Capital Budgeting

One of the important functions of finance manager is assessing the financial viability of investments or projects. Functional managers like production, marketing and R&D managers submit project proposals that require initial investments. These investments generate a series of cash inflow over the years. The initial cash outflow and series of cash inflows hold good for both investments in real projects as well as financial instruments. For example, if you invest Rs. 100,000 to buy a 10-year bond at 8%, it produces Rs. 8000 interest cash inflow every year for 10 years and then Rs. 100000 principal cash inflow at the end of 10 years. Similarly, if a firm invests Rs. 100 million in a setting up a plant to produce automobile component, the project would generate cash inflow for the next 10 to 15 years. It is important to assess the financial viability of the projects before accepting the project. In this chapter, we discuss how to assess the financial viability of any investment proposal.

Project Life-cycle

A typical project life cycle is (a) identification of project, (b) technical feasibility (c) commercial feasibility (d) financial feasibility (e) project implementation and (f) project post-audit analysis. In the first stage, managers across the organization identify projects they want to undertake in their departments. These projects could be replacement of an existing equipment or adding a new equipment to improve the productivity of their units or sending their employees for training or introducing a new product. Managers would be normally busy around the budget time in identification of the projects and submit them to budget authority. These projects

are included in capital budgeting and they are distinct from operational budgets. Project proposals are assessed as a part of budgeting exercise. Finance department of most organizations would disallow any new project, which are not approved in the budget unless the project is of critical nature. Once the sponsor of the project identifies the project, she/he will collect technical data related to the project and assess technical feasibility. For example, if a manufacturer of chemicals wants to manufacture mosquito coil or mat, the first think to be checked is whether the company has technical capability to produce the product. If it doesn't have internal technical capability, then it should look for consultants or technical collaborators who can help them in executing the project. Once the technical feasibility is established, the project sponsor should check whether there is adequate demand for the product. The process of assessing the demand at different price points is called commercial feasibility. If the project is on replacing an existing equipment, there is no for detailed technical and commercial viability studies. It is adequate to collect basic technical features of the equipment and its compatibility with other equipment. Using information collected during technical feasibility and commercial feasibility, the project sponsor or finance department prepares cash flow projection and assess the financial feasibility. The question answered at this stage is whether the project generate adequate return more than the cost at which we undertake the project. Once the project is financially viable and adequate funds are available to take up the project, the project gets the approval and the sponsor starts implementing the project. The progress of the project is continuously monitored to ensure there is no cost or time overrun. Most projects fail mainly due to substantial escalation in the project cost, which is partially on account of time delay or under estimation of project cost. In the entire project life cycle, project execution is most critical stage. After few years of execution of the project and once cash flows start flowing from the project, a detailed post-audit project note is prepared. The purpose of this audit is to learn

from past experience of project preparation and execution and such experience is useful while taking up future projects.

Capital Budgeting Techniques

Project sponsor requires three input to assess the financial feasibility of the project. The first one is estimation of project cash flows which include initial investment in the project and periodical cash inflows from the project. The sponsor also requires what should be minimum required rate of return so that she/he can compare the project return with the minimum required rate of return. Finally, the project sponsor would require a decision rule. The decision rule depends on capital budgeting technique. We start our discussion with decision rule, the easiest one among the three. Most organizations use one of the discounted cash flow techniques (DCF) which is an extension of our previous discussion on Time Value of Money in Chapter 2. The three widely used DCF techniques are (a) Net Present Value (NPV), (b) Internal Rate of Return (IRR) and (c) Profitability Index (PI). In all these three methods, we consider time value of money and adjust the cash flows of different periods using discount rate.

Net Present Value

The Net Present Value (NPV) of a project is equal to present value of cash inflows less present value of cash outflows. The term 'cash outflow' refers to how much the firm should bring in additional cash to take up the project. Similarly, the cash inflow refers to how much the firm gets net cash from the project. The difference is 'surplus' cash expressed in today's value and available to equity holders. The NPV measure is objective because everything is represented in terms of cash. There is no role for accounting measure or regulations in the entire evaluation. The cash flows are discounted at the rate equal to cost of capital. We will discuss more about cost

of capital[1] later. We discuss the capital budgeting techniques on the assumption that cash outflows, cash inflows and cost of capital are given. The general decision rule is accept the project if the net present value is greater than or equal to zero. If two or more projects are mutually exclusive, the decision rule is accept the project whose NPV is highest among the projects. A group of projects is called mutually exclusive projects in they are similar in nature and we can take only one of them. For example, a firm is considering in setting up a new plant and considering a capacity of 100000 units per day or 120,000 units per day. These two projects are mutually exclusive because if our decision is in favour of accepting 100,000 units project, we will not take up 120,000 units project even though the NPV of both projects are positive. If the firm is setting up two independent projects, the firm might accept both projects if the NPV of the two projects are positive. The NPV of a project is computed as follows:

$$NPV = \sum_{t=0}^{n} \frac{CF_t}{(1+r)^t} = CF_0 + \frac{CF_1}{(1+r)^1} + \frac{CF_2}{(1+r)^2} + \cdots \ldots + \frac{CF_n}{(1+r)^n}$$

Where: CF_t = project cash flow at time 't'

r = discount rate, which is equal to cost of capital

N = total number of cash flows or life of the project

Illustration 1

[1] A simple definition of cost of capital is the cost that a firm incurs in raising capital required for the project.

The plant manager of Alpha Ltd. wants to add a new machine to increase production capacity. The machine will cost Rs. 10 million at time zero and expected to generate an incremental cash inflow of Rs. 2 million every year for the next 10 years. The cost of capital of the firm is 12%. Find the NPV of the project.

Year	Cash Flow	PV of CF at 12%
0	-10	-10.00
1	2	1.79
2	2	1.59
3	2	1.42
4	2	1.27
5	2	1.13
6	2	1.01
7	2	0.90
8	2	0.81
9	2	0.72
10	2	0.64
Net Present Value (NPV)		1.30

Decision: Since the Net Present Value is positive, the project is accepted.

Illustration 2

Refer the facts given in Illustration 1. As the plant manager is evaluating the machine, another supplier offered a different machine that costs Rs. 12 million but expected to generate incremental cash inflow of Rs. 2.50 million per year for next 10 years. Though the machine cost 20% more, its productivity is higher and rejections are lower and thus improves the cash inflow. Which one of the two machines should be accepted?

Year	Machine A	Machine B

	Cash Flow	PV of CF at 12%	Cash Flow	PV of CF at 12%
0	-10	-10.00	-12	-12.00
1	2	1.79	2.5	2.23
2	2	1.59	2.5	1.99
3	2	1.42	2.5	1.78
4	2	1.27	2.5	1.59
5	2	1.13	2.5	1.42
6	2	1.01	2.5	1.27
7	2	0.90	2.5	1.13
8	2	0.81	2.5	1.01
9	2	0.72	2.5	0.90
10	2	0.64	2.5	0.80
Net Present Value (NPV)		1.30		2.13

Decision: Since NPV of Machine B is more than NPV of Machine A, the firm should buy Machine B.

By discounting, the NPV brings down all future cash flows to time zero and hence allows us to add them up and take a decision. The NPV of the above illustration shows that Alpha Ltd. would be richer to an extent of Rs. 1.30 million today if it invests in Machine A and Rs. 2.13 million if it invests in Machine B. Though the machine will be generating the cash flows in the future, NPV shows its impact today. For example, if an infrastructure company like L&T gets an order for Rs. 20 billion for developing a greenfield airport project, why the stock market reacts positively and stock price of the company increases? If the estimated NPV of the order is Rs. 2 billion (Rs. 2000 million) and if there are 100 million shares outstanding, the stock price should increase to an extent of Rs. 20 per share. Though the company might take another 5 years to complete the project, the value of the firm increases on getting the order. Our assumption is this order is not already factored in the stock price. We are not sure how the stock market estimates the NPV of the project and then incorporate the same in stock price but the idea is the value of firm increases when

it takes up projects with positive NPV. Thus, accepting positive NPV projects is a value creation activity.

Our NPV decision rule is accept the project if the NPV is greater than or equal to zero. While greater than zero is clear, why should firms accept projects with zero NPV. If there is no funds constraint, there is no justification to reject the zero NPV project. Zero NPV refers to a situation where the project gives exactly the required rate of return. A positive NPV refers to a situation where the project gives more than the required rate of return. Since zero NPV projects give what you want to earn from projects, there is no justification for rejecting the project.

Internal Rate of Return

The Internal Rate of Return (IRR) of a project is equal to the rate at which the present value of the cash inflows is equal to present value of cash outflows. In other words, at IRR, the NPV of the project is equal to zero. Since the viability of the project is presented as a percentage or rate, it improves the communication particularly, if the final decision marker is not familiar with the DCF techniques. The IRR computation is bit tedious. We need to find out NPV at different rates and finally narrow down the rate at which the NPV of the project is zero. Microsoft EXCEL and other spread sheet software simplify the computation. The EXCEL formula for computing IRR is "=IRR(cash flow range)".

$$\boldsymbol{NPV = 0 = \sum_{t=0}^{n} \frac{CF_t}{(1+IRR)^t} = CF_0 + \frac{CF_1}{(1+IRR)^1} + \frac{CF_2}{(1+IRR)^2} + \cdots \ldots + \frac{CF_n}{(1+IRR)^n}}$$

Where: CF_t = project cash flow at time 't'

IRR = Internal Rate of Return

N = total number of cash flows or life of the project

The decision rule is accept the projects whose IRR is greater than or equal to cost of capital. If the projects are mutually exclusive, the decision rule is accept the project whose IRR is largest among the IRRs whose value is greater than cost of capital.

Illustration 3

Consider the information provided in illustration 2. The production manager of Alpha Ltd wants to add a machine and considering two machines. Machine A costs Rs. 10 million and generates cash inflow of Rs. 2 million for 10 years and Machine B costs Rs. 12 million and generate cash inflow of Rs. 2.50 million for 10 years. Evaluate the two investment proposals using Internal Rate of Return (IRR).

Year	Machine A		Machine B	
	Cash Flow	PV of CF at 12%	Cash Flow	PV of CF at 12%
0	-10	-10.00	-12	-12.00
1	2	1.79	2.5	2.23
2	2	1.59	2.5	1.99
3	2	1.42	2.5	1.78
4	2	1.27	2.5	1.59
5	2	1.13	2.5	1.42
6	2	1.01	2.5	1.27
7	2	0.90	2.5	1.13
8	2	0.81	2.5	1.01
9	2	0.72	2.5	0.90
10	2	0.64	2.5	0.80
Net Present Value (NPV)		1.30		2.13
Internal Rate of Return (IRR)		15.10%		16.19%

The IRR of the Machine A and Machine B are 15.10% and 16.19% respectively. Since IRR of both machines is above the cost of capital of 12%, both qualifies for

investments. Since they are mutually exclusive investment proposal, the decision is in favour of selecting Machine B whose IRR is greater than the IRR of Machine A. In case of NPV, we said an investment of Rs. 12 million in Machine B adds a value of Rs. 2.13 million. In IRR, our interpretation is the project generates a return of 16.19% against the requirement of 12%. Most managers understand the IRR quickly without any further explanation. In that sense, IRR communicates the project viability in a way that everyone can understand.

If the communication from IRR is superior, why do we need to measure NPV? The reason is IRR scores better on communication but fails on few other issues. One of the major shortcoming of IRR is at times, there are two IRRs and the decision maker may not know which one she or he should use in taking decision. Sometime, the decision maker may not even know the existence of another IRR. The multiple IRR happens when the project cash flows have more than one sign change. They are called non-normal cash flows. Suppose you are taking up a mining project which requires an investment of Rs. 1000 million at time zero. It produces Rs. 3000 million earning in year 1 and another Rs. 3000 million in year 2. Then you spend another Rs. 3000 million to close the mine. The project on the face of it a great project because for an investment of Rs. 1000, you get Rs. 3000 at the end of year 1. Whatever you receive in year 2, you will be spending in year 3 and hence cancels out. But if you use EXCEL to compute IRR, it returns a negative IRR of 34%.

Year	Cash Flow
0	-1000
1	3000
2	3000
3	-3000
IRR	-34%

Since you know the answer is not consistent with your logic and you feel there should be another positive IRR, you can ask the EXCEL to rework the IRR by giving a guess value of say 30%. Your revised EXCEL specification is =IRR(Range,30%) and it returns an IRR of 260%.

	A	B
1	Year	Cash Flow
2	0	-1000
3	1	3000
4	2	3000
5	3	-3000
6	IRR	260%
7		=IRR(B2:B5,30%)

Though multiple IRR is bit rare event, one should remember that it is possible when the cash flows are not normal. Another criticism of IRR is it assumes projects cash flows are reinvested at the rate of IRR. In the above example, it is assumed that the cash flows of Year 1 and Year 2 are reinvested at the rate of 260%. You can observe this implicit assumption by considering IRR equation where all cash flows are discounted at IRR.

$$\boldsymbol{NPV = 0 = \sum_{t=0}^{n} \frac{CF_t}{(1+IRR)^t} = CF_0 + \frac{CF_1}{(1+IRR)^1} + \frac{CF_2}{(1+IRR)^2} + \cdots \ldots + \frac{CF_n}{(1+IRR)^n}}$$

Just because we happen to hit a great project, it is not practical that we will get similar projects in future so that we can reinvest our cash flows in those projects. Even if we assume that we get such super-projects, the question is why should we give the benefit of those projects to the current project. Practitioners today use Modified Internal Rate of Return (MIRR) to overcome this problem. In addition to

cash flow details, we need the rate of borrowing and rate at which we will reinvesting the cash flows. We can assume both values equal to cost of capital. If we compute MIRR for the above mining project on the assumption that our cost of capital is 12%, it shows 31.46%. We are skipping the mathematics behind this computation.

	A	B
1	Year	Cash Flow
2	0	-1000
3	1	3000
4	2	3000
5	3	-3000
6	IRR	31.46%
7		=MIRR(B2:B5,12%,12%)

Though IRR communicates well, the trouble is we end up in having three IRR for the mining project that we discussed above. Though such occurrence is rare, we need to be cautious while using IRR. We close our discussion on IRR with a simple solution. When you evaluate financial feasibility of the projects, compute and report both NPV and IRR or MIRR. Use NPV for decision making and let non-finance decision makers use IRR or MIRR for understanding the project viability.

Profitability Index

Profitability Index is the ratio of present value of cash inflow to present value of cash outflow[2]. It measures the return the project generate for every one Rupee investments in the project after adjusting the time value.

[2] Profitability Index can also be computed as ratio of net present value to project cash outflow.

$$Profitability\ Index\ = \frac{Present\ Value\ of\ Cash\ Inflow}{Present\ Value\ of\ Cash\ Outflow}$$

If profitability index is more than 1, it means the present value of project cash inflow is more than present value of project cash outflow. For Machine A and Machine B evaluation that we have performed in Illustration 2, the profitability index values are shown below:

	Machine A	Machine B
PV of COF	10.00	12.00
PV of CIF	11.30	14.13
Net Present Value	1.30	2.13
IRR	15.10%	16.19%
Profitability Index	1.13	1.18

The index is useful when the firm has limited funds but there are several projects competing for funds for their projects. Under this situation, all projects are ranked on profitability index. Projects are accepted in the same descending order till funds are available. Here is an example of selection of projects in a situation where the firm faces funds constraint.

Illustration 4

Alpha Ltd., received eight project proposals from various departments as a part of budgeting exercise. The details of the projects along with NPV and IRR are given below.

Project #	PVCOF	PVCIF	NPV	IRR (%)
1	250	316	66	17.20
2	100	96	-4	10.70
3	300	343	43	16.60
4	100	114	14	12.10
5	100	107	7	11.80
6	350	413	63	18.00

7	400	448	48	13.50
8	500	530	30	11.20
Total	2000	2267	267	

Total funds required for accepting all positive NPV projects is Rs. 2000 million. Alpha Ltd., has only Rs. 1000 million and hence need to select only few projects out of seven positive NPV projects. The Profitability Index was computed for each projects and then projects are ranked on the basis of Profitability Index. The details are given below:

Project #	PVCOF	PVCIF	NPV	IRR (%)	PI	Cum COF
1	250	316	66	17.20	1.264	250
6	350	413	63	18.00	1.180	600
3	300	343	43	16.60	1.143	900
4	100	114	14	12.10	1.140	1000
7	400	448	48	13.50	1.120	1400
5	100	107	7	11.80	1.070	1500
8	500	530	30	11.20	1.060	2000
2	100	96	-4	10.70	0.960	2100
Total	2100	2367	267			

The last column of the above table sows cumulative cash outflow. The cumulative cash outflow values show the first four projects (Project Nos. 1, 6, 3 and 4) require Rs. 1000 million. The NPV of these four projects is equal to Rs. 186 million. If we use NPV for project selection, we will select Project Nos. 1, 6 and 7 and the cumulative NPV of these three projects is equal to Rs. 177 million. This is lower than the NPV of four projects selected on the basis of PI. If the firm uses IRR, then it will select project number 6, 1 and 3 which requires cash outflow of Rs. 900 million. The next highest IRR of the project is Project 7 which requires Rs. 400 million but funds are not available to take up the project.

In addition to capital constraint, in there are other constraints, Profitability Index may not provide an easy correct solution. Under such conditions, it is desirable to use linear programming where the objective function is maximize the NPV of the projects subject to capital and other constraints.

Among the three DCF techniques, Net Present Value is consistent with wealth maximization objective. With increased financial literacy, particularly among managers, the awareness of NPV is generally high. IRR can supplement the NPV. Even for those who are familiar with NPV concepts, IRR provides an additional insight.

Payback Period

Our focus so far on the return of the project. The other dimension of the project is risk associated with the project. DCF techniques address the risk while estimating cost of capital. We will discuss this part later. Many firms use payback period as a risk measure. The Payback Period is equal to time required to recover the investments in the project. Since the projects come with some inherent risk, the first thing most project investors would worry is preserving capital. How long will it take to get back my money invested in the project is a usual question asked by the providers of funds. While we can appreciate such question from small entrepreneurs, even very large organizations use payback period while assessing projects. For the two machines of Alpha Ltd., that we used in earlier illustrations, let us compute payback period.

Year	Machine A		Machine B	
	Cash Flow	Cum CF	Cash Flow	Cum CF
0	-10	-10	-12	-12.0
1	2	-8	2.5	-9.5
2	2	-6	2.5	-7.0
3	2	-4	2.5	-4.5
4	2	-2	2.5	-2.0
5	2	0	2.5	0.5
6	2	2	2.5	3.0
7	2	4	2.5	5.5
8	2	6	2.5	8.0
9	2	8	2.5	10.5
10	2	10	2.5	13.0
Payback Period		5 Years		< 5 Years

The payback period for machine A is 5 years. The cash flows of Machine A recovers the capital invested in Machine A during five year period. Cash flows of Machine B returned the invested capital less than 5 years (to be precise, it takes 4.75 years). A project with a shorter payback period is generally preferred compared to another project whose payback period is longer. The 'preference' is on account of risk. Some of the main draw backs of the payback period method are time value of money is not considered and cash flows after the payback period are not considered. We can adjust the time value of money by considering discounted cash flows. This is called Discounted Payback Period. For Machine A, the discounted payback period is close to 9 years. For Machine B, it is close to 8 years to get back their initial investments after taking into account time value of money. Payback period is not generally used for taking decision on accepting or rejecting the project. It is computed and included along with other project related statistics. The users sees payback period as a measure of risk. In few cases, project's whose payback period is more than hurdle payback period are not considered for further analysis even if the NPV or IRR are attractive.

Accounting Rate of Return (ARR)

Today, NPV and IRR are commonly used by firms and banks while evaluating projects. But it took several years for these techniques to reach managers. Prior to this period, managers use Accounting Rate of Return (ARR) for project financial feasibility. There is no universal definition for ARR. One of the definitions of ARR is Profit After Tax divided by Average Investments. There are many problems with this measure in addition to absence of clear definition. ARR ignores time value of money. Since this measure is not used nowadays, we are skipping further discussion on this measure.

Estimating Cash Flows

In all our illustrations while explaining DCF techniques, we have provided cash flows and used the same in computing NPV and IRR. Let us discuss the principles that we use in estimation of cash flows.

(i) Incremental Cash Flow

We follow a principle called incremental cash flow in estimation of cash flows. That is, if a project requires any incremental cash investments, it is cash outflow for the project. Similarly, if the project generates any cash for the organization, it is cash inflow. Cash outflow typically consists of land, building, machinery and furniture required for the project. Land, building, machinery and furniture will enable the firm to build plant but to run the plant, the firm would need working capital to run the plant. The working capital includes inventory, receivables and minimum cash required to run the business. A part of the inventory is purchased on credit basis. The difference between current assets and current liabilities is net working capital and this has to be funded by firm. The incremental working capital required to run the project is also part of cash outflow.

(ii) Opportunity Cost

We generally ignore assets which are idle but used in the project. Suppose your company has 100 acres land purchased several years back. You are currently using 30 acres of land and balance 70 acres is idle. Now you are taking up a project that requires 3 acres of land. Should we consider the cost of the land as project cost? If we decide to consider, we have other challenges. Suppose the purchase cost of the land is Rs. 2 million and current market value of the land is Rs. 100 million. Which one we should consider as project cost? Going by the incremental cash flow principle, we conclude that we should not consider the land cost as project cost because there is no incremental cash flow. Many of you may disagree with this decision of not considering the land cost. Your argument is the company can sell the land and realize Rs. 100 million. If the company plan to sell the land, then we have two mutually exclusive projects. That is, the first project is selling land which will give NPV of Rs. 100 million and second project is taking up some industrial activity which will yield and NPV of Rs. X million. If X is greater than Rs. 100 million, we will take up the industrial project, otherwise we will sell the land. To compute the NPV of industrial project, we don't need to consider the land cost. If we are not likely to sell the land whether we take the project or not, then there is no benefit of considering the land cost as project cash flow. If you are still not convinced, here is a simple example.

Suppose you have a house which has 600 Square Feet (sq. ft.) open space on the back side. You purchased this plot 20 years back at the cost of Rs. 200 per sq. ft. and today the market value is Rs. 4000 per sq. ft. Your wife or mother wants to grow few vegetables. Will you include land cost to decide whether to grow vegetables or not? If you argue on this line, she may refuse to cook for a day and you will end up in spending few hundreds to eat your dinner in a hotel.

In general we ignore non-cash flow items but there is an exception. If there is an opportunity cash flow to the firm and if the project denies the cash flow by using the resource, the project should bear the cost. Suppose a firm is generating rental income by constructing a warehouse. Your project requires the space and it means the firm will terminate the rental agreement, demolish the warehouse and hand over the space to your project. Then your project should bear the present value of rental income as project cost. We need to be objective in our decision whether an item is opportunity cost or not. If there is a real cash flow loss to the firm due to the project, we should consider the cash flow loss as opportunity cost.

(iii) Sunk Cost

We should not consider costs which are already incurred and not recoverable whether we accept or reject the project. Though this item falls within the incremental cash flow principle, it is emphasized again. Suppose your company started a R&D project six years back and spent Rs. 300 million so far. You are now examining a project which uses the output of the R&D project. Should we consider Rs. 300 million spent on R&D as project cost? Many of you may feel we should consider the R&D cost. The typical argument is – is it not fair to ask the project to bear the cost of R&D which it is going to use? Or who will pay for R&D project cost? Suppose you decide to compute NPV of the project by including the R&D cost and also by excluding R&D project cost. When you include R&D cost, the project gives a negative NPV of Rs. 40 million. When you exclude R&D cost, the project gives a positive NPV of Rs. 260 million. Will you go ahead with the project? Or reject? Most of you agree that we should go ahead with the project because we recover at least Rs. 260 million out of Rs. 300 million spent on R&D.

(iv) Cash Inflow

Cash inflow is equal to sales or revenue less all expenses other than depreciation and interest. We exclude depreciation because it is non-cash expenses and it is not part of cash flow. However, we consider depreciation for computing tax cash outflow. We exclude interest because we don't want to mix up financing and investment decision. Financing decision is independent of investment decision and it is discretionary on the top management to decide how to fund the project. Funding also depends on market conditions and other realities. The manager who sponsor the project has no control on financing decision. It doesn't mean we completely ignore the debt, interest and tax benefit that a firm gets on account of borrowing. We consider all these three variables while computing cost of capital. The project cash inflow definition turns bit complex with many inclusion and exclusion. We define the cash inflow as follows:

$$CIF_t = (Profit\ before\ Depreciation, Interest\ and\ taxes - Taxes)_t$$

The taxes are to be computed separately as per tax regulation. Since we provided working capital margin, we don't worry about the collection of sales and payment of expenses. We can continue to follow accrual basis of accounting. We assume projects have fixed life though firms may continue the project by replacing equipment. The life of the project is equal to life of the major equipment used in the project. The life of the most industrial equipment is between 10 and 30 years. The cash inflow of last year has few additional values. The salvage value of the equipment net of taxes are considered as cash inflow to the project. The working capital provided earlier is no more required and hence it is also taken as cash inflow. We will do a comprehensive case study after completing our discussion on cost of capital.

Cost of Capital

In all our earlier illustrations, we are discounting cash flows by using a given discount factor. The discount factor is equal to cost of capital. The actual definition is bit lengthy. It is equal to risk-adjusted weighted average opportunity cost of capital. We introduced discounting as a methodology of adjusting the time differences in cash flows. In addition to time value of money, discounting also considers the risk associated with the cash flows. Firms raise capital from variety of sources and we can broadly classify them as debt and equity. Equity holders bear more risk compared to debt holders. We adjust this risk differences by assigning higher value for cost of equity compared to cost of debt. The purpose for which the capital is raised also affects the risk associated with the capital. For example, a replacement of an existing equipment is less risky compared to risk associated with expansion project. Similarly, risk associated with entirely a new project is more than expansion project. In computing the cost of debt and cost of equity, the risk associated with the project is considered. That is, if a steel manufacturing company raises equity and debt to start retail chain, the cost of debt and cost of equity will reflect the risk associated with the retail chain business. Cost of debt is equal to interest rate. The challenge is computing cost of equity. We know cost of equity should be greater than cost of debt.

For both cost of debt and cost of equity, the reference rate is risk free rate. Investments in government securities are generally risk free. Suppose you have Rs. 10 million with you. You can invest in government securities and earn an interest yield of 6%. There is no risk in this investment. Asian Paints plans to double the production capacity and approaches you with a 10-year bond issue. You are willing to subscribe the bond if Asian Paints offers more than 6%. Since corporate bonds are riskier than risk-free government bonds, you need compensation for taking

additional risk. Suppose Asian Paints offers 10% interest rate. You find this is reasonable and invested Rs. 4 million. You plan to invest another Rs. 4 million in Asian Paints equity shares. What is the minimum return you need to invest in Asian Paints equity? Between bond and Asian Paint equity, you have an option to invest in a portfolio of securities. Investing in portfolio of securities carries lower risk compared to investing in Asian Paints equity. Portfolio Theory shows how to measure the risk of the portfolio of securities. We are skipping the theoretical discussion related to measuring portfolio risk in this course. The risk associated with equity is assessed through a measure called ***equity beta***. Equity beta is a relative risk measure and benchmarked with the risk of portfolio of securities. Normally, stock market index like S&P 500 or NSE-50 (NIFTY) are used in the place of portfolio of securities. The beta of market index is 1. Asian Paints equity beta is derived by comparing the volatility of equity returns of Asian Paints against the volatility of returns of market index. If the Asian Paints stock returns show more volatility than NIFTY volatility, then equity beta of Asian Paints is more than 1. We are skipping the computation part of equity beta. Let us google it to find out what is the equity beta of Asian Paints. Reuters India shows the equity beta of Asian Paints is 0.94 on March 30, 2017. What does it mean? It means on average when the market increase or decrease by 1%, Asian Paints stock price will increase or decrease by 0.94%. You can search equity beta of few other listed companies that you are familiar and check whether they are consistent with your understanding of the risk of investing in the equity of those companies. Once we measure equity risk, we can compute the cost of equity. Cost of equity is the minimum return that you would expect to invest your money in Asian Paints stocks.

Here is a simple formula for computing cost of equity.

$$\textbf{Cost of Equity} = \textbf{Risk Free Return} + [\textbf{Equity Beta } x \ (\textbf{Market Return} - \textbf{Risk Free Return})]$$

Here are some practical tips on how to get the values of the above equation.

- Risk free return can be identified by visiting central bank website. In India, you can visit Reserve Bank of India website and find out the current government bond or treasury bills yield.
- Equity beta for most listed companies can be found though google search; Reuters, Bloomberg, yahoo finance are few sources through which we can get equity beta of most companies.
- Market Return – Risk Free Return is average historical excess return posted by the stock market over risk free return. It is long term average. For the US market is it is around 4% and for Indian market, it is around 7%.

Suppose yours is a start-up and unlisted company. How to measure equity beta? There is no way for us to measure equity beta of your company. But the purpose of measuring equity beta is to assess the risk associated with the equity investments. You can use the equity beta of similar listed company in the market or average equity beta of few similar companies.

Let us complete our computation of cost of equity of Asian Paints. Cost of equity of Asian Paints is [6% + (0.94 x 7%)] or 12.58%. The additional 6.58% is equity risk premium.

We have cost of equity and cost of debt. We have already incorporated the risk associated with debt and equity instruments while computing the cost of equity and cost of debt. They are risk adjusted cost of equity and cost of debt. Suppose Asian Paints has a target debt to total capital of 20% and equity to total capital of 80%. We

use these two values as weights for computing weighted average cost of capital. We need to make one final adjustment. We ignored tax shield on interest expenses while computing cash inflow. We mentioned that we will consider this while computing cost of capital. The effective after-tax interest rate is interest rate x (1-tax rate). If corporate tax rate is 30% and Asian Paints bond interest rate is 10%, the effective interest cost for Asian Paints is 7%. The equation to compute weighted average risk adjusted cost of capital is as follows:

$$WACC = Cost\ of\ Debt\ x\ (1 - tax\ rate) x\ \frac{Debt}{Total\ Capital} + Cost\ of\ Equity\ x\ \frac{Equity}{Total\ Capital}$$

For Asian Paints, the weighted average risk adjusted cost of capital is as follows:

$$WACC = \ 10\%\ x\ (1 - 30\%)\frac{20}{100} + 12.58\%\ x\ \frac{80}{100} = 11.46\%$$

Asian Paints will use 11.46% as discount rate in evaluating all paint industry related projects.

To sum up our discussion, we learned how to estimate cash outflow, cash inflow, principles behind estimating cash flows, cost of capital and how to use them in evaluating financial viability of the projects using one of the three DCF techniques. Let us do a comprehensive exercise.

Case Study

PT (P) Ltd. is setting up a project to manufacture electrolytic capacitor and few other electronic components in Dharwar District, a most backward industrial area in Karnataka. The product is used in many electronic devices and the installed capacity of the project is 30 million unit per annum. The project is promoted by two entrepreneurs, one having good experience in trading electronic components and the other promoter is having 20 years of experience at senior level in manufacturing of capacitors. Though the existing marketing environment is competitive, the demand is expected to grow at a high rate due to increased usage of electronic products and emergence of new products. The company estimates if the current trend in demand continues, there will be at least 10% gap between demand and supply in next three years. The technology involved in manufacture of capacitor is well known and hence there is no need for any technology partner for the project. However, the promoters plan to hire a technical consultant for setting up the plant. While critical plant and machinery are to be imported, the other machines are available indigenously. The estimated cost of the project and means of financing the project are listed below.

Project Cost Estimate (Rs. In Lakhs)		Means of Finance (Rs. In Lakhs)	
Land and Site	20.00	Share Capital	
Building	40.00	Promoters Contribution	100.00
Plant and Machinery - Imported	150.00	Public	-
- Domestic	50.00	Rupee Loan @ 12% interest	200.00
Technical Consultant Fees	20.00	Interest Free Development Loan	30.00
Net Working Capital	50.00		
Total	330.00	Total	330.00

The revenue and expenses related to project are given below:

1. Capacity Utilization: 50% in year 1, 65% in year 2, 85% from Year 3 to Year 10.
2. The company expects that the sales price per unit will be Rs. 1.40 per unit and will increase at the rate of 5% per year on account of inflation.
3. Raw Material Cost is purely variable and is expected to be 60% of sales
4. Utilities are expected to be Rs. 5.00 lakhs for Year 1, Rs. 6.00 for Year 2 and Rs. 8 for year 3 to 10.
5. Employee Cost: Fixed Rs. 10 lakhs for Year 1 and increase at the rate of 5% per year
6. Factory Overhead: Fixed: Rs. 4 lakhs for Year 1 and increase at 10% per year (mainly to handle additional maintenance expenses and inflation)
7. Administrative Expenses: Fixed Rs. 8 lakhs per year.
8. Selling Expenses: Fixed: Rs. 2 lakhs per year; Variable: 5% of Sales
9. Other Expenses: Rs. 15 lakhs for Year 1 and increase 5% per year.

10. Depreciation: 20% under Written Down Value Method for Income Tax purpose.
11. Principal part of the loan is to be repaid from Year 4 to Year 8 at the rate of 20% of loan amount.
12. Tax Rate: 30%
13. The life of the project is 10 years. At the end of 10^{th} year, the land, building and book value of machines are realized at book value (depreciated value).
14. The average equity beta of few electronic component manufacturing companies is equal to 1.40. The risk free rate is 7% and market equity risk premium is 8%

Required

(a) Find the financial viability of the project by computing IRR and NPV of the project (Make necessary additional assumptions).
(b) Find Pay-back period of the project.
(c) Perform sensitive analysis on an assumption of 5% forecast error on all variables.

Special Issues in Capital Budgeting

In most cases, DCF techniques assess the financial viability of the project correctly. We discuss two cases where we need to take some deviation. The first one is when projects of different lives are evaluated, NPV might fail. For example, a production manager wants to replace an existing equipment and considering two machines. The first machine has 3 years life and the second one has 4 years life. In evaluating these two machines, if we go by NPV we might end up with wrong decision. We can overcome this issue by converting the NPV of two projects into average annual cost. If we take simple average, we are ignoring time value of money. When we convert the NPV into annuity, we are considering both time value of money and also yearly cost.

Illustration

A plant manager is evaluating two machines as a replacement of an existing machine. Machine A costs Rs. 15 million and the operating cost of the machine per year is 3 million for three years. Machine B costs Rs. 18 million and the operating cost is Rs. 2.50 million for four years. Since all values are cash outflows, we need to minimize the cost or select lower NPV. The discounting factor is 10%. Our NPV computation shows Machine A costs in present value terms Rs. 23.02 million. Similarly machine B costs Rs. 26.66 million in present value terms. Since we need to minimize the NPV, our selection is Machine A. If we convert them into annuity, we get a different picture. For Machine A, the annuity value is Rs. 8.61 million per year for three years. For Machine B, the annuity works out Rs. 7.69 million per year for four years. We choose machine B though NPV gives different recommendation.

Machine A			Machine B		
Year	-15.00	-15.00	-18.00	-18.00	-15.00
0	-3.00	-2.73	-2.50	-2.27	-3.00
1	-3.00	-2.48	-2.50	-2.07	-3.00
2	-3.00	-2.25	-2.50	-1.88	-3.00
3			-2.50	-1.71	
		-22.46		-25.92	
		-9.03		-8.18	

The second special case is when you have an option to execute projects in stages. For example, you can set up a plant with a capacity of 8000 units per day. Instead of that, you can set up a plant for 3000 units per day and expand it to 8000 units per day at the end of 3 years if there is sufficient demand for the product. The NPV of two-stage project will be lower than single stage project. However, two stage project

allows the firm not to expand or defer the expansion after evaluating the market condition at the end of year 3. The two-staged project will cost more and it will produce less revenue during Phase 1 where the units are lower. If we go by Net Present Value, we may select 8000 units per day project. The in-built option of the second project is not formally considered when we apply DCF techniques for evaluation capital investments. Let us do an example.

Illustration

Alpha & Co., is considering a new project with 8000 units as capacity. The immediate market requirement is 3000 units but the market research states the demand will increase to 8000 units at the end of 3 years with 80% probability. The cost of the plant for 8000 units is Rs. 80 million. The cash inflow for first three years is Rs. 6 million per year. From year 4 to 10, the cash inflow can be Rs. 18.50 million per year if the demand increases to 8000 units or Rs. 6 million if the increase in demand has not materialized. The probability of the demand increasing to 8000 units is 80%. The expected value of revenue from year 4 to 10 is equal to 18.5*0.80 + 6.00*0.20, which is equal to Rs. 16 million. The net present value of the project at 6% discount rate is Rs. 11.03 million. Alpha & Co can take up the project in two stages. In stage 1, it can set up a plant for 3000 units and expand to 8000 units. The project cost at time zero for 3000-unit project is Rs. 35 million and it has to incur another Rs. 55 million at the end of three years. The cash inflow for first three years is Rs. 5.80 million. From Year 4 to 10, the cash inflow can be either 5.80 or 18.50 million depending on the outcome of the market demand. The expected value of cash inflow from year 4 to 10 is Rs. 15.96 million [(18.5*0.8)+(5.8*0.2)]. The NPV of the project at 6% discount rate is Rs. 9.13.

The workings are shown below.

Year	One-Stage	Two-Stage
0	-80.00	-35.00
1	6.00	5.80
2	6.00	5.80
3	6.00	-49.20
4	16.00	15.96
5	16.00	15.96
6	16.00	15.96
7	16.00	15.96
8	16.00	15.96
9	16.00	15.96
10	16.00	15.96
NPV	11.03	9.13

If we go by the NPV, we will select one-stage project because it offers a NPV of Rs. 11.03 million against Rs. 9.13 million of other project. Even though we have the probability value of the market size reaching 8000 units, we used it to derive the expected value of cash flows instead of handling them separately. Suppose we compute NPV for a scenario where the market size has improved to 8000 units by 3rd year and NPV for another scenario where the market size remains at 3000 units. After computing NPV under each scenario, we can merge them using probability values. The workings under this approach is shown below:

Year	One-Stage		Two-Stage	
	Demand Increases	No change in Demand	Demand Increases	No change in Demand
0	-80	-80	-35	-35.00
1	6	6	5.8	5.80
2	6	6	5.8	5.80
3	6	6	-49.2	5.80
4	18.5	6	18.5	5.80
5	18.5	6	18.5	5.80
6	18.5	6	18.5	5.80
7	18.5	6	18.5	5.80

8	18.5	6	18.5	5.80
9	18.5	6	18.5	5.80
10	18.5	6	18.5	5.80
NPV	22.75	-35.84	21.04	7.69

Outcome	One-Stage NPV	Two-Stage NPV
Best (p=0.80)	22.75	21.04
Worst (p=0.20)	-35.84	7.69
Expected Value of NPV	11.03	18.37

The expected value of the project if Alpha & Co executes the project in two stages is Rs. 18.37 million against Rs. 11.03 million NPV if the project is executed with full capacity from the beginning. Now our decision is in favour of executing the project in two stages. Under the two-stage project, the project manager has an option to expand the capacity or stay with the existing capacity depending on market growth. In a way, the difference between Rs. 18.37 million and Rs. 9.13 million can be treated as value option. That is, the NPV of one-stage project without considering the option explicitly is Rs. 9.13 million. The NPV of one-stage project increases to Rs. 18.37 when we explicitly consider the option to expand the capacity. The difference of Rs. 9.24 million can be treated as option value. You can observe there is no change in the NPV value between the two approaches as far as one-stage project is concerned. It continues to be Rs. 11.03 million because there is no option. For two-stage projects, the NPV increases from Rs. 9.13 million to Rs. 18.37 million. Real option models measure the option value with the help of option pricing model. Since these models are not developed fully, we have shown the option value using the NPV framework itself.

Our common-sense also suggests that the two-stage project is desirable. Because, when we opt for two-stage project, we lose Rs. 1.71 million in the best-case scenario but in the worst-case scenario, we gain Rs. 43.53 million. That is, we are avoiding

a major loss of Rs. 35.54 million when we put a plant for 8000 units but running the plant at 3000 units throughout the life of the project.

Summary

Investments in projects is a continuous activity for most growing firms. Project are different types. They are broadly classified under four heads – Improvement Projects, Replacement Projects, Expansion Projects and New Projects. The new projects can be related to same industry or unrelated to existing business. Functional Managers evaluate the projects on technical and commercial viability before seeking funds for the projects. Functional Managers and finance managers perform financial viability before sanctioning funds for the projects. A project is financially viable if the present value of cash inflows generated by the project is more than or equal to present value of cash outflows required for taking up the project. In financial feasibility evaluation, we consider only incremental cash flows. We exclude sunk cost but consider opportunity cost if there is a real loss of cash flows to the firm due to execution of the project. Cash outflows include investment in land, building, machines, incremental working capital required for running the project. Cash inflow of a project is equal to Profit before depreciation, interest and taxes less taxes. Tax is computed as per tax laws but excluding interest expenses. Debt, interest and tax benefit on interest are considered while computing cost of capital. Cash inflows and outflows are discounted to adjust time differences in the cash flow and risk associated with the cash flows. Cash flows are discounted using risk-adjusted weighted average cost of capital. Cost of debt is equal to interest rate. Cost of equity is computed using equity beta, risk-free rate and market return. Net Present Value and Internal Rate of Return are two widely used discounted cash flow techniques used for assessing the financial viability of projects. A project is financially viable if NPV is greater than or equal to zero or IRR of the project is

greater than or equal to cost of capital. Project sponsors also compute payback period and report along with NPV and IRR of the project. Accepting positive NPV project is a value creation activity and consistent with wealth maximization objective.