, p. 187.

[53]Pritchard and Hindelang, p. 201.

[54]Pritchard and Hindelang, p. 202.

during recent years for satisfactory environmental protection and restoration, salvage values for projects of a certain character can easily turn negative. Such is the case with strip mining operations and gravel pits, since operators are being increasingly obligated to restore the landscape. Nuclear power plants must deal not only with decontamination of spent nuclear fuel and radioactive waste, but also with the decommissioning of time-expired, contaminated structures and the restoration of their sites.[55]

Negative salvage values of considerable magnitude change the cash-flow pattern of an investment proposal. The stream of benefits over time should not only cover interest and amortization of the initial capital outlay, but also accumulate some sort of sinking fund to cover decommissioning costs at the end. In cases of negative salvage values, a considerable expenditure can occur after revenues.[56] The amount of this expenditure can be affected by inflation, the stringency of government regulations, cost of materials, labor, and similar factors.

ECONOMIC/SOCIAL COSTS

In addition to the "normal" causes of uncertainty, firms may be exposed to uncertainty because of their failure to anticipate correctly the environmental and/or social impacts of the investment choices. Although these costs and their associated probabilities may be hard to quantify, they should be included in the analysis, possibly through Buhler's qualitative data approach, discussed above.

There are many possible environmental/social impacts: health, air and water quality, standards of living, the efficient use of resources, etc. Although some of these impacts currently

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[55]Asztély, p. 187.

[56]Asztély, p. 190.

are not regulated, they may, nevertheless, subject the firm to future financial uncertainty because of their potential for regulation after the introduction of the new product. Also, firms may find themselves vulnerable to private lawsuits for unregulated impacts.[57] The firm's choice of projects may be harmful in that it invites unilateral intervention by the state, without any particular regard for competitive factors.[58]

CONCLUSIONS

There are many sources of risk and uncertainty in the capital budgeting decision process. These sources must be identified and taken into account, either quantitatively or qualitatively in order for a correct decision to be made. If possible, sensitivity analyses should be performed to determine the extent of the impact of the risk on the decision-making process.

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[57]Evans, Dorla A., "Investment Decision Making Under Uncertainty: Potential Environmental/Social Impacts of New Products," The Engineering Economist, Vol. 32, No. 4, Summer 1987, p. 263.

[58]Quirin and Wiginton, p. 40.

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