Project Evaluation Methods (PEM)

Chapter 1: Introduction

IEPM - International Exchange Programmes in Management

Curso Institucional/ Institutional Course

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PEM - Chapter 1

TYPES of INVESTMENT PROJECTS

Investment

In economics, can be defined as the act of incurring an immediate cost in the expectation of future rewards.

Examples

i. Plant construction and installation of equipment;

ii. People who invest time on vocational education;

iii. Firm that shuts down a loss-making plant;

It is an investment because:

- the payments it must make to extract itself from contractual commitments, including severance payments to labour, are the initial expenditure; and
- the prospective reward is the reduction in future losses.

TYPES of INVESTMENT PROJECTS

Features behind majority of investment decisions :

I. The investment is partially or completely irreversible, that is, the initial cost of investment is at least partially sunk;

II. There is uncertainty over the future rewards from investment;

We only can assess the probabilities of the alternative outcomes that can mean greater or smaller profit (or loss) for our project;

III. There is the possibility of delay the investment decision to get more information (but never, of course, complete certainty) about the future.

These three characteristics interact to determine the optimal decisions of investors.

TYPES of INVESTMENT PROJECTS

Investment projects that have the features I, II and III:

These investment opportunities arise from firm’s managerial resources:

- Technological knowledge;
- Reputation;
- Market position; and
- Possible scale.

All that resources may have been built up over time and they enable the firm to productively undertake investments that individuals or other firms cannot undertake.

Examples of investment opportunities with these characteristics:

- Development of patents;
- Ownership of land or natural resources.

TYPES of INVESTMENT PROJECTS

Irreversibility of an investment:

Investment expenditures are sunk costs when they are firm or industry specific.

<u>Examples</u>

i. Most investments in marketing and advertising are firm specific and cannot be recovered.

ii. The investment in a steel plant is industry specific (it can only be used to produce steel).
In this case, one might think that because in principle the plant could be sold to another steel company, the investment expenditure is recoverable and is not a sunk cost. But this is incorrect. If the industry is reasonably competitive, the value of the plant will be the same for all firms in the industry, so there would be little to gain from selling it.

TYPES of INVESTMENT PROJECTS

Irreversibility of an investment:

Note

Some investments that are not firm or industry specific are often partly irreversible. Because buyers in markets for used machines, unable to evaluate the quality of an item, will offer a price that corresponds to the average quality in the market. On the other hand, sellers, who know the quality of the item they are selling, will be reluctant to sell an above-average item. This will lower the market average quality and therefore the market price.

Examples

- Investment in office equipment;
- Investment in cars/ trucks; and
- Investment in computers.

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TYPES of INVESTMENT PROJECTS

Possibility of delay the investment decision :

- Firms do not always have opportunity to delay their investments.
  <u>Example</u>
  Occasions in which strategic considerations make it imperative for a firm to invest quickly and thereby preempt investment by existing or potential competitors.

- In most investments, the possibility of delay the decision is at least feasible. There may be a cost to delay (which translates the risk of entry by other firms, or simply foregone cash flows). But this cost must be weighed against the benefits of waiting for new information.

TYPES of INVESTMENT PROJECTS

Examples of investment projects:

I. Consider a firm that is trying to decide whether to invest in a project. It is necessary to assume a stochastic process to model the underlying uncertainty of the project (since future values of the project are unknown). Therefore, the project evaluation depends on the process assumed.

<u>Case study</u>

A firm that has the monopoly right (for a certain period of time) to explore an oil field or a copper mine (or a gold mine) and must decide when (and whether) to begin the activity. That is, the firm must determine the optimal time (and the optimal value) of investment.

TYPES of INVESTMENT PROJECTS

Examples of investment projects:

II. Consider a firm that has a project composed by several stages, which are performed sequentially and in a particular order. The firm does not earn any cash flows from the project until the project is complete. For each stage, the objective is deciding to continue or stop (temporarily or permanently) the investment. The project evaluation depends on the process assumed to model the underlying uncertainty of the project.

<u>Case study</u>

An investment in a new drug by a pharmaceutical company can be decomposed into several stages. For example, the company begins with research that, with some probability, leads to a new compound, and continues with extensive testing until Medicines Agency approval is obtained. Finally, the project concludes with the construction of a production facility and the marketing of the drug.

QUANTITATIVE TECHNIQUES APPLIED in PROJECT EVALUATION

Quantitative techniques applied to value projects (for which, the investment is irreversible; there is high uncertainty over the future rewards from the investment; and there is possibility to delay the investment decisions):

- Net Present Value Rule (NPV);
- Internal Rate of Return (IRR);
- Contingent Claims Analysis (outside of the scope of the course);
- Monte Carlo Simulation;
- Dynamic Programming;
- Decision Tree Analysis (outside of the scope of the course);
- Binomial Tree Approach;
- (…).

QUANTITATIVE TECHNIQUES APPLIED in PROJECT EVALUATION

Net Present Value Rule (NPV)

- Given a project with an economic life of **n** periods of time (for example, years) , we define

  C_t – the cash flow at the end of period **t**;

  CO_t – the capital outlays at the beginning of period **t**; and

  r – the discount rate per period.

- **Present Value of Future Cash Inflows**: $\sum_{t=1}^{n} \frac{C_t}{(1+r)^t}$.

- **Present Value of Capital Outlays**: $\sum_{t=0}^{n-1} \frac{CO_t}{(1+r)^t}$.

- The **Net Present Value of the project** is calculated by subtracting the Present Value of the Capital Outlays from the Present Value of the Cash Inflows:

$$NPV = \sum_{t=1}^{n} \frac{C_t}{(1+r)^t} - \sum_{t=0}^{n-1} \frac{CO_t}{(1+r)^t}.$$

QUANTITATIVE TECHNIQUES APPLIED in PROJECT EVALUATION

Net Present Value Rule (NPV)

- **Investment Rule**

  Invest in a project when the NPV is greater than zero (since the project will increase the value of the firm).

  - **Comments**

    i. If the NPV is equal to zero then the project will only yield the required rate of return (therefore the project will not increase the firm value).

    ii. If the NPV is lesser than zero then the project should be rejected (since the project will cause a decrease in the value of the firm).

QUANTITATIVE TECHNIQUES APPLIED in PROJECT EVALUATION

Net Present Value Rule (NPV)

- **Notes**

i. If the capital outlay occurs only at the beginning of period 1 (that is, at the present moment) then it is already at a present value and it is not necessary to discount it any further. The formula of NPV in such situation is:

$$\mathbf{NPV} = \sum_{t=1}^{n} \frac{C_t}{(1+r)^t} - CO,$$

(**CO** is the capital outlay at the beginning of period 1, where t = 0.)

ii. The discount rate (**r**) is defined by:

$$r = \left[(1+r1)\times(1+r2)\times(1+r3)\right] - 1,$$

where, **r1**, **r2** e **r3** represent, respectively, the real income, the risk premium and inflation.

Net Present Value Rule (NPV)

Remark

There are issues that arise in calculating the NPV, such as:

- how should the expected stream of cash inflows from a new project be estimated?
- how should inflation be treated? and
- what discount rate should be used in calculating the present values?

In literature we find several papers that deal with this questions [for example, Bradley e Frey (1978) (*); Kim e Lee (1991)(**)].

(*) Bradley, S. P., S. C. Frey. 1978. Equivalent mathematical programming models of pure capital rationing. *Journal of Financial and Quantitative Analysis*. **13** 345-361.

(**) Kim, J., B. Lee. 1991. Equivalent mathematical programming models of the capital budgeting problem. *Computers Ind. Engng*. **20**(4) 451-460.

Internal Rate of Return Rule (IRR)

- Given a project with an economic life of **n** periods of time (for example, years) , we define

  $\mathbf{C_t}$ – the cash flow at the end of period **t**;

  $\mathbf{CO_t}$ – the capital outlays at the beginning of period **t**; and

  r – the discount rate per period.

- The **Internal Rate of Return** is the calculated rate of return (or discount rate) **i** at which the **NPV** will be equal to zero.

- **Interpretation of IRR**

  The **IRR** represents the highest rate at which future cash flows can be discounted so that the NPV is zero.

- **Investment Rule**

  Invest in a project when the **IRR** is equal or greater than the required rate of return (**r**).

Monte Carlo Simulation

It is a controlled statistical sampling technique for estimating the performance of complex stochastic systems (that is, systems that evolve over time) when analytical models do not suffice.

Monte Carlo Simulation consists of:

- imitate the performance of the real system by using probability distributions to randomly generate various events that occur in the system. (therefore, a simulation model synthesizes the system by building it up component by component and event by event);
- repeat several times the following procedure (which, is known as **simulation run**):
  - randomly generate an event, ***e***;
  - test the simulated system with the event ***e***, which allows to obtain a statistical observation on the performance of the system: ***o***.

Dynamic Programming

Is a general tool for dynamic optimization and is particularly useful in treating uncertainty. Dynamic programming breaks a whole sequence of decisions into just two components:

- the immediate decision; and
- a valuation function that encapsulates the consequences of all subsequent decisions, starting with the position that results from the immediate decision.

Binomial Tree Approach

Is a very popular technique for evaluating financial options. The basic idea of this approach is associated to the construction of a binomial tree representing the possible changes of the value of the underlying asset during the life of the option. In each time step, the value of the underlying asset has a certain probability of moving up by a certain percentage amount and a certain probability of moving down by a certain percentage amount. In the limit, as the time step becomes smaller, this approach leads to the lognormal assumption for asset prices.

Comment

The evaluation of financial options is outside of the scope of this Course. However, assuming a number of assumptions, it is known that there are some types of investment projects that can be considered analogous to financial options. For this reason, it is possible to apply the Binomial Tree Approach for assessing some types of investment projects.