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A Study on Risk Analysis in Capital Budgeting.

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ABSTRACT

Capital budgeting is an investment decision tool that deals with the future cash flows and tells us whether we should undertake a project or not, which includes installing a new machinery, replacing an old machinery, a research equipment planning, power plants cost benefits or solving a complex business problem. It determines its feasibility whether it is profitable to do the project or not because we have to decide the future cash flows which are full of uncertainty. So we estimate the cash flows based on our assumptions, which have a risk of deviation of results. Considering this risk with various techniques is called risk analysis in capital budgeting.

Key words: *cash flows, risk, assumptions, simulation, sensitivity analysis, business problem, new project, replacement decision.*

1. Introduction

In essence, two words have been used, one is risk and the other is uncertainty. Many times, their meaning is considered to be the same but there is a difference between the two which is very important to understand so that the person determining cash flow can keep this thing in his viewpoint or perspective while determining them that he should understand them in different ways as to what is called risk and what is called uncertainty.

1.1 What is Risk?

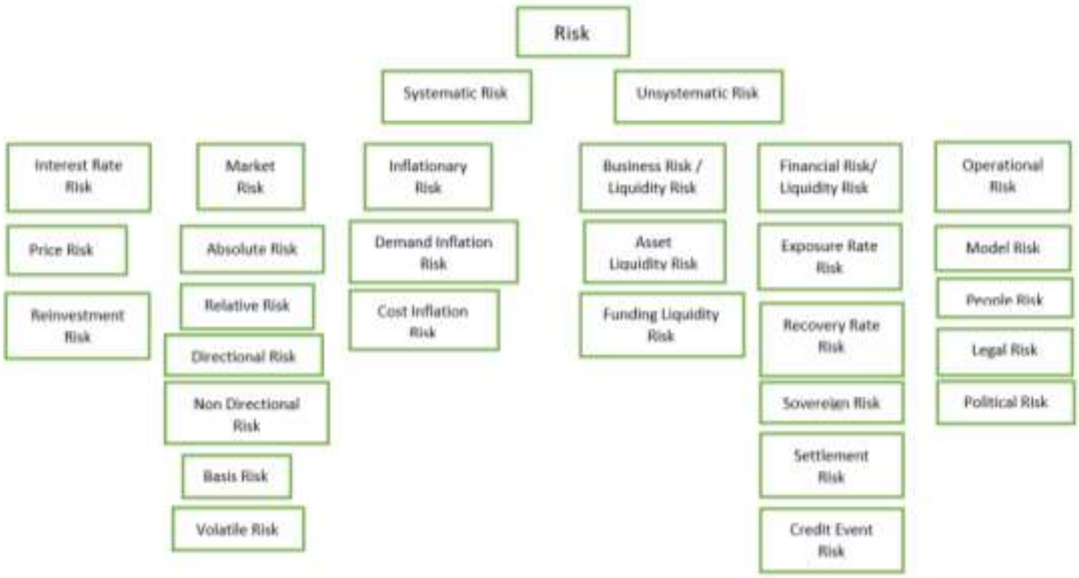
Risk is a situation where several outcomes (a range of outcomes), are possible within the range, any one outcome can occur each possible outcome has a known probability, such probabilities are assessed by reference to past information about relative frequencies of outcomes.

'Risk' therefore refers to the possibility that the actual outcome will differ from expected outcome"

1.2 Types of Risk

The general definition of risk is differences in outcome but there are two categories of risk. The first category is of risks that we can control while the second category includes risks that we cannot control. Both these categories include different factors that causes risk.

A diagrammatic representation of all types of risks is as follows:



Above diagram is presented a general view of risk. However risk in capital budgeting decisions based on project or problem.

1.3 Risk in Capital Budgeting:

The various types of risk in capital budgeting decisions are Project Specific Risk, Competition Risk, Industry Specific Risk, Market Risk and International Risk.

Project Specific Risk: The oil rigs which are used for searching oil in the sea are deployed in different projects, so the risk of not finding oil is different for different projects, which can be called project specific risk. Similarly, if efforts are made to generate electricity through different technologies, then risk of failure of the technology is called project specific risk.

Competition Risk: It is possible that the machinery or technology for which cash flows are being estimated may out of circulation prematurely due to competition and thereafter no cash flows. Hence there is a risk of obsolete in market due to competition may always prevail in case of capital budgeting decision which is called competition risk.

Industry Specific Risk: Different industries have different risks. In some industries risk is high whereas in some industries have low risk because of their nature of product or service quality. For Example, the raw material on which an industry is directly based may be available in future and conditions for the same are favorable or unfavorable due to which it is not possible to say how much change would occur in its rate. Therefore in projection of cash flows there is a risk of price change in raw material of a specific industry which may we can call industry related risk or industry risk.

Market Risk: There is a direct impact of government policies at industries. What and how the government's decision will be, affects the market, which creates market risk. These includes fiscal policy, monetary policy, Reserve Bank Intervention etc. brought by government.

International Risk: If cash flows related to the project are in foreign currency, then it is difficult to determine the foreign currency rate for a very long term future. Foreign currency rate fluctuate due to the impact of international events which are not certain and hence lead to international risk.

1.4 Uncertainty is a situation where the range of outcomes is unknown, the probability of outcomes is unknown or, both are unknown. Let us explain with an example. Mr. A come out of an examination hall saying, "There is a 60% chance that I will get 80 marks and a 40% chance that I will score 50 marks." A's friend, Anne comes out of the hall saying, "God only knows how I have done." Mr. A is a case of risk. Anne's is a case of uncertainty.

The 'future' by definition, is uncertain, therefore, cash flows when they occur are likely to differ from what were expected. This uncertainty about a project's future cash flows gives rise to risk. But risk is not the same as uncertainty.

2.1 Techniques of Risk Analysis in Capital Budgeting

Strategic Techniques: Probability, Variance of Standard Deviation, Coefficient of Variation. **Conventional Techniques:** Risk Adjusted Discount Rate, Certainty Equivalents Factor. **Other Techniques:** Sensitivity Analysis, Simulation, Decision Tree.

To identify ways to reduce risk we must first be able to measure the degree of risk. The degree of risk can be identified based on probability and probability distribution and the expected value can be determined on the basis of probability.

2.1 Probability

Probability means the chance of occurrence or non-occurrence of an outcome. The aggregate of probabilities of all possible outcomes associated with an event is one.

For example, if there is a 70% chance that it would rain today, the probability associated with rain is 0.7. Since the only two possible outcomes are "Rain" and "No rain", the probability associated with "No rain" is 0.3.

2.2 Probability Distribution

Suppose a range of different, outcomes is possible. Suppose that the chance of occurrence of each such outcome is different. We can express this position meaningfully by assigning appropriate numerical values to the chances of occurrence. The resulting representation of all the possible outcomes is known as probability distribution. For Instance, in project X the values of various cash flows and the probabilities are as given below: The resultant position is the probability distribution.

Outcome	Value	Probability
1	40000	0.10
2	70000	0.15
3	100000	0.20
4	200000	0.25
5	300000	0.30

Expected Value is the weighted average of all possible values with probability of occurrence being the assigned weight.

3.1 Standard Deviation

Project cash flows are forecasts. A forecast cannot be accurate and there can be a margin of error. The risk associated with a project can be expressed, as the extent to which the actual value of outcome will differ from the expected value. This risk is measured with the help of a statistical tool known as Standard Deviation.

By definition, Standard Deviation is a standardized unit of deviation from mean. This measure is denoted by the symbol σ. The square of Standard Deviation (o²) is known as variance of distribution. Higher the Standard Deviation, higher is the risk associated with a project.

Standard Deviation σ: A unit of measure

Standard Deviation is a measure of risk. It is expressed in the same units as the range of probable outcomes is expressed. That is, if you are applying the σ to evaluating % returns in a security, σ is expressed in % age terms. If it is computed for outputs in tones, σ is expressed in tones, etc.

Standard Deviation σ: What it means

Probabilities of different outcomes in a project may be normally distributed or it may be skewed consider the following two cases.

Probability Set I	Probability Set II
0.15	0.03
0.20	0.27
0.30	0.40
0.20	0.18
0.15	0.12
1.00	**1.00**

The first set is known as formal probability distribution, in as much as the distribution on either side of mid-point (0.30) is even. In the second set the probability distribution is said to be skewed. Statistics tells us that when the density function of probabilities which are normally distributed, is presented graphically, it will look like in a bell-shaped curve. The expected or estimated NPV of a project, which is the mean value, will occupy the central point.

3.2 Standard Deviation σ - Decision

Now that we know how Expected Value (a return) and how Standard Deviation (a risk) computed, we must learn how to put them to use in decision-making. The following decision rules will be helpful.

Between two projects, which have the same return, the one with the lower risk will be preferred. Between two projects, which have the same risk, the one with the higher return will be preferred. Between two projects, which have different levels of risk and return, the choice would depend on the risk preferences of the investor. The aggressive investor will prefer the one, which gives higher return whereas the conservative investor will prefer the one, which involves lower risk.

4.1 Risk Adjusted Discounted Rate (RADR)

Business is about taking risk and earning return. If you take more risk, you would like to earn more return. Hence projects with higher risk

should earn higher return. The discount-rate in capital budgeting represents the expected rate of return. Projects with higher risk are generally expected to provide a higher return. And projects with relatively lower risk are expected to provide a lower rate of return. Consequently all projects should not be discounted at the same rate, namely the company's cost of capital. Hence the cut-off discount rate should be adjusted upwards or downward to take care of the additional (or lower) risk element. This is referred to as risk adjusted discount rate.

4.2 Irving Fisher Model:

Irving Fisher propounded a formula for computing risk-premium adjusted discount rate. This model depicts a more exact method of deriving the RADR, as under: (1 + Base discount rate) x (1 + Risk premium) = (1+ Risk adjusted discount rate)

5.1 Certainty Equivalent Factor (CEF):

Certainty Equivalent Factor (CEF) is the ratio of assured (or certain) cash flows to uncertain cash flows.

Under this approach, the cash flows expected in a project are converted into risk-less equivalent amounts. The adjustment factor used is called Certainty Equivalent factor, or Certainty Equivalent Co-efficient. This varies between 0 and 1. A coefficient of 1 indicates that the cash flows are certain. The greater the risk in a cash flow, the smaller will be the certainty equivalent factor for inter and the larger will be the certainty equivalent factor "for payments". While employing this method, the decision-maker estimates the sum he must be assured of receiving, in order that he is indifferent between an "assured sum" and the expected value of a "risky sum".

CEF =CCF / UCF,   CEF= Certainty Equivalent Factor, CCF = Certain Cash Flows, UCF = Uncertain Cash Flows

6.1 Sensitivity Analysis:

Sensitivity is one of the methods of analysing the risk surrounding the capital expenditure decision, and enables an assessment to be made of how responsive the project's NPV is to changes in those variables based due to on which NPV is computed.

We know that NPV is computed based on a set of critical variables (an input parameters). Examples are: selling price, sales volume, discount rate, initial cost, operating costs, or estimated benefits. During a project's life, any one or more of these input parameters may undergo a change. Such changes a demon natural because each of these elements is only an estimate. An adverse change can result in original computed NPV turning zero. If this happens, the decision-maker would be hit hard. Hence the decision maker is keen to ensure that estimates contain a reasonable buffer to absorb unforeseen changes in the critical variables of the project. To put it differently, the finance manager seeks answers to "What if?" situations in order to satisfy himself that there are no hidden surprise also wants to ensure that the resilience of project estimates to changes is not outside the range of comfort. In this process, he analyses the risk surrounding a capital expenditure decision. The analysis helps him to assess how responsive is the project's NPV to changes in the variables that are used in computing the NPV. This method of analysis is called Sensitivity Analysis. In short, sensitivity analysis measures the percentage change in input parameter, which leads to reversal of an investment decision. It may be noted that sensitivity percentage does not carry a + or – sign because sensitivity seeks to measure only the downside risks. E.g. if we take initial investment size as a variable, an increase alone is adverse, decrease is favorable. The input parameter and the decision of change leading to sensitivity are captured in the accompanying table. This analysis seeks which of the variables in the estimation of project flows, could have the most adverse effect on the overall outcome of an appraisal, if they were to fall short of – expected outcomes.

Method of Computation: Sensitivity is computed as the ratio of downside change in input parameter to the value of initial parameter.

-Each input variable is considered separately and all other assumptions are held constant.

-The extent of change in an input parameter that would result in zero NPV is computed.

-The extent of change so determined is expressed as a percentage.

- This process is repeated for all critical variables to test their sensitivity.

- If a variable is likely to undergo change beyond the levels tested, the project is reviewed afresh.

Decision Rule: The lower the change percentage the higher is the sensitivity of the project to that input parameter. This is because a small change in input parameter leads to a reversal of investment decision. For example, if NPV were to become zero, with 1% change in fixed costs, relative to a 10% change in say sales, the project is said to be more sensitive to fixed costs than to sales.

Sensitivity= Change / Base × 100

6.2 Limitations of sensitivity analysis

Interdependency of factors: The analysis requires that changes in each key variable are isolated. However, the decision-maker may be interested in a combination of the effect of changes in two or more key variables. The variables are generally interdependent. It may not always be meaningful to look at the variables in isolation.

Probability: The analysis does not also examine the probability of any particular variation in costs or revenues that might occur.

Uncontrollable factors: The analysis may bring to surface certain key variables as critical factors on which the decision maker may have no control, and thus it will not provide a helpful guide for follow up action.

Does not eliminate risk: Sensitivity analysis does not eliminate risk. It merely measures the resilience level of identified variables to changes in assumptions. Such an analysis can indicate why a project may fail, and may point to a need for a review of the decision.

Sensitivity analysis – change in more than one variables: In the foregoing, we have considered the impact on NPV, of a changes do occur in more than one variable at the same time, e.g. variable cost and selling price may vary at the same time. Such changes may take place in either one direction (unfavorable) or in opposite directions, namely, a favorable change being accompanied by an unfavorable change in another.

7.1 Decision Tree:

In a capital budgeting exercise, the decision-maker has to identify and evaluate the various alternative courses of action leading to the investment decision. A decision tree captures these alternatives in the form of a diagram and is useful for clarifying the range of alternative courses of action, assessing possible outcomes, i.e. multiplicity of choices and outcomes,

In statistical speak, when a sequential series of conditional decisions are required to be taken under conditions of uncertainty, decision tree model comes in handy to visualize and evaluate all possible options for action.

Consider this example. The purchase of an asset could lead to an increase in sales. This increase can either be low, medium or high with probabilities of 0.5, 0.3 and 0.2 respectively. Each of these could be referred to as a branch and may yield differing contributions and fixed costs, and in turn to differing profit levels giving rise to various outcomes. Such possibilities are captured in a decision tree.

There are two stages in preparing a decision tree. The first step is drawing the decision tree itself, in a manner that reflects all the choices and outcomes. The second step is to incorporate probabilities, relevant values and derive expected monetary values.

Decision Rule: A decision tree is analyzed and evaluated using toll – back method. That is, the value of each circle and each square is computed by evaluating from right to left. This technique proceeds from the last decision in the sequence, and work back to the first, for each of the possible decisions. There are two rules in this evaluation.

Rule1: The expected monetary value (EMV) at a chance node (branches emanating from a circle) is the aggregate of the expected values of the values of the various branches that emanate from the chance node,

Rule2: The expected value at a decision node (branches emanating from a square) is the highest among the expected values of the various branches that emanate from the decision node.

8.1 Simulation:

The decision tree approach can become unwieldy if different estimates of cash flows are involved in the evaluation of a decision process. For instance, consider a project with a 3-year life, which we want to analyses using decision tree approach. Suppose further that for each of the three periods, four different estimates of cash flows are made. This will throw 64 outcomes. (4 x 4 x 4). Evaluating the possible outcomes in 16 chances nodes is rather cumbersome and difficult. To this difficulty, simulation offers a solution.

Simulation is a mathematical mode that represents actual decision making under conditions of uncertainty, for evaluating alternative courses of action. Such a model involves conducting a series of organized experiments to predict the probable outcome of that solution in a given period of time Simulation provides a trial and error movement toward an optimal solution.

8.1 Advantages of simulation model

Simulation allows experimentation with a model of the system, rather than the actual operating System. Any individual, who is not technical expert can comprehend simulation model more easily, than exercise is time saving. Use of simulation helps in gaining on insight into certain managerial problems, where analytical solution of a model is not possible, or where the actual environment is difficult to observe.

8.2 Limitations of simulation model

Use of simulation, in place of any other technical involves a tradeoff. We should bear in mind the limitation of this model.

It is not precise. Nor is it an optimization process. It merely provides different solutions when simulation runs are repeated. But it does not provide an answer. Often, it is a rather complicated procedure to develop a simulation model. A good simulation model is seen to be expensive. Not all situations can be evaluated using simulation. Only situations involving uncertainty are candidates, without a random component, all simulated experiments will produce the same result.

8.3 Simulation and Sensitivity analysis: A comparison

The Monte Carlo simulation is a method of estimating the probability distribution of different out- comes. It is a decision support system, which can be applied to the cash flows of a project, to forecast a range of possible situations. The approach uses a random number generator. Random numbers are the applied in accordance with the assigned probabilities to the various outcomes. An overall probability distribution of cash flows gets simulated. It is most appropriate in circumstances where the decision- maker is dealing with numerous cash flows, which are independent - a criterion that may be difficult to meet, as cash flows are rarely completely independent. Sensitivity analysis is used to analyses the effect on project profitability of possible changes in input variables, such as sales, direct costs, items of expenses, etc. Sensitivity analysis expresses cash flows in terms of unknown variables; and then calculates the consequences of under or over estimating the variables. A major problem with sensitivity analysis is that the underlying variables are likely to be inter-related. Sensitivity analysis allows the decision-maker to consider changing the effect of one variable at a time. Monte Carlo simulation allows the decision-maker to consider all possible combinations. Therefore allows inspection of the entire distribution of project outcomes.

9.1 Hillier's Model:

Capital budgeting involves making estimates of future cash flows. These future cash flows may be either (a) Dependent or (b) Independent. Cash flows are said to be Dependent if the cash flows of a particular year are effected by cash flows of the previous years. For instance, if the actual cash flows in the early years were to be different from that estimated, it is reasonable to assume that the cash flows in later years could also be different than that originally estimated. In such a case cash flows are said to be dependent. Cash flows are said to be independent if the cash flows of a particular year are affected by cash flows in later years could continue to be the same as to assume that the cash flows in later years could continue to be the same as originally estimated. In such a case cash flows are said to be independent.

10. Conclusion:

In capital budgeting, we estimate future cash flows. It is not necessary that the cash flows estimated by us are accurate. While estimating cash flows, there is a risk of them being more or less than the estimate, which we call risk in capital budgeting. Therefore, this risk is measured in many ways and work has to be done on ways to reduce the risk. First of all, we measure the risk of capital budgeting and then suggest ways to reduce it such as adjusting the discount rate, finding the certainty equivalent factor, finding the sensitivity, taking decisions through decision tree, etc. In the methods of measuring risk in capital budgeting, attention is also paid to market trends, the pace of the economy, the movement of the business, the performance of that sector and the efficiency of the managers of the business. On the basis of these, it is important to understand them as good or bad factors to estimate future cash flows so that they can also be estimated in the form of cash flows. These are measured on the basis of future prospects that what are the possibilities of different performance of a factor. Like how much the share price of that business is likely to increase in the future, the effect of which can also be measured on its cash flows, meaning if its share price is this much now, then projecting cash flows on the basis of what it will be in the future because the results till now are showing accurate results on this basis, then it is possible that the future results may also be similar. But it can also be different from this, which is called risk and the factors due to which it can change are called risk factors. Then by measuring those factors we can measure the risk in capital investing.

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