

Risk Analysis in Capital Budgeting

Expected Value

- Simple average of all possible values after taking into account the probability of occurrence.

Formula: $EV = \sum P \times R$

Where, P = Probability & R = value

Standard Deviation:

- The risk associated with the project can be expressed, as the extent to which the actual value of outcome will differ from the expected value

Formula: $\sigma = \sqrt{\sum P \times d^2}$

Decision Rule:

1. Between two projects, which have the same risk, the one with higher return will be preferred.
2. Between two projects, which have the same return, the one with the lower risk will be preferred.
3. Between two projects, which have different levels of risk and return, the choice would depend on the risk preferences of the investor.

Risk Adjusted Discount Rate

- The Cut-off discount rate adjusted upwards or downwards to take care of the additional or lower risk element is referred to as RADR

Formula:

$$RADR = \text{Cost of Capital} + \text{Premium for risks}$$

Certainty Equivalent Factor

Ratio of assured cash flows to uncertain cash flows

Formula: $CEF = CCF / UCF$
 $\therefore CCF = UCF \times CEF$

CCF = Certain Cash Flows;

UCF = Uncertain Cash Flows

Method of computation under CE approach:

Step 1: Convert uncertain cash flows to certain cash flows by multiplying it with CEF

Step 2: Discount certain cash flows at the **risk free rate** to arrive at NPV

SENSITIVITY ANALYSIS

Sensitivity analysis measures the percentage change in input parameter, which leads to a reversal of an investment decision

Sensitivity measures only the downside risk.

Formula:

$$\text{Sensitivity (\%)} = (\text{Change} / \text{Base}) \times 100$$

Method of Computation:

1. Each input variable is considered separately and all other assumptions are held constant.
2. The extent of change in an input parameter that would result in Zero NPV is computed
3. The extent of change so determined is expressed as a %
4. This process is repeated for all critical variables to test their sensitivity.
5. 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.

SIMULATION

- Construction of a model to represent a real-life situation, which facilitates substitution of critical variable within the model and assists in predicting possible outcomes.

Method:

Step 1: Define the problem and lay down the model (ex: Determining the NPV of a project)

Step 2 : Identify the parameters and the exogenous variables.

Step 3: For each parameter specify a Rupee value.

For each exogenous variable assign a probability distribution in ascending order of value.

Compute cumulative probability.

Step 4: Generate random number class intervals.

This must be done by matching cumulative probabilities precisely with the assigned probabilities.

Step 5: Assign random numbers to each of exogenous variables and ascertain value. For this purpose, use Random Number Table as also the Random number intervals of step 4.

Step 6: For each simulation run, solve the model laid out in Step 1. The simple average of the various values solved under Step 1 would be the final value.

Simulation vs. Sensitivity

- The Monte Carlo simulation is a method of estimating the probability distribution of different outcomes.
- 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.
- RNs are applied in accordance with the assigned probabilities to the various outcomes. An overall probability distribution of cash flows gets simulated.
- Sensitivity Analysis is used to analyse the effect on project profitability of possible changes in input variables.
- SA expresses cash flows in terms of unknown variables, and then calculates the consequences of under or over estimating the variables.

Hillier's Model

- According to this model, the cash flows of the firm are classified as either Independent or Dependent.
- Probability distribution analysis of cash flows for each period greatly minimizes the risk element. It is the normal practice to derive the PV of cash flows using either a risk-free rate or a normal hurdle suitably adjusted to reflect the residual risk if any.

A. **Independent Cash Flows:** Where the project cash flows of a period are not serially dependent on the cash flow outcome of preceding periods, such cash flows are termed as Uncorrelated or Independent cash flows.

Computation procedure of Variance:

Step 1: Compute the variance of cash flows of each year separately. The appropriate discount rate will be the risk free rate or a normal hurdle rate suitably adjusted to reflect residual risk.

Step 2: Discount them at the rate $(1 + r)^{2n}$ and aggregate the resultant values, where n represents year.

Step 3: Compute SD; $\sigma = \sqrt{\text{Variance}} (\sqrt{\text{step 2}})$

B. Perfectly Correlated Cash Flows:

Cash flows that are perfectly correlated carry greater risk than those that are less perfectly correlated.

Step 1: Compute the SD of cash flows for each of the periods

Step 2: Compute their present value and aggregate the result

Z : Values

- Z Value is the Ratio of the deviation of desired value from Mean Value to Standard Deviation.

$$Z = (X - \bar{X}) / \sigma$$

Step 1: Compute Z value using the formula

$$Z = (X - \bar{X}) / \sigma$$

Where,

X = Desired NPV

$\bar{X}$ = Originally estimated NPV and

σ = Standard Deviation of possible NPVs

Step 2:

- If the resultant value is negative,
it means that Z falls in the left tail of the normal distribution curve.
- If the resultant value is positive,
it means that Z falls in the right tail of the normal distribution curve.

Step 3: Compute table value corresponding to the Z value.

Step 4:

- (a) If the Z value is on the left tail and the probability to be computed is “**greater than**”,
then **Add** the table value to 0.5 to arrive at the probability.
- (b) If the Z value is on the left tail and the probability to be computed is “**less than**”,
then **Deduct** the table value to 0.5 to arrive at the probability
- (c) If the Z value is on the right tail and the probability to be computed is “**greater than**”,
then **Deduct** the table value to 0.5 to arrive at the probability.
- (d) If the Z value is on the right tail and the probability to be computed is “**less than**”,
then **Add** the table value to 0.5 to arrive at the probability

Real Options in Capital Budgeting

- Real options associated with a capital budgeting exercise, can be grouped into following varieties.
1. Investment-timing options – An option to wait, before making additional investment.
 2. Growth options – An option to expand, (or vary the output)
 3. A put option – An option to shrink or abandon an investment