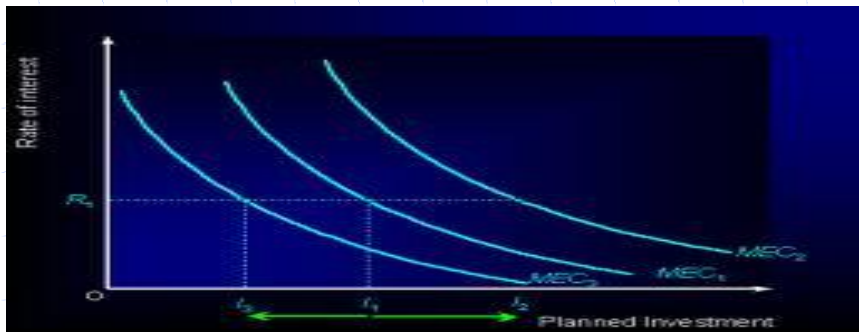


Project Cost Management

Investment Appraisal / Discounted Cash Flow Part 1

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What is investment appraisal?

- ◆ An evaluation of the financial returns arising from an investment. Commonly, used techniques are discounted cash flow and return on investment.
- ◆ On daily basis, we make commercial decision such as "if I invest £1,000 today in a construction business, what will be my return in 5 years times?"

Key considerations in making investment decisions are:



- How much will the investment cost? Are there funds available?
- How long will it take before my investment starts to yield returns?
- How long will it take to pay back the investment?
- What are the expected profits from the investment?
- Could the money that is being ploughed into the investment yield higher returns elsewhere?

Discounted Cash Flow

- ◆ The value of money is dependent on the time at which it is received. A sum of money on hand today is worth more than the same sum of money to be received in the future because the money on hand today can be invested to earn interest to gain more than the same money in the future. Thus, studying the present value of money (or the discounted value) that will be received in the future is very important. This concept will be demonstrated in the following subsections.

Present Value

- ◆ Present value (PV) describes the process of determining what a cash flow to be received in the future is worth in today's pounds. Therefore, the Present Value of a future cash flow represents the amount of money today which, if invested at a particular interest rate, will grow to the amount of the future cash flow at that time in the future. The process of finding present values is called **Discounting and the interest rate**; and to calculate present values is called the **discount rate**.

Prove of DCF equations

To illustrate this concept, if you were to invest £100 today with an interest rate of 10% compounded annually, this investment will grow to $[100 \times (1 + 0.1)]$ in one year = £110. It means your investment earned 10.

If you are to reinvest the money earned at year 1 (£110) in the succeeding year; at the end of year two, the investment will grow to $[110 \times (1 + 0.1)] = £121$

Accordingly, investing a current amount of money, **P**, for one year, with interest rate (*r*) will result in a future amount, **A** using the following equation.

$$A = P \cdot (1 + r)$$

If **P** is invested for *n* years then the future amount **A** will be greater than **P**.

Prove of DCF equations (cont.)

$$A = P \cdot (1 + r)^n \dots\dots \text{equation (1)}$$

In contrary to the Equation 1, the present value (the discounted value), P , of a future sum of money, A , that will be received after n years if the discount rate is r is calculated as follow:

$$P = A / (1 + r)^n \dots\dots \text{equation (2)}$$

For example, the present value of £100 to be received three (3) years from now is £75.13 if the discount rate is 10% compounded annually.

Note: this two equations are very important.

DCF model

◆ A valuation method used to estimate the attractiveness of an investment opportunity. Discounted cash flow (DCF) analysis uses future free cash flow projections and discounts them (most often using the weighted average cost of capital) to arrive at a present value, which is used to evaluate the potential for investment. If the value arrived at through DCF analysis is higher than the current cost of the investment, the opportunity may be a good one.

◆ Calculated as:

$$DCF = \frac{CF_1}{(1+r)^1} + \frac{CF_2}{(1+r)^2} + \dots + \frac{CF_n}{(1+r)^n}$$

CF = Cash Flow

r = discount rate (WACC)

Also known as the Discounted Cash Flows Model.

Overview of appraisal

- ◆ The basic purpose of systematic appraisal is to achieve better spending decisions for capital and current expenditure on schemes, projects and programmes.
- ◆ An understanding of discounting and **Net Present Value (NPV)** calculations is fundamental for proper appraisal of projects and programmes. A good understanding of:
 - i. Cost Benefit Analysis (CBA);
 - ii. Internal Rate of Return (IRR);
 - iii. Multi Criteria Analysis (MCA); and
 - iv. Cost Effectiveness Analysis (CEA) are all essential for economic appraisal purposes.



Basic investment appraisal techniques

Analytical methods:

- ◆ The recommended analytical methods for appraisal are generally discounted cash flow techniques which take into account the **time value of money**.
- ◆ In investment decision, companies or individuals generally prefer to receive benefits as early as possible while paying costs as late as possible.
- ◆ This concept of time preference is fundamental to proper appraisal and so it is necessary to calculate the **present values** of all **costs and benefits**.

Net Present Value Method (NPV)

- ◆ In the NPV method, the revenues and costs of a project are estimated and then discounted and compared with the initial investment.
- ◆ The preferred option is that with the highest positive net present value. Projects with negative NPV values should be rejected because the present value of the stream of benefits is insufficient to recover the cost of the project.
- ◆ **NPV method are more reliable.** The NPV method should be used where money values over time need to be appraised. Nevertheless, the other techniques also yield useful additional information and may be worth using.

Basic investment appraisal techniques (cont.)

- The NPV methods will be considered in details because of their reliability.
- However, we will look at other analytical methods briefly such as:
 - i. Cost Benefit Analysis (CBA);
 - ii. Internal Rate of Return (IRR);
 - iii. Multi Criteria Analysis (MCA); and
 - iv. Cost Effectiveness Analysis (CEA);
 - v. etc



Internal Rate of Return (IRR)

- ◆ The IRR is the discount rate which, when applied to net revenues of a project sets them equal to the initial investment. The preferred option is that with the IRR greatest in excess of a specified rate of return. An IRR of 10% means that with a discount rate of 10%, the project breaks even. The IRR approach is usually associated with a hurdle cost of capital/discount rate, against which the IRR is compared. The hurdle rate corresponds to the opportunity cost of capital. In the case of public projects, the hurdle rate is the TDR. If the IRR exceeds the hurdle rate, the project is accepted.
- ◆ There are disadvantages associated with the IRR as a performance indicator. It is not suitable for the ranking of competing projects. It is possible for two projects to have the same IRR but have different NPV values due to differences in the timing of costs and benefits. In addition, applying different appraisal techniques to the same basic data may yield contradictory conclusions.

Benefit / Cost ratio (BCR)

- The BCR is the discounted net revenues divided by the initial investment. The preferred option is that with the ratio greatest in excess of 1. In any event, a project with a benefit cost ratio of less than one should generally not proceed. The advantage of this method is its simplicity.
- Using the BCR to rank projects can lead to suboptimal decisions as a project with a slightly higher BCR ratio will be selected over a project with a lower BCR even though the latter project has the capacity to generate much greater economic benefits because it has a higher NPV value and involves greater scale.



Discount rate

◆ The discount rate is a concept related to the NPV method. The discount rate is used to convert costs and benefits to present values to reflect the principle of time preference. The calculation of the discount rate can be based on a number of approaches including, among others:

- i. The social rate of time preference
- ii. The opportunity cost of capital
- iii. Weighted average method



- ◆ The same basic discount rate (usually called the test discount rate or TDR) should be used in all cost-benefit and cost-effectiveness analyses of public sector projects.
- ◆ The current recommended TDR is 5%. However, if a commercial State Sponsored Body is discounting projected cash flows for commercial projects, the cost of capital should be used or even a project-specific rate.

Payback and Discounted payback

- The payback period is commonly used as an investment appraisal technique in the private sector and measures the length of time that it takes to recover the initial investment.
- However this method presents obvious drawbacks which prevent the ranking of projects. The method takes no account of the time value of money and neither does it take account of the earnings after the initial investment is recouped.



Sensitivity analysis

- ◆ An important feature of a comprehensive CBA is the inclusion of a risk assessment. The use of sensitivity analysis allows users of the CBA methodology to challenge the robustness of the results to changes in the assumptions made (i.e. discount rate, time horizon, estimated value of costs and benefits, etc). In doing so, it is possible to identify those parameters and assumptions to which the outcome of the analysis is most sensitive and therefore, allows the user to determine which assumptions and parameters may need to be re-examined and clarified.
- ◆ Sensitivity analysis is the process of establishing the outcomes of the cost benefit analysis which is sensitive to the assumed values used in the analysis.

Scenario analysis

- The scenario analysis technique is related to sensitivity analysis. Whereas the sensitivity analysis is based on a variable by variable approach, scenario analysis recognises that the various factors impacting upon the stream of costs and benefits are inter-independent.
- In other words, this approach assumes that that altering individual variables whilst holding the remainder constant is unrealistic (i.e. for a tourism project, it is unlikely that ticket sales and café-souvenir sales are independent).
- Rather, scenario analysis uses a range of scenarios (or variations on the option under examination) where all of the various factors can be reviewed and adjusted within a consistent framework.

Switching values

- This process of substituting new values on a variable-by-variable basis can be referred to as the calculation of switching values.
- These can provide interesting insights such as what change(s) would make the NPV equal zero or alternatively, by how much must costs or benefits fall or rise, respectively, in order to make a project worthwhile. The switching value is usually presented as a % i.e. a 20% increase in investment costs reduces project NPV to 0.
- This is very useful information and should be afforded a prominent place in any decision-making process. Moreover, given the importance of this information the switching values chosen should be carefully considered and should be realistic and justifiable. For example, for capital projects requiring an Exchequer commitment over the medium to long-term, operating and maintenance costs should always be examined. Similarly, any project reliant upon user charges should always examine the impact of changes in volumes and the level of charges.

NPV - TIME and MONEY

1. Amount of 1

The amount to which a sum of money invested at the beginning of Year 1 will accumulate at the specified rate of interest by the end of a specified period of time.

Formula:

$$A = P (1+r)^n$$

Where:

A = the final sum

P = the principal (initial sum)

r = the rate of interest pa

n = the number of years.

Example: TIME and MONEY

If £123.40 were to be invested at 10.5% compound interest, how much would it accumulate to by the end of 15 years?

$$A = 123.40(1 + 0.105)^{15}$$

$$A = 123.40 * 4.471$$

$$A = 551.76$$

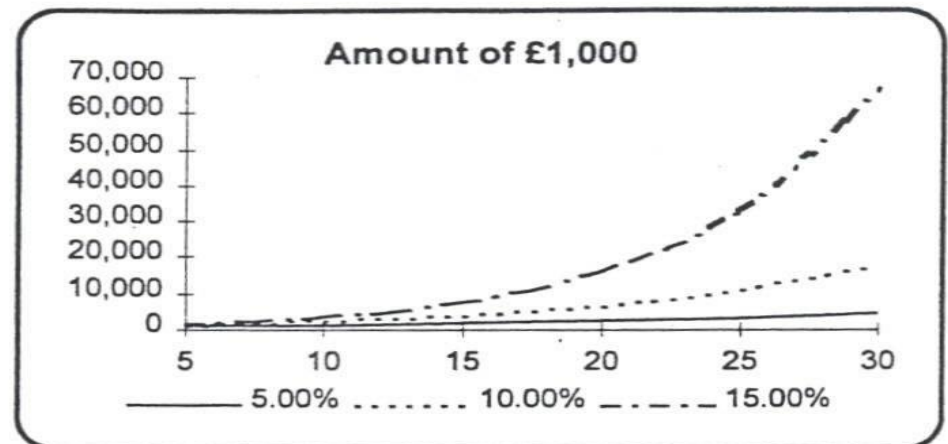
The effect of varying the number of years and the interest rate:

As might be expected, the value of A will be higher for higher rates of interest. Over longer periods of time this can produce some spectacular difference. If we look at the amount to which £1,000 will accumulate over (say) 30 years at different interest rates we get the following result:

Example: TIME and MONEY (cont.)

Years	5.00%	10.00%	15.00%
5	1,276	1,611	2,011
10	1,629	2,594	4,046
15	2,079	4,177	8,137
20	2,653	6,727	16,367
25	3,386	10,835	32,919
30	4,322	17,449	66,212

Or graphically:



Note that after about 20 years the paths start to diverge considerably.

Changing the compounding periods:

In the above example, the interest was credited to the account at the end of each year. Interest upon this interest (interest accruing) was not, therefore calculated until the end of the following year. Had interest been credited to the account at the end of each month, then clearly at any given time the account would contain more money and the final sum would be greater. To calculate this new figure, an adjusted version of the **Amount of 1 formula** is used:

Formula:

$$A = P(1+(r/t))^{nt}$$

Where:

A = the final sum

p = the principle (initial sum)

r = the rate of interest pa

n = the number of years.

t = the number of compounding periods per year.

Note: In this example, interest upon interest is on monthly basis. In the first example, interest was only considered on annual basis. **More explanation to be provided in class.**

$$A = 123.40(1 + (0.105/12))^{15 \times 12}$$

$$A = 123.40 * (1.00875)$$

$$A = 123.40 * 4.7978$$

$$A = 592.04$$

Annual Interest Rates and Effective Annual Interest Rates

- ◆ In both of the above examples the quoted interest rate was 10.5%, yet in the second example more interest accrued to the investor than in the first example. The reason for this is that in the **second example** the presence of monthly compounding periods meant that interest payments exerted a greater influence than in the first example. Annual interest rates can be converted to Effective annual interest rates by application of the following:

Formula:

$$\begin{aligned} & [(1+(r/t)^t]-1 \\ & = [(1+(0.105/12))^{12}]-1 \\ & = 0.11020 \\ & = 11.02\% \end{aligned}$$

Annual Interest Rates and Effective Annual Interest Rates

In other words, compounding annually at the rate of 11.02% has the same effect as compounding monthly at 10.5%:.

$$A = 123.40(1+.1102)^{15}$$

$$A = 123.40 * 4.797$$

$$A = 592.02$$

The effect of variations in the compounding interval can be illustrated as follows:

Compounding Frequencies	"t"	Effective Annual Interest Rate	Value of £1,000 after 10 years
Annually	1	10.000%	2,593.74
Quarterly	4	10.381%	2,685.06
Monthly	12	10.471%	2,707.04
Weekly	52	10.506%	2,715.67
Daily	365	10.516%	2,717.91

Converting sub-annual rates to annual rates:

- If a rate of interest or a rate of return is quoted (say) quarterly, it can be converted to an annual rate by applying the formula:

Formula:

$$r_a = [(1+r_q)^t] - 1$$

Where:

r_a = The rate of interest or return pa

r_q = The rate of interest or return per quarter

t = The number of compounding periods per year.

Thus an investment which offers a rate of return of 2.5% quarterly has an annual rate of return of:

$$r_a = [(1+0.025^4)] - 1$$

$$r_a = .1038$$

Or 10.38% per annum

Converting annual rates to sub-annual rates

The converse of the above would be a situation in which we needed to know what rate of return per quarter equated to an annual rate of return of 10%.

Formula:

$$r_q = [(1+r_a)^{(1/t)}] - 1$$

Substituting:

$$r_q = [(1+0.10)^{(1/4)}] - 1$$

$$r_q = .0241$$

or 2.41 % per quarter.

Working out the growth rate of an asset

It is sometimes necessary to work out the compound rate of growth of an asset which has increased in value over a period of time. If, for example, a house was bought 10 years ago for £80,000 and is now worth £120,000, what has been the rate of capital appreciation pa?

Example:

Increase in value: $(120,000 - 80,000) / 80,000 = 50\%$

Formula (vi): $r = [(1 + r)^{(1/n)}] - 1$

Substituting: $r = [(1.50)^{(1/10)}] - 1$

$r = .04138.$

Or 4.138% pa.

Working out the growth rate of an asset (cont.)

The conclusion that can be drawn from this is that if the £80,000 had been invested at a rate of 4.138% pa 10 years ago, it would have grown in value to £120,000. We can check this back:

$$\begin{aligned} A &= P (1+r)^n \\ 80,000 * (1 + 0.04138)^{10} \\ &= £120,000 \end{aligned}$$

Had it been possible to invest the money in an account yielding more than 4.138% pa, or in an account where interest was credited more than once a year, then the resultant return would exceed the return on buying the house. For example, if interest had been credited quarterly the final sum would have been:

$$\begin{aligned} A &= 80,000(1 + (.04138/4))^{10*4} \\ A &= 80,000 * (1.010353)^{40} \\ A &= 80,000 * 1.5093 \\ A &= 120,747 \end{aligned}$$

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