CHAPTER 4

CASH FLOW AND INVESTMENT APPRAISAL

A cash flow is a financial model of a project or contract. It is the actual flow of money, i.e. it takes account of delays between incurring a commitment and making a money transaction. An expense is the actual payment of a cost and an income is the actual receipt of a revenue. The difference between a company's total income and its total expense over a period of time is termed the company's cash flow.

Cash in = receipt = income
Cash out = payment = expense
Cash flow = Cash in - Cash out

While the first part of the chapter studies the flow of money during the course of a contract or project, the second part describes investment appraisal techniques. An engineer with the appropriate education is required to convert the differences between available alternatives into terms which can be easily understood. The contents explain the basis of the required calculations and give useful applications which include: economic comparison between different items of plant or methods, setting plant hire rates, and assessing the replacement age of plant items. Note that in setting up the example problems, all costs are assumed and not necessarily related to real-life numbers; they are only used to demonstrate the principle.

4.1 Contract Cash Flow

The Need to Forecast Contract Cash Flow

The contractor's expense on a contract will typically exceed his progress income over an appreciable part of the contract. The deficit may be made up from the contractor's working capital or money must be borrowed to provide the necessary operating funds.

Since the cash flow forecast for the company is simply the sum of the forecasts for the individual contracts, it is necessary for the contractor to determine the cash flow of the contract and to make regular revisions to it.

Large companies with many concurrent contracts may use the positive cash flow of one contract to handle the negative cash flow of another. In case of bad cash flow forecasting, the company must not taking on a new contract and the work schedules of existing contracts should be adjusted. The ability to forecast cash flow needs accurately can increase a company's growth rate.

Cash Out Forecast

The principal components of the contractor's expenses result from:

- initial costs to start the contract such as costs of bonds and site mobilization costs
- direct job costs which include costs of labour, materials, plant, and subcontractors
- general overhead costs and taxes which can be spread uniformly over contract duration.

Details of these costs will be discussed in Chapter 5.

The following types of costs can be used to model the way in which costs are likely to be incurred:

Start cost: cost incurred at start of activity or resource
Finish cost: cost incurred at finish of activity or resource
Time-related cost: cost applied over duration of an activity or resource
Usage-related cost: cost per unit of resource used
Production-related cost: cost per unit of resource provided

This means that the cost estimate can take full account of the interrelationship between cost and time and allows a realistic forecast of cash expenses to be produced. Such a procedure is extremely complicated, and can be used only with computer support. However, a simplified approach will be demonstrated hereinafter.

Because the contractor pays his bills throughout each month, a smooth curve is considered to be an acceptable representation of contract cash expenses.

Cash In Forecast

Case of Admeasurement Contract

Table 4.1 shows a typical monthly payment request (invoice) in case of admeasurement contract. The quantities of work are determined by actual field measurement of the completed items. The value of this work is determined and then the sum of the previous progress payments made by the client is subtracted. Materials stored on site, but not yet incorporated into work, should be taken into account. Retention money should also be taken into account. The client will issue a check in the amount due in a four-week period. A step curve is used to represent contract cash income.

Case of Lump Sum Contract

In this case, progress is measured in terms of estimated percentages of completion of major job components. These are established by negotiation between the contractor and the client. The use of the activity schedule to specify these percentages may facilitate payment requests. Table 4.2 shows a typical periodic invoice in case of lump sum contract. Contract cash income is represented by a step curve.

Case of Cost-Plus Contract

In case of cost-plus contract the contractor may prepare estimates of expenses for the coming month and receives the money in advance. Then, at month's end, he prepares an accounting of his actual expenses. Any difference is adjusted with the next monthly estimate.

A Simplified Approach to Forecast Contract Cash Flow

Contract Revenue / Income Curve

The contract revenue / income curve can be derived as follows:

- Produce an activity schedule in bar chart form. If adjustments have been made to effect levelling of resources, the schedule should reflect these variations.
- Determine the value of each activity per week.

Table 4.1 Monthly Payment Request (case of admeasurement contract)

Item no.	Description	Quantity	Unit	Rate	Amount
10 -- --	Excavation	Q1	M^3	R1	Q1.R1
				Σ	a

Cost of work performed to date = a
Cost of materials stored on site = b
Revenue = 0.95 a + 0.75 b = c
Previous payments = d
Payment due = c - d = e

Table 4.2 Periodic Payment Request (case of lump sum contract)

Item no.	Description	Total cost	% Complete	Completed to date
51 -- --	Grouting	T1	C1	T1.C1
			Σ	a

Cost of work performed to date = a
Cost of materials stored on site = b
Revenue = 0.95 a + 0.75 b = c
Previous payments = d
Payment due = c - d = e

- Sum up the activities weekly and then the monthly revenue in case of admeasurement contract, or sum up the activities weekly and then the periodic revenue in case of lump sum contract.
- Adjust the revenue for advanced payment and retention.
- Draw cumulative adjusted revenue versus time curve.
- Shift the above curve by the lag between submitting invoices and receiving revenue to get the income curve.

Contract Cost / Expense Curve

When the mark-up, see section 5.6, is uniformly spread throughout the contract, the cost / expense curve can be derived as follows:

- If the mark-up; M, is expressed as a percentage of tender price, then: Cumulative cost = cumulative revenue × (1 - M)
- Draw cumulative cost versus time curve.
- Group cost headings that have the same payment delay between incurring the cost and making the payment.
- Calculate the proportion of costs due to each group.
- Shift the cumulative cost of each group by the specified amount to get its cumulative expense.
- Sum up contract cumulative expenses.
- Draw cumulative expense curve.

Contract Cash Flow Curves

Having determined the contract cumulative income and expense curves, one can combine them on one graph to represent the contract cumulative cash flow curves. However, the difference between these two curves can be drawn to represent the contract cumulative net cash flow.

The following example demonstrates the above procedures for developing contract cash flow curves.

Example 4.1

The activities involved in a construction contract are given in Table 4.3. The value of the work involved in each activity is listed in the table. The mark-up is 10% of tender value and is assumed to be uniformly distributed over the contract. The contractor will receive an advanced payment of 10% of tender value. This will be deducted from each monthly revenue. Retention is 5% and is paid on contract completion. Labour cost is assumed to be 30% of

Table 4.3 Data for Example 4.1

Activity	Duration (weeks)	Preceding activity	Overlap	Value (LE)
A	5	-		30000
B	4	A		20000
C	5	A	-1	15000
D	5	A		15000
E	5	B	2	25000
F	4	B,C		16000
G	6	D		18000
H	4	E	1	8000
I	3	F,G	2 with G	9000
J	2	H,I		4000

total contract cost and is paid after one week's delay. The delay for other payments is one month. Revenue is received after 4 weeks from submitting invoices.

Assuming all the activities are scheduled on their early start timings, it is required to derive revenue and income curves, cost and expense curves and contract cash flow curves. Compare contract net cash flows for revenue received after 4 and 6 weeks from submitting invoices.

Determine the effect on contract cash flow of scheduling the activities on their late start timings while the revenue is received with 4 week's delay.

Solution

The timings of each activity are determined using the precedence diagram shown in Figure 4.1. Cash flow calculations for early start and late start scheduling are given in Figures 4.2 and 4.3 respectively. These figures are self explanatory. For the purpose of this example it has been assumed that revenue is uniformly distributed over the activity duration.

Figure 4.4 gives a comparison between revenue and income curves for early start scheduling. Figure 4.5 gives this comparison for cost and expense curves.

Figures 4.6a and 4.6b combine the expense and income curves for revenue payment delayed by four and six weeks respectively. These are the contract cumulative cash flows. The corresponding contract net cash flows are shown in Figure 4.7. These figures demonstrate that the longer the revenue payment delay the greater will be the negative cash flows experienced during the contract.

Finally, Figure 4.8 compares the contract net cash flows for scheduling the activities on their early and late start timings. Note that cash flows based on late start schedule will produce low initial payments and high later ones.

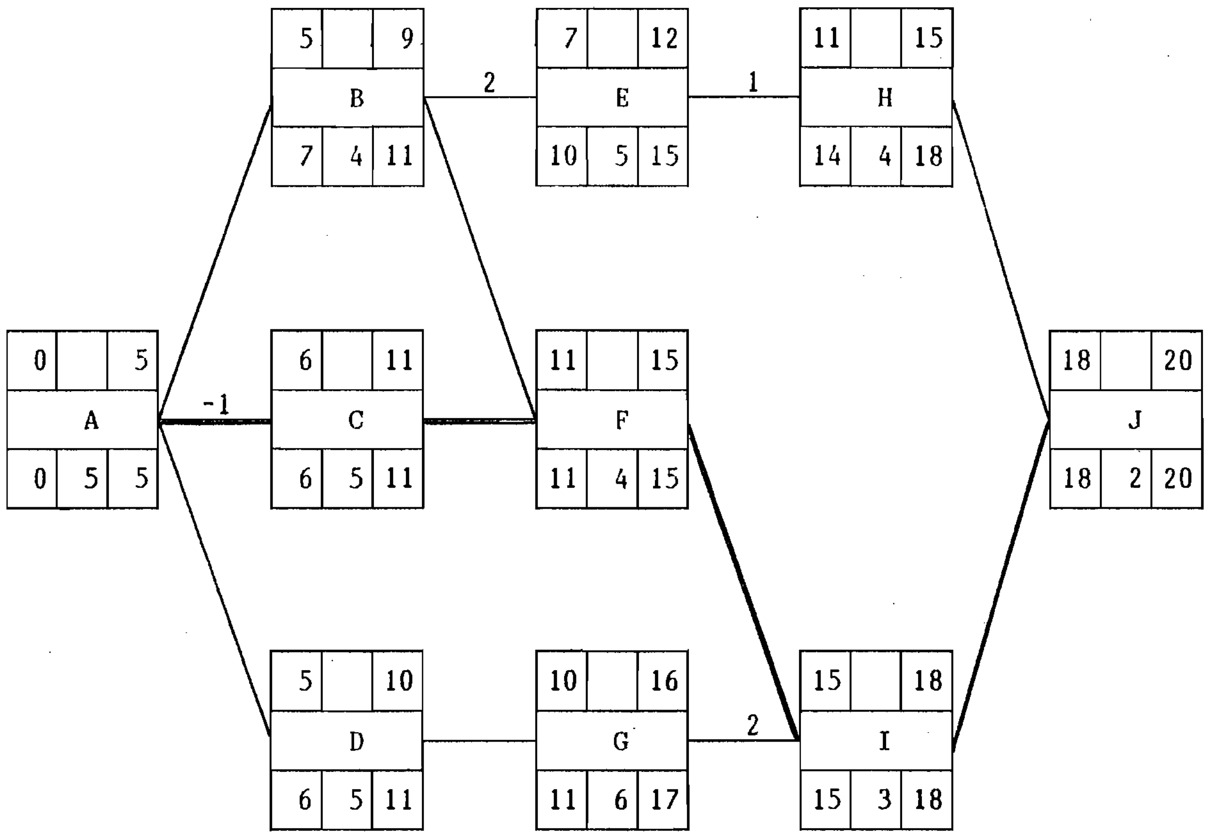

Figure 4.1 Precedence Network of Example 4.1

Factors That Minimize Contractor's Negative Cash Flow

1. Front end rate loading: earlier items in bill of quantities carry a higher mark-up than later items. This reduces negative cash flows in contract early stages.

2. Reduction of delays in receiving revenue.

3. Adjustment of work schedule to late start timing.

4. Coinciding the timing of delivery of large materials orders with the submittal of the contractor's monthly pay estimate.

5. Delay in paying labour, plant hirers, materials suppliers and subcontractors. This would reduce negative cash flows but undermine commercial confidence in the company.

6. Increasing the mark-up and reducing the retentions.

7. Increasing mobilization and advance payment.

8. Achievement of maximum production in the field.

9. Quick settlement of claims.

Activity	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
Month No.		1				2				3				4				5				6				
A	6*	6	6	6	6																					
C							3	3	3	3	3															
F												4	4	4	4											
I																3	3	3								
J																			2	2						
B						5	5	5	5																	
D						3	3	3	3	3																
E								5	5	5	5	5														
G											3	3	3	3	3	3										
H												2	2	2	2											

	Item		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
a	Weekly revenue		6.0	6.0	6.0	6.0	6.0	8.0	11.0	16.0	16.0	11.0	11.0	14.0	9.0	9.0	9.0	6.0	3.0	3.0	2.0	2.0						
b	Monthly revenue					24.0				41.0				52.0				33.0				10.0						
c	Cumulative revenue					24.0				65.0				117.0				150.0				160.0						
d	Advanced payment	16																										
e	Adj. month. revenue = 0.85 b					20.4				34.9				44.2				28.1				8.5						
f	Retention																					8.0						
g	Cum. adj. revenue	16				36.4				71.3				115.5				143.5				160.0						
h	Income (4 weeks lag)	16								36.4				71.3				115.5				143.5				160.0		
i	Income (6 weeks lag)	16										36.4				71.3				115.5				143.5				160.0
j	Cumulative cost=0.9c					21.6				58.5				105.3				135.0				144.0						
k	Cum. lab. cost=0.3j					6.5				17.6				31.6				40.5				43.2						
l	Cum. lab. expense					6.5				17.6				31.6				40.5				43.2				43.2		
m	Other costs = 0.7j					15.1				41.0				73.7				94.5				100.8						
n	Other expenses					0.0				15.1				41.0				73.7				94.5				100.8		
o	Cum. expenses =l +n					6.5				32.7				72.5				114.2				137.7				144.0		144.0
p	Mid month cum.expense			3.2				19.6				52.5				93.4				126.0				140.9				144.0
q	Cum. cash flow=h -o	16				9.5				-16.7 3.7				-36.1 -1.2				-42.9 1.3				-22.2 5.8				-0.5 16.0		16.0
r	Cum. cash flow=i -p	16		12.8				-3.6				-36.5 -16.1				-57.0 -22.1				-54.7 -10.5				-25.4 2.6				-0.5 16.0

All cash values of this figure should be multiplied by 1000.

Figure 4.2 Cash Flow Calculations for Early Start Timing.

	Activity		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
	Week No.		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
	Month No.			1				2				3				4				5				6				
	A		6*	6	6	6	6																					
	C								3	3	3	3	3															
	F													4	4	4	4											
	I																	3	3	3								
	J																				2	2						
	B									5	5	5	5															
	D								3	3	3	3	3															
	E												5	5	5	5	5											
	G													3	3	3	3	3	3									
	H																2	2	2	2								
a	Weekly revenue		6.0	6.0	6.0	6.0	6.0	0.0	6.0	11.0	11.0	11.0	16.0	12.0	12.0	12.0	14.0	8.0	8.0	5.0	5.0	2.0						
b	Monthly revenue					24.0				23.0				50.0				46.0				17.0						
c	Cumulative revenue					24.0				47.0				97.0				143.0				160.0						
d	Advanced payment	16																										
e	Adj. month. revenue = 0.85 b					20.4				19.6				42.5				39.1				14.5						
f	Retention																					8.0						
g	Cum. adj. revenue	16				36.4				56.0				98.5				137.6				160.0						
h	Income (4 weeks lag)	16								36.4				56.0				98.5				137.6				160.0		
i	Income (6 weeks lag)	16										36.4				56.0				98.5				137.6				160.0
j	Cumulative cost=0.9c					21.6				42.3				87.3				128.7				144.0						
k	Cum. lab. cost=0.3j					6.5				12.7				26.2				38.6				43.2						
l	Cum. lab. expense					6.5				12.7				26.2				38.6				43.2				43.2		
m	Other costs = 0.7j					15.1				29.6				61.1				90.1				100.8						
n	Other expenses					0.0				15.1				29.6				61.1				90.1				100.8		
o	Cum. expenses =l +n					6.5				27.8				55.8				99.7				133.3				144.0		144.0
p	Mid month cum.expense			3.2				17.2				41.8				77.8				116.5				138.7				144.0
q	Cum. cash flow=h -o	16				9.5				-11.8 / 8.6				-19.4 / 0.2				-43.7 / -1.2				-34.8 / 4.3				-6.4 / 16.0		16.0
r	Cum. cash flow=i -p	16		12.8				-1.2				-25.8 / -5.4				-41.4 / -21.8				-60.5 / -18.0				-40.2 / -1.1				-6.4 / 16.0

* All cash values of this figure should be multiplied by 1000.

Figure 4.3 Cash Flow Calculations for Late Start Timing.

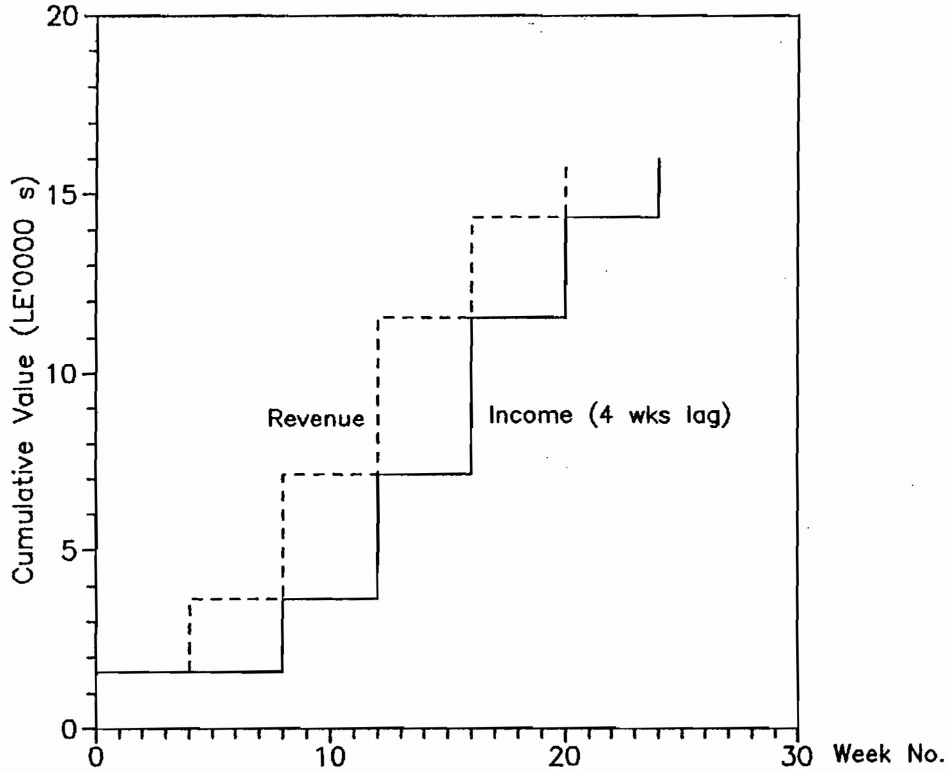

Figure 4.4 Contract Revenue and Income Curves.

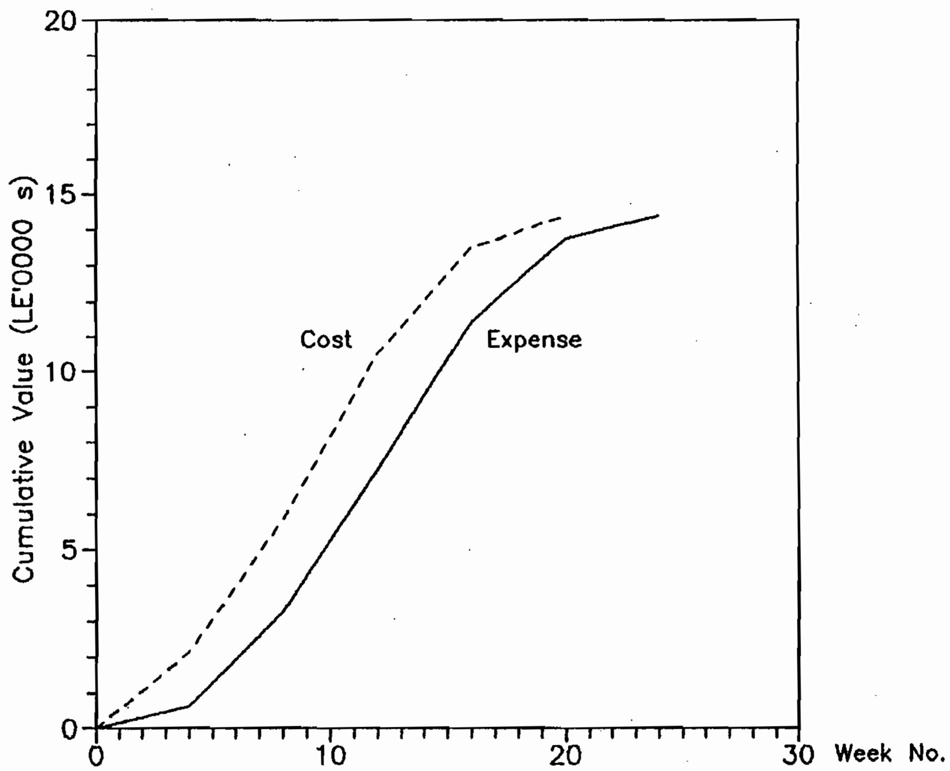

Figure 4.5 Contract Cost and Expense Curves.

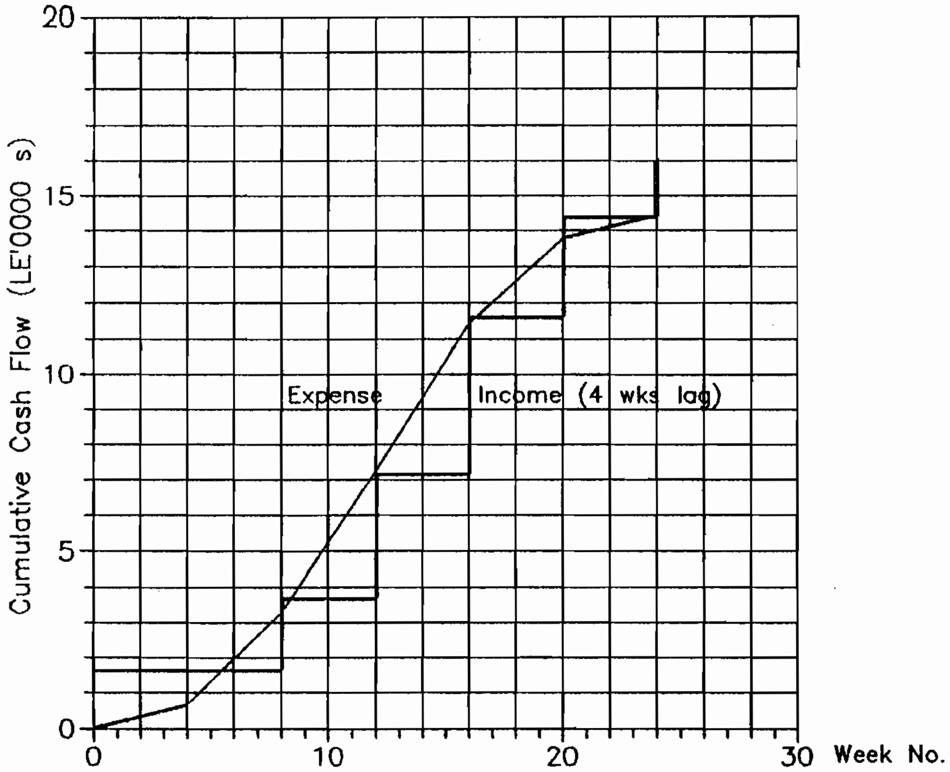

Figure 4.6a Contract Expense and Income Curves (delay in revenue payment is four weeks)

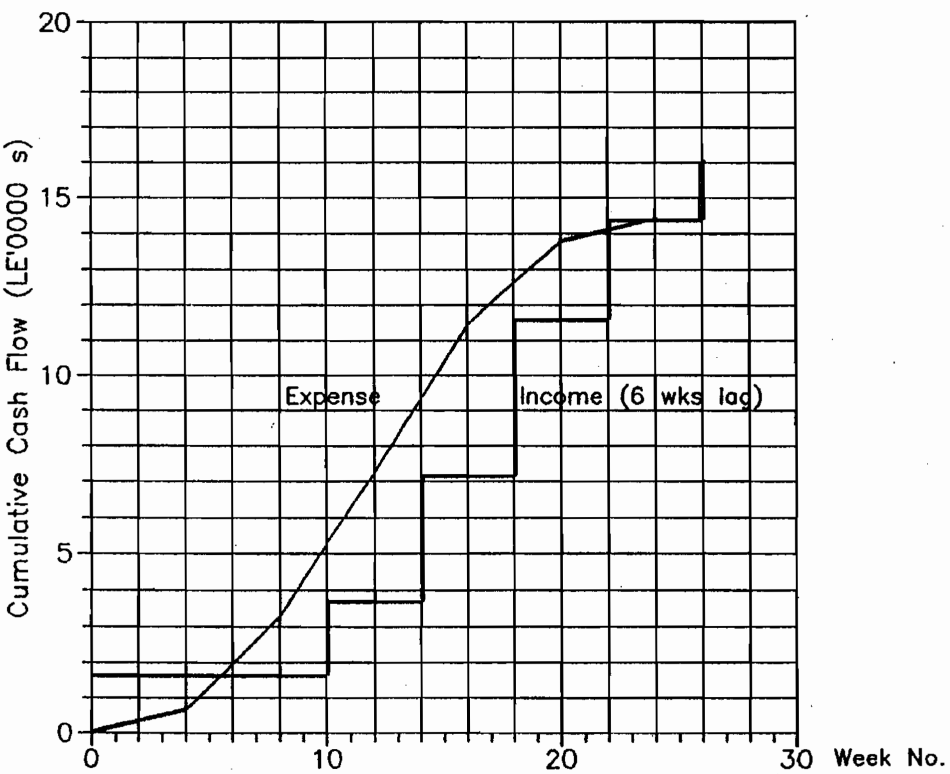

Figure 4.6b Contract Expense and Income Curves (delay in revenue payment is six weeks)

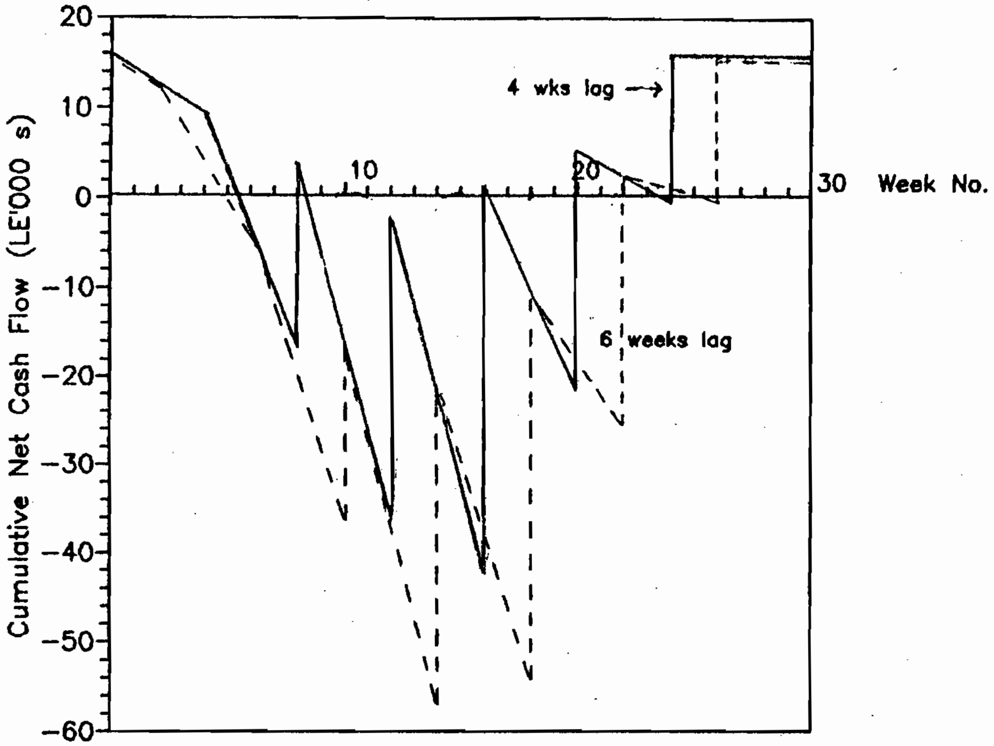

Figure 4.7 Comparing Contract Net Cash Flow for Revenue Received after Four and Six Weeks.

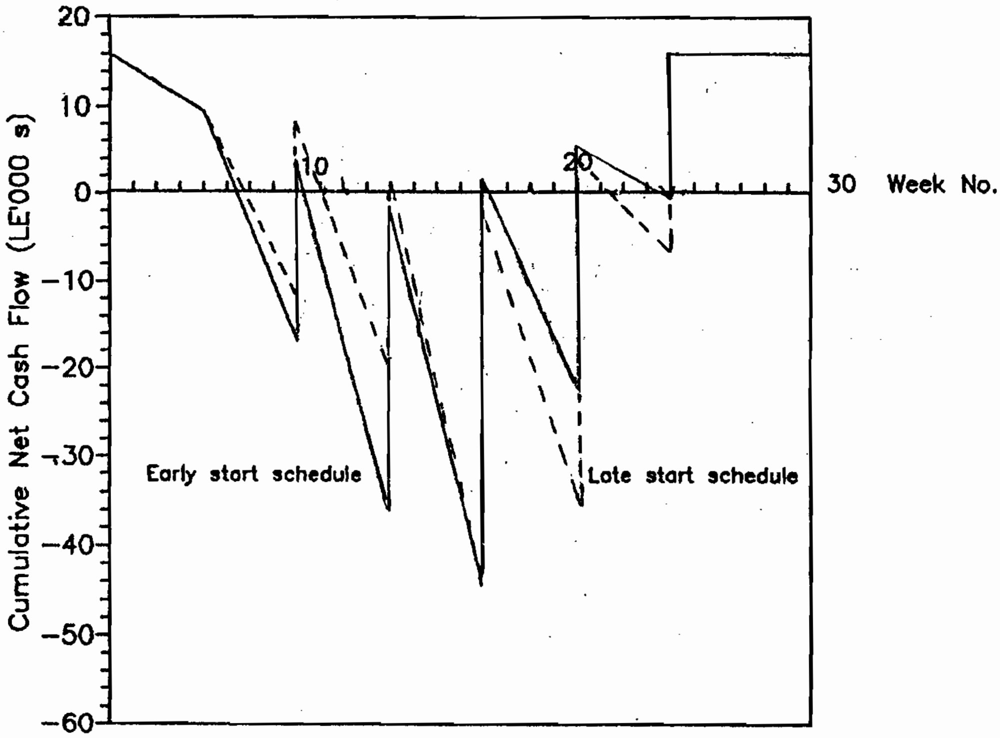

Figure 4.8 Comparing Contract Net Cash Flow for Scheduling the Activities on their Early and Late Start Timings.

Calculation of Financial Charges

The cash invested in the contract is represented by the negative area between the expense and income curves. This area, A, can be calculated in units of "LE . weeks" if the vertical scale is in Egyptian pounds and the horizontal scale in weeks.

If the rate of investment is r% per year, then financial charges can be calculated as follows:

$$\text{Financial Charges} = A \times r / 52$$

It is important to point out that if the contractor borrows the negative cash with interest, then r equals the interest rate.

Example 4.2

Calculate financial charges for the cash expended in the contract given in Example 4.1. Assume investment rate = 24% per year.

Solution

In this contract the positive cash flow given by the advanced payment may be used by the contractor to handle the negative cash flow of another contract. Therefore the real investment of the contractor should be represented by the difference between the negative and positive areas of the cash flow.

The scale used to draw Figures 4.6a and 4.6b indicates that one square unit represents 20000 LE.weeks.

<u>Case of revenue payment delayed by four weeks</u>

positive area = 2.7 square units
negative area = 10.5 square units
then financial charges = (10.5 - 2.7) 20000 (0.24) / 52
= LE 720.

<u>Case of revenue payment delayed by six weeks</u>

positive area = 2.7 square units
negative area = 22.8 square units
then financial charges = (22.8 - 2.7) 20000 (0.24) / 52
= LE 1855.

4.2 Project Cash Flow

The time scale of a project is much longer than that of a contract. Consequently the investment in a project is insensitive to delays of few weeks in payments. A typical project cash flow is shown in Figure 4.9.

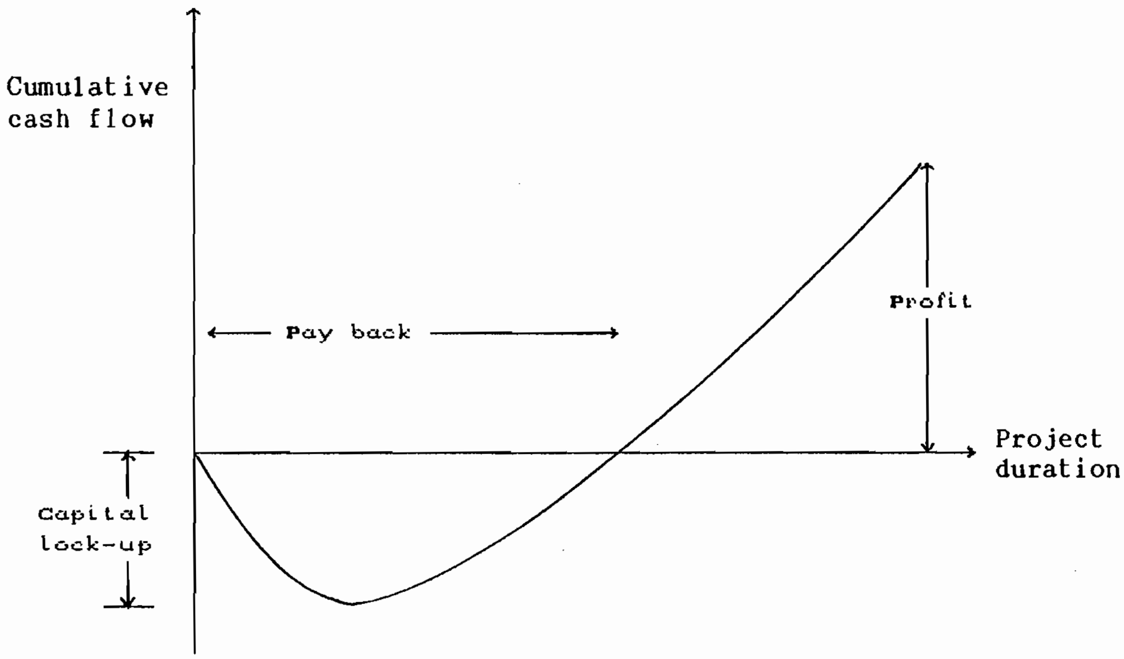

Figure 4.9 A Typical Project Cash Flow

Profitability Indicators

The profitability of a project may be assessed by the following indicators; see Figure 4.9:

Profit

It is the arithmetical difference between total payments and total receipts. It does not give the effect of time on the flow of money.

Maximum Capital Lock-up

It is the maximum demand for capital. It does not take into consideration any positive cash flow.

Payback Period

It is the length of time which elapses between the inception of a project and the time when the cash benefits flowing from it have equalled the initial investment. The project with the shortest payback period is ranked the best. The defect of the payback method is that it does not take into account any cash flow which arises after the end of the payback period.

However, all the investment cash flows together with the effect of their timing can be taken into consideration by the discounted cash flow method. It is usual to use this method with one or more of the above indicators for investment appraisal.

4.3 Discounted Cash Flow (D.C.F.)

Discounting is the process whereby a future sum of money is evaluated at a date prior to the future date. The value of future money is dependent upon the time at which it is received. It is more desirable to have one pound today than a year or more from now. Comparing pounds in hand today with future pounds requires that the worth of future pounds be discounted.

If the annual discount rate is r%, then the sum of [LE p] arising at time zero is equivalent to [LE $p(1+r)^n$] in n years' time. In other words, the sum of [LE c] arising in n years' time has a present value of [LE $c/(1+r)^n$], or

$$p = \frac{c_n}{(1+r)^n} \tag{4.1}$$

where p = present value of investment

c_n = cash flow incurred over the duration n

r = discount rate per time period.

The period of time need not be confined to one year, so long as the discount rate (investment rate) is linked to the period of time.

Net Present Value (N.P.V.)

The summation of the present value of all cash flows of the project under consideration gives the net present value, where receipts are considered positives and payments are considered negatives. It is assumed that a project will be acceptable if it gives a positive NPV.

Example 4.3

Calculate the NPV of the project which involves making an immediate investment of LE 1000 and receiving: LE 400 at the end of year 1, LE 500 at the end of year 2, and LE 600 at the end of year 3. The discount rate is 10% per annum.

Solution

$$NPV = -1000 + 400/1.1 + 500/(1.1)^2 + 600/(1.1)^3 = LE\ 227$$

It is important to point out that the D.C.F. analysis tends to favour low capital / high operating cost projects rather than higher capital / lower operating cost projects. On the other hand, on long life projects the cash flow in later years is virtually discounted to zero.

In many projects a stream of benefits not expressed in money values may be obtainable in different ways each giving rise to a different stream of payments. It may be helpful to assess the present value of the flow of costs associated with the project in such cases. Then the project with the least NPV is the best investment.

Internal Rate of Return (I.R.R.)

Instead of calculating the NPV of a project at a stated discount rate the problem may be presented as that of determining the discount rate which would result in a zero NPV. This approach is referred to as the internal rate of return method. This return must be constant over the life of the project.

The criterion usually applied under this method is that a project should be acceptable if it produces an IRR greater than the minimum return on capital. Therefore, if the required cost of capital is 12%, the project should be accepted when the IRR is shown to be greater than 12%.

Example 4.4

Calculate the IRR for the project given in Example 4.3.

Solution

The IRR is given by solving for r in the equation:

$$-1000 + 400/(1+r) + 500/(1+r)^2 + 600/(1+r)^3 = 0$$

This equation can be solved, by plotting a graph of NPV against r, given in Figure 4.10, with a final interpolation when one is close to the answer; or

$$5.7 / (5.7 + 27) = (22 - r) / (22 - 20)$$

or $r = 21.65\%$

Example 4.5

Suppose projects A and B represent alternative ways of carrying out a job. The cash flows are as follows:

	Investment (LE)	Income at the end of year 1	year 2	year 3
Project A	10000	3000	5000	6000
Project B	10000	6000	4000	3000

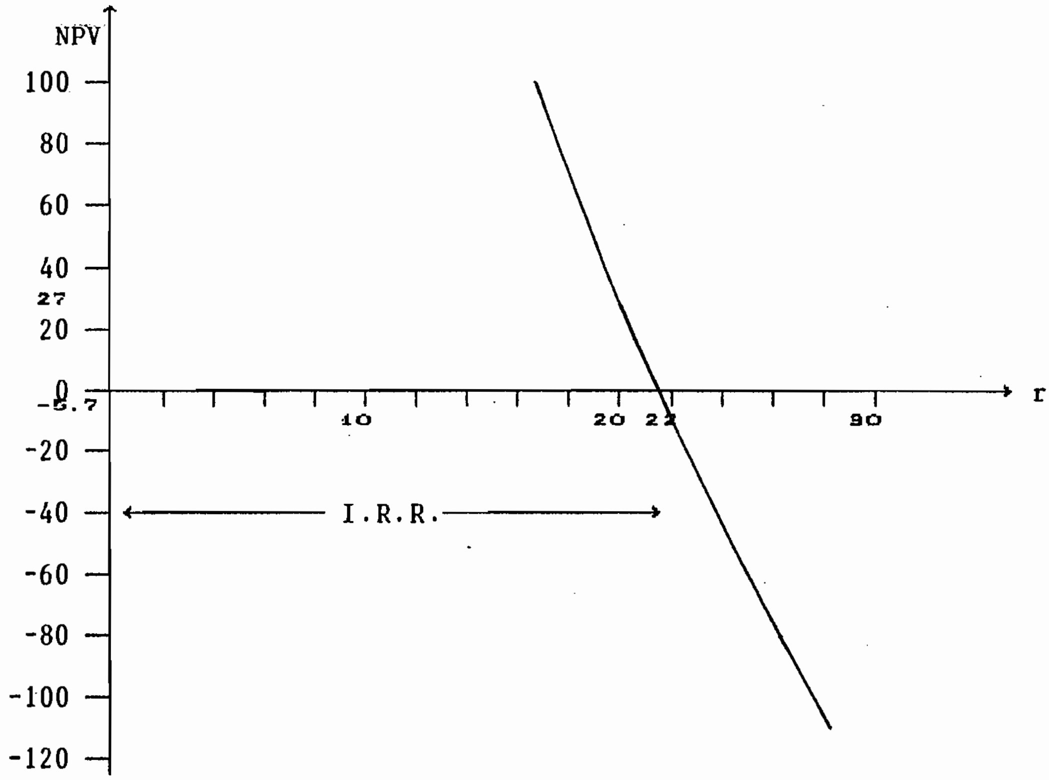

Figure 4.10 Calculation of Internal Rate of Return

If the cost of capital is 10% per year, rank the two projects according to their NPV and IRR.

Solution

<u>Project A</u>

$$NPV = -10000 + 3000/1.1 + 5000/(1.1)^2 + 6000/(1.1)^3$$
$$= LE\ 1367.4$$

$$10000 = 3000/(1+r) + 5000/(1+r)^2 + 6000/(1+r)^3$$

then $IRR = 16.8\%$

<u>Project B</u>

$$NPV = -10000 + 6000/1.1 + 4000/(1.1)^2 + 3000/(1.1)^3$$
$$= LE\ 1014.3$$

$$10000 = 6000/(1+r) + 4000/(1+r)^2 + 3000/(1+r)^3$$

then $IRR = 16.7\%$

Based on NPV or IRR, Project A is better than Project B.

However, in some cases the above two indicators give different results. There is no firm rule as to which indicator gives the best guide for decision making. Most companies calculate a number of indicators. It is probably that either NPV or IRR would be used in conjunction with one of the indicators given in article 4.2: for the selection of a project or to identify a preferred contract cash flow.

Selection of the Discount Rate

A comparison between the present value of two cash flows which have different patterns over time depends upon the discount rate used.

For public projects, the discount rate should represent the internal opportunity cost of capital: that is the greatest return earned on any project.

If a project in the private sector is to be financed by a share capital, the cost of capital should correspond with the long-term return which the ordinary shareholders may expect from a company of the type concerned; the rate of return earned by investing money in other companies.

An important factor which powerfully influences the choice of discount rate is the degree of uncertainty which surrounds the outcome of a particular project. In general the greater the uncertainty, the greater will be the discount rate.

4.4 Equivalent Uniform Annual Cost (E.U.A.C.)

EUAC converts the capital sums to an annual cost. When costs vary from year to year it is necessary to convert the varying annual costs to a present value and then to convert this present value to an EUAC. This method can be used in the following cases:

- when the lives of proposals under comparison are not equal
- to compare the purchase price and running costs with the hiring cost.

Uniform Series of Payments

An amount C invested at the end of each of n periods at investment rate r will give a sum S so that:

$$S = C(1+r)^{n-1} + C(1+r)^{n-2} + \ldots\ldots. + C(1+r) + C$$

or $$S = C[(1+r)^{n-1} + (1+r)^{n-2} + \ldots\ldots. + (1+r) + 1] \qquad (a)$$

then $$S(1+r) = C[(1+r)^{n} + (1+r)^{n-1} + \ldots\ldots. + (1+r)] \qquad (b)$$

(b)-(a) $S.r = C\,[(1+r)^n - 1]$

then $$S = C\,\left[\frac{(1+r)^n - 1}{r}\right] \quad (4.2)$$

and $$C = S\,\left[\frac{r}{(1+r)^n - 1}\right] \quad (4.3)$$

In equation 4.3, C is the uniform amount to be invested at the end of each period in order to produce a fixed amount, S, at the end of n periods.

Now the present value of S is

$$P = C\,\left[\frac{(1+r)^n - 1}{r(1+r)^n}\right] \quad (4.4)$$

and $$C = P\,\left[\frac{r(1+r)^n}{(1+r)^n - 1}\right] \quad (4.5)$$

The bracketed factor in equation 4.4 is known as the uniform series present worth factor while that given in equation 4.5 is known as the capital recovery factor.

Example 4.6

The following information belongs to the ownership and operating costs of a construction machine . Calculate the hourly rate of this equipment assuming investment rate = 16% per year. Neglect overheads.

Capital cost	LE 65000
Salvage value	LE 6000
Repairs and maintenance / year	15% of capital cost
Average working hours / year	2400
Years of life of the equipment	12
Fuel at 20 litre / hour	LE 0.3 / litre
Oil	10% of fuel cost

Solution

Operating cost / year = [20 (0.3) 2400] 1.1 + 0.15 (65000)
= 15840 + 9750
= LE 25590

Assume that the uniform annual revenue obtained from the equipment is LE R. The cash flows can now be represented in Table 4.4.

In order that the desired rate of return be achieved the present value of cash totals must be zero or:

$$65000 = (R - 25590)\,[(1.16)^{11} - 1] / 0.16(1.16)^{11} + (R - 19590) / (1.16)^{12}$$
$$= 5.028(R - 25590) + 0.168(R - 19590)$$

then R = 37906
or the hourly rate = 37906 / 2400 = LE 15.79

Table 4.4 Cash Flows for Example 4.6

End of year	Cash out (LE)	Cash in (LE)	Cash total (LE)
0	65000	0	- 65000
1	25590	R	R - 25590
2	25590	R	R - 25590
3	25590	R	R - 25590
4	25590	R	R - 25590
5	25590	R	R - 25590
6	25590	R	R - 25590
7	25590	R	R - 25590
8	25590	R	R - 25590
9	25590	R	R - 25590
10	25590	R	R - 25590
11	25590	R	R - 25590
12	25590	R + 6000	R - 19590

Example 4.7

Two alternative projects are to be compared. They have the following cash flows:

	Project A	Project B
Capital cost (LE)	403 000	500 000
Return / year (LE)	130 000	150 000
Expenditure / year (LE)	80 000	90 000
Life of project (years)	25	25
Salvage value (LE)	80 000	80 000

If the minimum attractive rate of return is 10%, make the necessary calculations to support a recommendation to invest in one of the projects.

Solution

Consider the increment project (B - A) which has the following cash flows:

	Project (B - A)
Capital cost (LE)	97 000
Return / year (LE)	20 000
Expenditure / year (LE)	10 000

If the increment project does not provide the minimum attractive rate of return, then the project with the higher capital investment should be rejected and the other with the lower capital investment accepted.

Put NPV = 0, or

$$- 97000 + (20000 - 10000)\ [(1+r)^{25} - 1] / r(1+r)^{25} = 0$$

$$- 9.7\ r(1+r)^{25} + (1+r)^{25} = 1$$

$$(- 9.7r + 1)\ (1+r)^{25} = 1$$

Solving, getting $r = 9.15\%$, i.e. $r < 10\%$ Therefore choose Project A.

Example 4.8

Compare the following two schemes of cash flows estimated at today's price pertaining to buying and operating an item of construction equipment. Consider investment rate = 12% per annum.

	scheme 1	scheme 2
Initial plant cost (LE)	25 000	22 000
Running cost / year (LE)	1 500	1 750
Life (years)	4	3

Solution

It is necessary to replace each scheme a different number of times so that they will have the same life. Therefore scheme 1 will be replaced twice whereas scheme 2 will be replaced three times.

$$\text{P.V. of scheme 1} = 25000\ [1 + \frac{1}{(1.12)^4} + \frac{1}{(1.12)^8}] + 1500\ [\frac{(1.12)^{12} - 1}{0.12(1.12)^{12}}]$$

$$= 25000\ (2.039) + 1500\ (6.195)$$

$$= \text{LE } 60266$$

$$\text{P.V. of scheme 2} = 22000\ [1 + \frac{1}{(1.12)^3} + \frac{1}{(1.12)^6} + \frac{1}{(1.12)^9}] + 1750\ (6.195)$$

$$= 22000\ (2.579) + 1750\ (6.195)$$

$$= \text{LE } 67579$$

Hence scheme 1 is more economic than scheme 2.

Uniform Gradient Series

For a number of payments which are increasing each period of time by a uniform amount, let the uniform increment at the end of each period be d. Consequently the payment at the end of the second period is d greater than that at the end of the first period. At the end of n periods it will be $(n-1)d$ greater.

The compound sum of the first increment, using equation 4.2, is

$$S_1 = (d/r)\ [(1+r)^{n-1} - 1]$$

similarly, the second increment will have

$$S_2 = (d/r)\ [(1+r)^{n-2} - 1], \text{ and}$$

generally

$$S_j = (d/r)\ [(1+r)^{n-j} - 1]$$

Then the total compound sum is

$$S' = (d/r)\ [(1+r)^{n-1} + (1+r)^{n-2} + \ldots\ldots. + (1+r)^2 + (1+r) - (n-1)]$$

$$S' = (d/r)\ [(1+r)^{n-1} + (1+r)^{n-2} + \ldots\ldots. + (1+r)^2 + (1+r) + 1] - nd/r$$

$$S' = \frac{d}{r}\ [\frac{(1+r)^n - 1}{r}] - \frac{nd}{r} \qquad (4.6)$$

In order to convert this sum into an equivalent uniform period payment over n periods, substitute the above S' for S in equation 4.3, then

$$C' = \frac{d}{r} - \frac{nd}{r}\ [\frac{r}{(1+r)^n - 1}] \qquad (4.7)$$

Example 4.9

The initial cost of a truck is LE 25000. It has a working life of six years. At the end of the six-year period it has a resale value of LE 4000. The cost of maintenance of the truck amounts to LE 1500 for the first year, and increases by LE 1000 for each succeeding year. If the current investment rate is 10% per year, what is the EUAC of the truck. If the contractor can sell the truck for LE 7500 at the end of the fifth year, should he advised to do so.

Solution

<u>Considering a six-year life</u>

The initial cost of LE 25000 can be converted to EUAC using Eq. 4.5

$$C_1 = 25000\ [\frac{0.1(1.1)^6}{(1.1)^6 - 1}] = \text{LE } 5740.2$$

The resale value of LE 4000 can be converted to EUAC using Eq. 4.3

$$C_2 = 4000\ [\frac{0.1}{(1.1)^6 - 1}] = \text{LE } 518.4$$

The EUAC of the maintenance of the truck can be calculated using Eq. 4.7

$$C_3 = 1500 + \frac{1000}{0.1} - \frac{1000(6)}{0.1}\ [\frac{0.1}{(1.1)^6 - 1}] = \text{LE } 3723.6$$

Total EUAC = 5740.2 + 3723.6 - 518.4 = LE 8945

Considering a five-year life

$$EUAC = 25000\ [\frac{0.1(1.1)^5}{(1.1)^5 - 1}] - 7500\ [\frac{0.1}{(1.1)^5 - 1}]$$

$$+ 1500 + \frac{1000}{0.1} - \frac{1000(5)}{0.1}\ [\frac{0.1}{(1.1)^5 - 1}] = LE\ 8677$$

As the EUAC of the truck for a five-year life is less than that for a six-year life, then it is better for the contractor to sell the truck after five years.

4.5 Breakeven Analysis (Equal Cost Analysis)

This technique is concerned with making a graphical comparison between the cost of two alternatives. The variable used for the comparison may be NPV, IRR or EUAC. The point at which the two alternatives have the same value is known as the breakeven point.

Example 4.10

Two alternatives for placing concrete are available for a contractor in his work: through a concrete pump and using labour gangs. The capital cost of the pump is LE 70000. Annual operating cost of the pump amounts to LE 6000. The choice of the pump will reduce annual labour cost from LE 30000 to LE 6000. What will be the minimum period for the pump to be used so that the choice of this alternative is justified? Assume investment rate is 16% per year.

Solution

	Concrete Pump	Labour
Capital cost (LE)	70 000	——
Annual cost (LE)	12 000	30 000

EUAC will be used to compare the two alternatives. For the labour alternative it equals LE 30000. For the pump alternative it can be calculated using the following equation:

$$EUAC = 12000 + 70000\ (CR)$$

where the capital recovery factor CR is calculated using different pump lifes. The calculations are given in Table 4.5.

A breakeven chart is given in Figure 4.11. The two alternatives have the same EUAC at about 75 months. This is the minimum period for the pump to be used so that the contractor may choose this alternative.

Table 4.5 EUAC Calculations for Example 4.10.

No. of years (n)	$CR = \frac{r(1+r)^n}{(1+r)^n - 1}$	EUAC
2	0.623	55 610
3	0.445	43 150
4	0.357	36 990
5	0.305	33 350
6	0.271	30 970
7	0.248	29 360
8	0.230	28 100

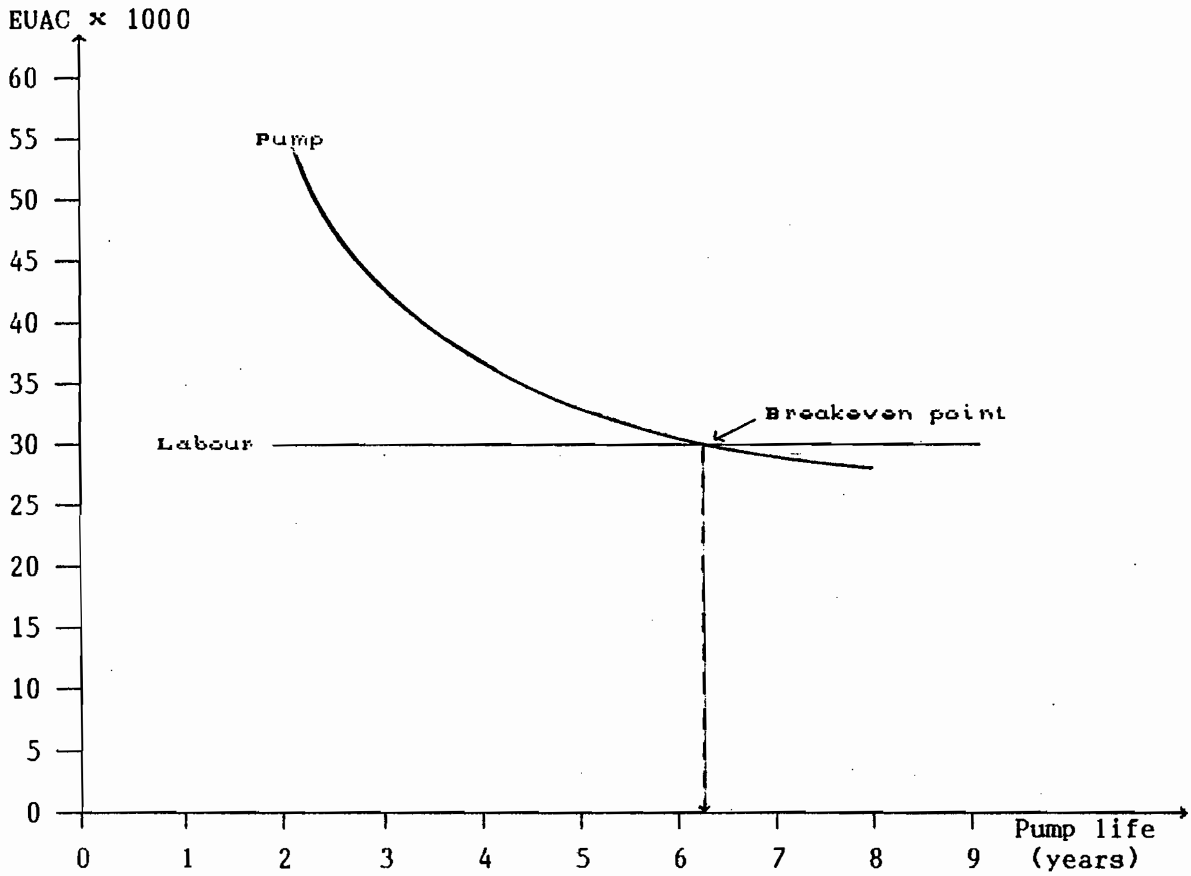

Figure 4.11 Breakeven Analysis for Example 4.10

4.6 Inflation

Cost inflation is measured as the reduction in purchasing power of the unit of currency. Cost escalation measures the total growth in cost of a project or contract compared with a reference estimate. This growth results from cost inflation and other sources.

Causes of Inflation

In simple terms, inflation is caused by an increase in the stock of money that is available for spending while the quantity of goods available for purchase does not increase by a proportionate amount. Another reason for inflation is the increase in wage earnings without a corresponding increase in productivity. This increase results in an increase of the price of manufactured goods and subsequently are reflected in increased prices to consumers.

Effect of Inflation

Most projects are appraised using cash flows based on today's prices. These uninflated cash flows gives a real rate of return. As the project is executed inflation will push up both the costs and revenues so that the achieved apparent rate of return will become larger than the real one by an amount equivalent to the inflation rate. By deflating the escalated cash flows, a real rate of return will be near the original value.

Example 4.11

Consider the set of cash flows given below. Assume that all annual cash movements take place at mid-year. Given that the cash in and cash out are escalated by 8% and 10% per year respectively, calculate cash flows in money-of-the-day (MOD). If the loss of purchasing power is 9% per year, calculate the cash flows in constant value money (CVM). Calculate the internal rate of return in each case.

Mid-Year	Cash in	Cash out	Cash total
1		120	-120
2	100	60	40
3	100	60	40
4	100	60	40
5	100	60	40

Solution

Cash flows in money-of-the-day (MOD) are as follows:

Mid-Year	Cash in	Cash out	Cash total
1		120.00	-120.00
2	108.00	66.00	42.00
3	116.64	72.60	44.04
4	125.97	79.86	46.11
5	136.05	87.85	48.20

Cash flows in constant value money (CVM) are as follows:

Mid-Year	Cash in	Cash out	Cash total
1		120.00	-120.00
2	99.08	60.55	38.53
3	98.17	61.10	37.07
4	97.27	61.67	35.60
5	96.38	62.23	34.15

Calculations of IRR :

1. Unescalated cash flows

$$-120 + 40/(1+r) + 40/(1+r)^2 + 40/(1+r)^3 + 40/(1+r)^4 = 0$$

This gives a real rate of return = 12.68%

2. Escalated cash flows

$$-120 + 42.00/(1+r) + 44.04/(1+r)^2 + 46.11/(1+r)^3 + 48.20/(1+r)^4 = 0$$

This gives an apparent rate of return = 18.3%

3. Deflated cash flows

$$-120 + 38.53/(1+r) + 37.07/(1+r)^2 + 35.60/(1+r)^3 + 34.15/(1+r)^4 = 0$$

This gives a real rate of return = 8.25%

Relationship between Apparent and Real Rate of Return

If the inflation rate = f% p.a., the real rate of return = r% p.a., and the apparent rate of return = i% p.a., then

$$(1+i) = (1+r)(1+f)$$

or

$$r = (1+i)/(1+f) - 1 \qquad (4.8)$$

Example 4.12

An item of equipment is purchased for LE 20000 and it is estimated that its use over the next four years will give rise to actual annual cash receipts of LE 8000, LE 8000, LE 4000 and LE 7000. The average rate of inflation over the next four years is expected to be 10% p.a. Calculate the rate of return in real terms.

Solution

Calculate the apparent rate of return from the following equation:

$$-20000 + 8000/(1+i) + 8000/(1+i)^2 + 4000/(1+i)^3 + 7000/(1+i)^4 = 0$$

This gives $i = 14.2\%$

Then $r = 3.8\%$

Dealing with Inflation in Project Appraisal

Inflation has to be considered in investment appraisal both in estimating the cash flows of a project and in selecting the discount rate. All cash flows should be made on a consistent basis. It is difficult to predict future rates of inflation.

Either express cash flows in terms of purchasing power when the appraisal is actually made or express actual cash flows expected in the future after assessing the effects of inflation and use an enhanced discount rate.

Dealing with Inflation in Contracts

Inflation increases capital required to finance construction and consequently the final contract price will be uncertain. The inflation risk may have considerable effect on contractor's investment. It is completely outside his control. It is normal for all or part of this risk to be taken by the clients on contracts exceeding one year. Clients who leave much of the inflation risk allocated to the contractors will have problems in getting their work complete to the required standard.

However, in a cost-reimbursable contract, the client pays the actual escalated costs. Admeasurement and lump sum contracts may be let on a fixed or adjusted basis. In a fixed-price contract the contractor must make allowance in his tendered price for some assumed level of escalation. In an adjusted-price contract, a contract price fluctuation clause is included to compensate the contractor for the escalated costs.

For example, the following Baxter formula is used in the United Kingdom. The Engineer apportions the work to 11 categories. These categories cover labour, provision and use of contractor's equipment and transport, and nine groups of materials; commonly utilized in civil engineering work. Each monthly payment to the contractor is adjusted by applying the relevant indices to the different categories. The formula gives the contractor the incentive to buy cheaply as the recovery is not related to the contractor's actual cost increase. It has the following form:

$$P_a = V . \sum_{j=1}^{11} F_j \left[\frac{I_{jc} - I_{jo}}{I_{jo}}\right] \tag{4.9}$$

where P_a = payment adjustment,

V = effective value of each monthly certificate,

F_j = coefficient representing proportional cost of items covered by the index j to the total estimated cost of work, so that summation of F_j values = 1; these coefficients are set by the Engineer,

I_{jo} = base index figure of category j, and

I_{jc} = current index figure of category j.

These indices are monthly prepared by governmental agencies to represent national price movements.