



SECTION - 3

CAPITAL BUDGETING

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3.1 CAPITAL BUDGETING

3.1.1 The concept of Capital Budgeting is also known as Investment Appraisal. It is basically concerned with Resource Optimization. It is also referred to as Capital expenditure with reference to Projects. Projects may be of different types such as new projects, expansion projects, diversification projects or modernization projects. Capital Budgeting is also gaining importance due to increased level of M & As.



- 3.1.2 Capital Budgeting assumes tremendous importance for an organization for the following reasons:
- By committing resources to a project, an organization gets committed to a particular process or technology.
 - Huge capital outlay
 - Long gestation periods
 - Decisions are strategic and generally irreversible.
- 3.1.3 Capital Budgeting is the cost of capacity resources that organizations purchase and use for years to make goods and provide services. *Capital assets* create these capacity-related costs.
- 3.1.4 Cost commitments associated with long-term assets create the following types of risks for an organization:
- Remain even if the asset does not generate the anticipated benefits
 - Reduce an organization's flexibility.
- 3.1.5 Therefore, organizations approach investments in long-term assets with considerable care and caution.

3.2 NEED TO CONTROL CAPITAL ASSETS

- 3.2.1 Organizations have developed specific tools to control the acquisition and use of long-term assets because:
- Organizations are usually committed to long-term assets for an extended time, creating the potential for:
 - Excess capacity that creates excess costs
 - Scarce capacity that creates lost opportunities
 - The amount of money committed to the acquisition of capital assets is usually quite large.
 - The long-term nature of capital assets creates technological risk.
- 3.2.2 *Capital budgeting* is a systematic approach to evaluating an investment in a capital asset.

3.3 INVESTMENT AND RETURN

- 3.3.1 The fundamental evaluation issue in dealing with a long-term asset is whether its future benefits justify its initial cost.
- 3.3.2 *Investment* is the monetary value of the assets the organization gives up to acquire a long-term asset.
- 3.3.3 *Return* is the increased future cash inflows attributable to the long-term asset.
- 3.3.4 *Investment* and *return* form the foundation of capital budgeting analysis, which focuses on whether the expected increased cash flows (return) will justify the investment in the long-term asset.



- 3.3.5 It has impact on opportunity loss if not planned timely or alternative options are not weighed properly.

3.4 TIME VALUE OF MONEY

- 3.4.1 *Time value of money (TVM)* is a central concept in capital budgeting.
- 3.4.2 As money can earn a return:
- Its value depends on when it is received.
 - Using money has a cost in the form of lost opportunity to invest the money in another investment alternative.
- 3.4.3 In making investment decisions, the problem is that investment is made much ahead of expected future return. We need an equivalent basis to compare the cash flows that occur at different points in time.
- 3.4.4 As money has a time-dated value, the critical idea underlying capital budgeting is: *“Amounts of money spent or received at different periods of time must be converted into their value on a common date in order to be compared”*.

3.5 FUTURE VALUE OF MONEY

- 3.5.1 As money has time value, it is better to have money now than in the future. Having Rs.100 today is more valuable than receiving Rs.100 in the future because the Rs.100 on hand today can be invested to grow to more than Rs.100.
- 3.5.2 The *future value (FV)* is the amount that today's investment will be after earning a stated periodic rate of return for a stated number of periods.
- 3.5.3 For one period: $FV = PV \times (1+r)$
- 3.5.4 The formula for a future value is $FV = PV \times (1+r)^n$
- 3.5.5 As investment opportunities usually extend over multiple periods, we need to compute future value over several periods.

3.6 PRESENT VALUE

- 3.6.1 Analysts call a future cash flow's value at time zero as *present value*. The process of computing present value is called *discounting*. We can rearrange the FV formula to compute the present value:

$$FV = PV \times (1 + r)^n$$

$$PV = FV / (1 + r)^n \text{ or } PV = FV \times (1 + r)^{-n}$$

3.7 CAPITAL BUDGETING PROCESS

- 3.7.1 The Capital Budgeting process consists of the following steps:
- a. Identification of potential investment opportunities
 - b. Collecting relevant data on investments & returns



- c. Evaluation using various criteria.
- d. Selection
- e. Project implementation without time or cost overrun.
- f. Performance Review at periodical intervals.

3.8 INVESTMENT OR PROJECT APPRAISAL

3.8.1 Investment appraisal consists of the following steps:

- 1. Forecast of project costs and benefits for a reasonable time frame,
- 2. Ascertaining the project risk wrt competition, Technology, Consumer preferences, market including international currency fluctuations.,
- 3. Estimating the cost of capital, weighted average cost of capital, mix of capital,
- 4. Application of suitable investment criteria by adopting proper means of financing
- 5. Analysing managerial strengths, capabilities, project and profitability sensitivity to any changes, regulations governing the project implementation etc;

3.9 INVESTMENT CRITERIA

3.9.1 The following are the most commonly used criteria to appraise investments:

- 1. Payback period
- 2. Accounting Rate of Return
- 3. Net Present Value (NPV)
- 4. Internal Rate of Return (IRR)
- 5. Profitability Index
- 6. Debt Service Coverage Ratio (DSCR)

3.9.2 The above investment criteria, their advantages and limitations are discussed subsequently in the chapter.

3.10 COST OF CAPITAL

3.10.1 The *cost of capital* is the interest rate used for discounting future cash flows. It is also known as the *risk-adjusted discount rate*.

3.10.2 The cost of capital is the return the organization must earn on its investment to meet its investors' return requirements.

3.10.3 The organization's cost of capital reflects:

- The amount and cost of debt and equity in its financial structure
- The financial market's perception of the financial risk of the organization's activities



3.11 AN ILLUSTRATION

3.11.1 Arctic Ice creams:

To show how each of these methods works and alternative perspectives, we apply each to Arctic Ice creams as it considers the purchase of a new automatic Ice cream machine:

- a. Cost: Rs.70,000
- b. Life: five years
- c. Benefit: expanded capacity and reduced operating costs would increase Arctic's net profits by Rs.20,000 per year
- d. Arctic's cost of capital is 10%
- e. The new machine would be sold for Rs.10,000 at the end of five years

3.12 PAYBACK CRITERION

3.12.1 The *payback period* is the number of periods needed to recover a project's initial investment:

- a. Arctic's initial investment of Rs.70,000/- is recovered midway between years 3 and 4
- b. The payback period for this project is 3.5 years

3.12.2 Many people consider the payback period to be a measure of the project's risk as:

- a. The organization has unrecovered investment during the payback period
- b. The longer the payback period, the higher the risk
- c. Organizations compare a project's payback period with a target that reflects the organization's acceptable level of risk
- d. It also has relevance to technology changes.

3.12.3 Problems with the Payback method: The payback criterion has two problems:

1. It ignores the time value of money. Some organizations use the discounted payback method, which computes the payback period but uses discounted cash flows.
2. It ignores the cash outflows that occur after the initial investment and the cash inflows that occur after the payback period.

3.12.4 Despite these limitations, some surveys show that the payback calculation is the most used approach by organizations for capital budgeting. This popularity may reflect other considerations, such as bonuses that reward managers based on current profits, that create a preoccupation with short-run performance

3.13 ACCOUNTING RATE OF RETURN

3.13.1 Analysts compute the accounting rate of return by dividing the average accounting income by the average level of investment.



- 3.13.2 Analysts use the accounting rate of return to approximate the return on investment.
- 3.13.3 The increased annual income that Arctic's will report related to the new Ice cream Machine will be Rs.8000 (Rs.20,000 – Rs.12,000 of depreciation). The average income will equal the annual income since the annual income is equal each year.
- 3.13.4 The average investment is Rs.40,000 $[(Rs.70,000 + 10,000) / 2]$.
- 3.13.5 The accounting rate of return for the investment is computed as: $Rs.8,000 / Rs.40,000 = 20\%$.
- 3.13.6 If the accounting rate of return exceeds the target rate of return, then the project is acceptable.
- 3.13.7 Like the payback method the accounting rate of return method has a drawback: By averaging, it does not consider the timing of cash flows.
- 3.13.8 This method is an improvement over the payback method in that it considers cash flows in all periods.

3.14 NET PRESENT VALUE

- 3.14.1 The *Net Present Value (NPV)* is the sum of the present values of a project's cash flows. This is the first method considered that incorporates the time value of money.
- 3.14.2 The steps used to compute an investment's net present value are as follows:
1. Choose the appropriate period length to evaluate the investment proposal. The period length depends on the periodicity of the investment's cash flows. The most common period used in practice is one year. Analysts also use quarterly and semiannual periods.
 2. Identify the organization's cost of capital, and convert it to an appropriate rate of return for the period length chosen in step 1.
 3. Identify the incremental cash flow in each period of the project's life.
 4. Compute the present value of each period's cash flow using the organization's cost of capital as the discount rate.
 5. Sum the present values of all the periodic cash inflows and outflows to determine the investment project's net present value.
 6. If the project's net present value is positive, the project is acceptable from an economic perspective
- 3.14.3 To determine the NPV of Arctic's investment:
1. The period length is one year. All cash flows are stated annually.
 2. Arctic's cost of capital is 10% per year. As the period chosen in step 1 is annual, no adjustment is necessary to the rate of return.
 3. The incremental cash flows are:
 - a. Rs.70,000 outflow immediately
 - b. Rs.20,000 inflow at the end of each year for five years



- c. Rs.10,000 inflow from salvage at the end of five years
- It is useful to organize the cash flows associated with a project on a time line to help identify and consider all the project's cash flows systematically.
4. The present value of the cash flows when the organization's cost of capital is 10% are:
- For a five-year annuity of Rs.20,000, $PV = Rs.75,816$
 - For the Rs.10,000 salvage in 5 years, $PV = Rs.6,209$
5. To sum the present values of all the periodic cash flows and determine NPV. The PV of the cash inflows (from step 4) is Rs.82,025. As the investment of Rs.70,000 takes place at time zero, the PV of the total outflows is Rs.(70,000). The NPV of this investment project is Rs.12,025.
6. As the NPV is positive, Arctic should purchase the Ice cream Machine. It is economically desirable

3.15 INTERNAL RATE OF RETURN

- 3.15.1 The Internal Rate of Return (IRR) is the actual rate of return expected from an investment.
- 3.15.2 The IRR is the discount rate that makes the investment's net present value equal to zero. If an investment's NPV is positive, then its IRR exceeds its cost of capital. If an investment's NPV is negative, then its IRR is less than its cost of capital.
- 3.15.3 By trial and error, or the use of a financial calculator or spreadsheet software, we find that the IRR in Arctic's is 16.14%. As a 16.14% IRR > 10% cost of capital, the project is desirable.
- 3.15.4 IRR has some disadvantages:
- It assumes that a project's intermediate cash flows can be reinvested at the project's IRR. It is frequently an invalid assumption.
 - It can create ambiguous results, particularly:
 - When evaluating competing projects in situations where capital shortages prevent the organization from investing in all positive NPV projects
 - When projects require significant outflows at different times during their lives
- 3.15.5 Moreover, because a project's NPV summarizes all its financial elements, using the IRR criterion is unnecessary when preparing capital budgets. Still, it is a widely used capital budgeting tool.

3.16 PROFITABILITY INDEX

- 3.16.1 The profitability index is a variation of the net present value method.
- 3.16.2 It is used to make comparisons of mutually exclusive projects with different sizes and is computed by dividing the present value of the cash inflows by the present value of the cash outflows.



- 3.16.3 A profitability index of 1 or greater is required for the project to be acceptable.
- 3.16.4 Recall that with Arctic's, the present value of the cash inflows was Rs.82,025 and the present value of the cash outflows was Rs.70,000.
- 3.16.5 Therefore, the profitability index for that project was 1.17 (Rs.82,025 / Rs.70,000).
- 3.16.6 It is possible for project A to have a higher profitability index while project B has a higher NPV. An organization must determine how to choose when the criteria give conflicting results.

3.17.DSCR

- 3.17.1 Coverage available to the lender to obtain interest on loan and repayment of debt.
- 3.17.2
$$DSCR = \frac{\text{Profit before long term Interest \& Depreciation and after tax}}{\text{Long term Interest} + \text{Long term Re payments}}$$

3.18 EFFECT OF TAXES

- 3.18.1 In practice, capital budgeting must consider the tax effects of potential investments. The exact effect of taxes on the capital budgeting decisions depends on tax legislation, which is specific to a tax jurisdiction.
- 3.18.2 In general, the effect of taxes is twofold:
- Organizations must pay taxes on any net benefits provided by an investment.
 - Organizations can use the depreciation associated with a capital investment to reduce income and offset some of their taxes. The rate of taxation and the way that legislation allows organizations to depreciate the acquisition cost of their long-term assets as a taxable expense varies over time and by jurisdiction.

3.19 EFFECT OF INFLATION

- 3.19.1 Inflation is a general increase in the price level.
- 3.19.2 To account for inflation we must adjust future cash flows so that we can compare Rs. of similar purchasing power. Similarly, we discounted future cash flows to the present using an appropriate discount rate to account for the time value of money.
- 3.19.3 We discount each cash flow by the appropriate discount rate and the expected inflation rate.
- 3.19.4 If Arctic's expected inflation of 2.5%, the combined discount rate would be 1.1275% = 1.10×1.025 .

3.20 UNCERTAINTY IN CASH FLOWS

- 3.20.1 Capital budgeting analysis relies on estimates of future cash flows.
- 3.20.2 As estimates are not always realized, many decision makers like to know how their estimates affect the decision they are making.



- 3.20.3 Estimating future cash flows is an important and difficult task. This is important because many decisions will be affected by those estimates. Difficult because these estimates will reflect circumstances that the organization may not have previously experienced.
- 3.20.4 Most cash flow estimation is incremental. This means that it is based on previous experience. For example, based on manufacturer claims, a new machine might be expected to decrease costs by 10%.
- 3.20.5 Many organizations assume that learning will systematically reduce the costs of a new system or process.
- 3.20.6 Cash flows related to sales of a new product are often estimated based on past experiences with similar products.
- 3.20.7 The forecast usually starts with previous experience and makes adjustments.

3.21 WHAT-IF & SENSITIVITY ANALYSIS

- 3.21.1 Two other approaches to handling uncertainty are what-if and sensitivity analysis:
- In the Arctic's example, Arctic might ask, "What must the cash flows be to make this project unattractive?"
 - Fortunately, computer spreadsheets make questions like this easy to answer.
- 3.21.2 Most planners today use personal computers and electronic spreadsheets for capital budgeting.
- 3.21.3 The planner can set up a computer spreadsheet to make changes to the estimates of the decision's key parameters.
- 3.21.4 If the analysis explores the effect of a change in a parameter on an outcome, we call this investigation a *what-if analysis*. For example, the planner may ask, "What will my profits be if sales are only 90% of the plan?"
- 3.21.5 A planner's investigation of the effect of a change in a parameter on a decision, rather than on an outcome, is called a *sensitivity analysis*. For example, the planner may ask, "How low can sales fall before this investment becomes unattractive?"

3.22 RISK ANALYSIS

- 3.22.1 Risks relates to:
- Implementation
 - Market
 - Financial
- 3.22.2 Keep the end result of the model in mind, i.e., the ability to vary the key drivers of the model results [Sensitivity Analysis].
- 3.22.3 The purpose is to de-risk the project through simulation of probable results
- Sensitivity analysis: Variation in key parameters and impact on profitability
 - Scenario analysis
 - Simulation
 - Break-even analysis: Minimum level of operation

3.23 AN ILLUSTRATION

Tristar Foods is planning to introduce a new food chain for the production and distribution of corn oil. The company has already spent Rs. 20000 in the analysis of the project. The new department may use the existing warehouse which could otherwise be rented out for Rs.15000 a year. The marketing task will be carried out by the existing manpower but a part of total cost Rs. 20000, will be allocated to the new food chain department. The rest of the details are shown in the table.

Input data	
Cost of new machine	150,000
Salvage value of new machine	10,000
Production (lts. Per day)	300
Working days per year	300
Working life of machine (years)	6
Income per lt. (net)	0.80
Salvage value of old machine	5,000
Warehouse cost	15,000
Allocated cost of marketing / year	20,000
Increase in working capital	5,000
Depreciation rate	25%
Corporate tax rate	30%
Capital gains tax rate	30%
Opportunity cost of capital(Debt)	12.5%
Post tax cost of debt	8.8%

ESTIMATION OF CASHFLOWS

YEAR	0	1	2	3	4	5	6
COST OF NEW MACHINE	(150,000)						
SALVAGE VALUE (OLD MACHINE)	5,000						
CHANGE IN WORKING CAPITAL	(5,000)						5,000
SALVAGE VALUE (NEW MACHINE)							10,000
REVENUE		72,000	72,000	72,000	72,000	72,000	72,000
WAREHOUSE COST		(15,000)	(15,000)	(15,000)	(15,000)	(15,000)	(15,000)
DEPRECIATION		(37,500)	(37,500)	(37,500)	(37,500)		
TAXABLE PROFIT		34,500	34,500	34,500	34,500	72,000	72,000
CAPITAL GAINS TAX	(1,500)						(3,000)
CORPORATE TAX		(10,350)	(10,350)	(10,350)	(10,350)	(21,600)	(21,600)
PROFIT AFTER TAX		24,150	24,150	24,150	24,150	50,400	50,400
CASHFLOWS	(151,500)	46,650	46,650	46,650	46,650	35,400	47,400
NPV	52,394.39						
IRR	19.83%						

Sensitivity analysis		
Production per day		
	52,394.39	19.83%
230	-755.55	0.09
235	3040.87	0.09
260	22023.00	0.14
265	25819.42	0.14
270	29615.85	0.15
280	37208.69	0.17
290	44801.54	0.18
295	48597.97	0.19

Sensitivity analysis		
Contribution Per litre		
	52,394.39	19.83%
0.50	-33025.16	0.01
0.55	-18788.57	0.04
0.60	-4551.98	0.08
0.65	9684.62	0.11
0.70	23921.21	0.14
0.75	38157.80	0.17

Production per day and contribution per litre

52,394.39	0.50	0.55	0.60	0.65	0.70	0.75
230	-66243.87	-55329.15	-44414.43	-33499.71	-22584.99	-11670.27
235	-63871.11	-52719.11	-41567.11	-30415.12	-19263.12	-8111.12
260	-52007.28	-39668.90	-27330.52	-14992.14	-2653.76	9684.62
265	-49634.52	-37058.86	24483.20	11907.55	668.11	13243.76
270	-47261.75	-34448.82	-21635.89	-8822.95	3989.98	16802.91
280	-42516.22	-29228.73	-15941.25	-2653.76	10633.72	23921.21
290	-37770.69	-24008.65	-10246.61	3515.43	17277.47	31039.50
295	-35397.92	-21398.61	-7399.29	6600.02	20599.34	34598.65

Notes:

1. There are three types of costs that need to be considered in the above case.
 - i. The initial feasibility study cost is a sunk cost and hence to be ignored
 - ii. The accounting allocated cost of 20000, should again be ignored as it is not incremental
 - iii. The warehouse cost is an opportunity cost and hence should be included



2. The working capital investment is released in the last year of the project
3. The post tax cost of debt is taken as interest is tax deductible
4. The first sensitivity table shows the impact of changes in production per day on the NPV and IRR
5. The second sensitivity table shows the impact of changes in contribution per liter on the NPV and IRR
6. The third table shows a combination of production and contribution on NPV

Scenario Analysis

Variables	Scenario-1	Scenario-2	Scenario-3
Production	250	290	310
Contribution	0.6	0.75	0.85
Investment	170000	160000	150000
Cost of debt	0.14	0.13	0.125

Note: Scenario analysis goes beyond sensitivity analysis. A number of variables representing one scenario are changed and the impact on the final result is studied.

Scenario Summary

	Current Values:	Pessimistic	most likely	optimistic
Changing Cells:				
Production	300	250	290	310
Contribution	0.80	0.60	0.75	0.85
Investment	150,000	170,000	160,000	150,000
Cost of debt	12.5%	14.0%	13.0%	12.5%
Result Cells:				
NPV	52,394.39	(51,775.61)	21,603.66	74,698.39
IRR	19.83%	-1.66%	13.59%	24.20%

Note: The scenario summary shows the results under best case and worst case scenario.

2 MIRR			
Check the reinvestment assumption of IRR			
0	-100000		
1	45000		
2	49000		
3	20000		
4	30000		
5	25000		
IRR	24%		
MRR	=Mirr (Cashflow range, guess rate, reinvestment rate)		19%

Note: Modified internal rate of return takes into account a different reinvestment rate, other than the internal rate of return. Normal IRR assumes that the intermediate cash flows are reinvested at the IRR. In a falling interest rate scenario, this assumption may not hold good. Hence, a modified internal rate of return is to be used. The above illustration shows how this can be done in using the Excel function.

Monte carlo simulation: Simulation is used to quantify risk in terms of probability of achieving a target NPV or IRR. Simulation is done for capturing the different possible outcomes and determining the probability of a particular event happening. In the example given below, the estimated probabilities associated with different cash flows of a project are given. These probabilities can be subjective probabilities. Using random numbers, a large number of cash flows are selected to construct a distribution of results. The simulation is takes into account all possible outcomes.

Monte Carlo Simulation

Year	Probability	Cashf lows
0	0.20	-2400.00
	0.20	-2365.00
	0.60	-2200.00
1	0.30	275.00
	0.50	352.60
	0.20	450.00
2	0.30	460.00
	0.60	525.13
	0.10	675.00
3	0.20	600.00
	0.70	714.06
	0.10	900.00
4	0.10	775.00
	0.80	960.75
	0.10	1100.00
5	0.10	1100.00
	0.80	1461.07
	0.10	1500.00

Monte Carlo Simulation:

- Illustration of Project Simulation
- Cash flows and associated probabilities are the required inputs
- The purpose is to quantify risk

Convert probability to cumulative probability

Year 0	Cumulative Probability		
	P	CP	Cash flows
	0.00	0.00	-2400
	0.20	0.20	-2365
	0.60	0.80	-2200
	0.20	1.00	-2200
Year 1	P	CP	Cash flows
	0	0.00	275.00
	0.3	0.30	352.60
	0.5	0.80	450.00
	0.2	1.00	450.00
Year 2	P	CP	Cash flows
	0.00	0.00	460.00
	0.30	0.30	525.13
	0.60	0.90	675.00
	0.10	1.00	675.00
Year 3	P	CP	Cash flows
	0.00	0.00	600.00
	0.20	0.20	714.06
	0.70	0.90	900.00
	0.10	1.00	900.00
Year 4	P	CP	Cash flows
	0.00	0.00	775.00
	0.10	0.10	960.75
	0.80	0.90	1100.00
	0.10	1.00	1100.00
Year 5	P	CP	Cash flows
	0.00	0.00	1100.00
	0.10	0.10	1461.07
	0.80	0.90	1500.00
	0.10	1.00	1500.00

Generation of random numbers: The random numbers are used to pick the different combination of cash flows. Each selection produces an IRR to form the IRR distribution.

Trial No	Random no	Investmen	Cash flow-	Cash flow-	Cash flow-	Cash flow-	Cash flow-	ORR
1	0.13	-2400.00	275.00	460.00	600.00	960.75	1461.07	0.13
2	0.33	-2365.00	352.60	525.13	714.06	960.75	1461.07	0.16
3	0.39	-2365.00	352.60	525.13	714.06	960.75	1461.07	0.16
4	0.98	-2200.00	450.00	675.00	900.00	1100.00	1500.00	0.25
5	0.47	-2365.00	352.60	525.13	714.06	960.75	1461.07	0.16
6	0.73	-2365.00	352.60	525.13	714.06	960.75	1461.07	0.16
7	0.76	-2365.00	352.60	525.13	714.06	960.75	1461.07	0.16
8	0.48	-2365.00	352.60	525.13	714.06	960.75	1461.07	0.16
9	0.66	-2365.00	352.60	525.13	714.06	960.75	1461.07	0.16
10	0.23	-2365.00	275.00	460.00	714.06	960.75	1461.07	0.15
11	0.92	-2200.00	450.00	675.00	900.00	1100.00	1500.00	0.25
12	0.75	-2365.00	352.60	525.13	714.06	960.75	1461.07	0.16
13	0.36	-2365.00	352.60	525.13	714.06	960.75	1461.07	0.16
14	0.72	-2365.00	352.60	525.13	714.06	960.75	1461.07	0.16
15	0.45	-2365.00	352.60	525.13	714.06	960.75	1461.07	0.16

From the simulated IRRs, the average and standard deviation of IRR is computed.

With average, standard deviation and the expected IRR as given below, the normal distribution tables are referred to obtain the probability of achieving different IRRs. For example, as given below, the probability of achieving an IRR of 14 percent is 68%.

Quantification of risk

expected irr	z	Probability
0.14	-0.4664	0.68
0.15	-0.2353	0.59
0.16	-0.0043	0.50
0.17	0.2268	0.41
0.18	0.4579	0.32
0.19	0.6890	0.25
0.20	0.9200	0.18
0.21	1.1511	0.12
0.24	1.8444	0.03
0.29	3.0000	0.001
0.03	-3.0000	0.999



Case Study

Internal Rate of Return: A Cautionary Tale

Tempted by a project with high internal rates of return? Better check those interim cash flows again.

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Maybe finance managers just enjoy living on the edge. What else would explain their weakness for using the internal rate of return (IRR) to assess capital projects? For decades, finance textbooks and academics have warned that typical IRR calculations build in reinvestment assumptions that make bad projects look better and good ones look great. Yet as recently as 1999, academic research found that three-quarters of CFOs always or almost always use IRR when evaluating capital projects. (John Robert Graham and Campbell R. Harvey, "The Theory and Practice of Corporate Finance: Evidence from the Field," Duke University working paper presented at the 2001 annual meeting of the American Finance Association, New Orleans.)

Our own research underlined this proclivity to risky behavior. In an informal survey of 30 executives at corporations, hedge funds, and venture capital firms, we found only 6 who were fully aware of IRR's most critical deficiencies. Our next surprise came when we reanalyzed some two dozen actual investments that one company made on the basis of attractive internal rates of return. If the IRR calculated to justify these investment decisions had been corrected for the measure's natural flaws, management's prioritization of its projects, as well as its view of their overall attractiveness, would have changed considerably.

So why do finance pros continue to do what they know they shouldn't? IRR does have its allure, offering what seems to be a straightforward comparison of, say, the 30 percent annual return of a specific project with the 8 or 18 percent rate that most people pay on their car loans or credit cards. That ease of comparison seems to outweigh what most managers view as largely technical deficiencies that create immaterial distortions in relatively isolated circumstances.

Admittedly, some of the measure's deficiencies are technical, even arcane, but the most dangerous problems with IRR are neither isolated nor immaterial, and they can have serious implications for capital budget managers. When managers decide to finance only the projects with the highest IRRs, they may be looking at the most distorted calculations — and thereby destroying shareholder value by selecting the wrong projects altogether. Companies also risk creating unrealistic expectations for themselves and for shareholders, potentially confusing investor communications and inflating managerial rewards. (As a result of an arcane mathematical problem, IRR can generate two very different values for the same project when future cash flows switch from negative to positive (or positive to negative). Also, since IRR is expressed as a percentage, it can make small projects appear more attractive than large ones, even though large projects with lower IRRs can be more attractive on an NPV basis than smaller projects with higher IRRs.)

We believe that managers must either avoid using IRR entirely or at least make adjustments for the measure's most dangerous assumption: that interim cash flows will be reinvested at the same high rates of return.



The Trouble with IRR

Practitioners often interpret internal rate of return as the annual equivalent return on a given investment; this easy analogy is the source of its intuitive appeal. But in fact, IRR is a true indication of a project's annual return on investment only when the project generates no interim cash flows — or when those interim cash flows really can be invested at the actual IRR.

When the calculated IRR is higher than the true reinvestment rate for interim cash flows, the measure will overestimate — sometimes very significantly — the annual equivalent return from the project. The formula assumes that the company has additional projects, with equally attractive prospects, in which to invest the interim cash flows. In this case, the calculation implicitly takes credit for these additional projects. Calculations of net present value (NPV), by contrast, generally assume only that a company can earn its cost of capital on interim cash flows, leaving any future incremental project value with those future projects.

IRR's assumptions about reinvestment can lead to major capital budget distortions. Consider a hypothetical assessment of two different, mutually exclusive projects, A and B, with identical cash flows, risk levels, and durations — as well as identical IRR values of 41 percent. Using IRR as the decision yardstick, an executive would feel confidence in being indifferent toward choosing between the two projects. However, it would be a mistake to select either project without examining the relevant reinvestment rate for interim cash flows. Suppose that Project B's interim cash flows could be redeployed only at a typical 8 percent cost of capital, while Project A's cash flows could be invested in an attractive follow-on project expected to generate a 41 percent annual return. In that case, Project A is unambiguously preferable.

Even if the interim cash flows really could be reinvested at the IRR, very few practitioners would argue that the value of future investments should be commingled with the value of the project being evaluated. Most practitioners would agree that a company's cost of capital — by definition, the return available elsewhere to its shareholders on a similarly risky investment — is a clearer and more logical rate to assume for reinvestments of interim project cash flows.

When the cost of capital is used, a project's true annual equivalent yield can fall significantly — again, especially so with projects that posted high initial IRRs. Of course, when executives review projects with IRRs that are close to a company's cost of capital, the IRR is less distorted by the reinvestment-rate assumption. But when they evaluate projects that claim IRRs of 10 percent or more above their company's cost of capital, these may well be significantly distorted. Ironically, unadjusted IRRs are particularly treacherous because the reinvestment-rate distortion is most egregious precisely when managers tend to think their projects are most attractive. And since this amplification is not felt evenly across all projects, managers can't simply correct for it by adjusting every IRR by a standard amount. (The amplification effect grows as a project's fundamental health improves, as measured by NPV, and it varies depending on the unique timing of a project's cash flows.)

How large is the potential impact of a flawed reinvestment-rate assumption? Managers at one large industrial company approved 23 major capital projects over five years on the basis of IRRs that averaged 77 percent. Recently, however, when we conducted an analysis with the reinvestment rate adjusted to the company's cost of capital, the true average return fell to just 16 percent. The order of the most attractive projects also changed considerably. The top-ranked



project based on IRR dropped to the tenth-most-attractive project. Most striking, the company's highest-rated projects — showing IRRs of 800, 150, and 130 percent — dropped to just 15, 23, and 22 percent, respectively, once a realistic reinvestment rate was considered. Unfortunately, these investment decisions had already been made. Of course, IRRs this extreme are somewhat unusual. Yet even if a project's IRR drops from 25 percent to 15 percent, the impact is considerable.

What to Do?

The most straightforward way to avoid problems with IRR is to avoid it altogether. Yet given its widespread use, it is unlikely to be replaced easily. Executives should at the very least use a modified internal rate of return. While not perfect, MIRR at least allows users to set more realistic interim reinvestment rates and therefore to calculate a true annual equivalent yield. Even then, we recommend that all executives who review projects claiming an attractive IRR should ask the following two questions.

1. What are the assumed interim-reinvestment rates? In the vast majority of cases, an assumption that interim flows can be reinvested at high rates is at best overoptimistic and at worst flat wrong. Particularly when sponsors sell their projects as “unique” or “the opportunity of a lifetime,” another opportunity of similar attractiveness probably does not exist; thus interim flows won't be reinvested at sufficiently high rates. For this reason, the best assumption — and one used by a proper discounted cash-flow analysis — is that interim flows can be reinvested at the company's cost of capital.

2. Are interim cash flows biased toward the start or the end of the project? Unless the interim reinvestment rate is correct (in other words, a true reinvestment rate rather than the calculated IRR), the IRR distortion will be greater when interim cash flows occur sooner. This concept may seem counterintuitive, since typically we would prefer to have cash sooner rather than later. The simple reason for the problem is that the gap between the actual reinvestment rate and the assumed IRR exists for a longer period of time, so the impact of the distortion accumulates. (Interestingly, given two projects with identical IRRs, a project with a single “bullet” cash flow at the end of the investment period would be preferable to a project with interim cash flows. The reason: a lack of interim cash flows completely immunizes a project from the reinvestment-rate risk.)

Despite flaws that can lead to poor investment decisions, IRR will likely continue to be used widely during capital-budgeting discussions because of its strong intuitive appeal. Executives should at least cast a skeptical eye at IRR measures before making investment decisions.

The authors, John C. Kelleher and Justin J. MacCormack, are consultants in McKinsey's Toronto office. They wish to thank Rob McNish for his assistance in developing this article.

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