READING 23: CAPITAL BUDGETING

LESSON 1: INTRODUCTION AND LEVEL I RECAP

Level I Recap

Capital budgeting is used to determine whether long-term investments such as acquiring new machinery, replacing current machinery, launching new products, and spending on research and development, are worth pursuing.

Steps in Capital Budgeting

- Generating ideas.
- Analyzing individual proposals.
- Planning the capital budgeting.
- Monitoring and post-auditing.

Categories of Capital Projects

- Replacement projects.
- Expansion projects.
- New products and services.
- Regulatory/safety and environmental projects.
- Other projects.

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Important Definitions

Sunk costs are those costs that cannot be recovered once they have been incurred.

An opportunity cost is the value of the next best alternative that is foregone in making the decision to pursue a particular project. Opportunity costs should be included in project costs.

An incremental cash flow is the additional cash flow realized as a result of a decision. Incremental cash flow equals cash flow with a decision minus cash flow without the decision.

An externality is the effect of an investment decision on things other than the investment itself.

A conventional cash flow stream is a cash flow stream that consists of an initial outflow followed by a series of inflows. The sign of the cash flows changes only once.

In a nonconventional cash flow pattern, the initial outflow is not followed by inflows only, but the direction of the cash flows can change from positive to negative again.

Basic Principles of Capital Budgeting

Decisions are based on actual cash flows: Only incremental cash flows are relevant to the capital budgeting process, while sunk costs are completely ignored.

Timing of cash flows is crucial: Analysts try to predict exactly when cash flows will occur, as cash flows received earlier in the life of the project are worth more than cash flows received late.

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Cash flows are based on opportunity costs: Projects are evaluated on the incremental cash flows they bring in over and above the amount that they would generate in their next best alternative use (opportunity cost).

Cash flows are analyzed on an after-tax basis.

Financing costs are ignored from calculations of operating cash flows. Financing costs are reflected in the required rate of return from an investment project, so cash flows are not adjusted for these costs.

Interactions between Projects

- Independent versus mutually exclusive projects: Independent projects are those whose cash flows are unrelated. Mutually exclusive projects compete directly with each other for acceptance.
- Project sequencing: Sometimes projects may only be undertaken in a certain order, so investing in one project creates the opportunity to invest in other projects in the future.
- Capital rationing: If the capital required to invest in all profitable projects exceeds resources available, the company must allocate funds to only the most lucrative projects to ensure that shareholder wealth is maximized.

Investment Decision Criteria

Net Present Value (NPV)

A project's NPV equals the present value of all expected inflows minus the present value of all expected outflows. The rate used to discount each cash flow is the project's cost of capital.

- A project should be undertaken if its NPV is *greater* than zero. Positive NPV projects increase shareholder wealth.

Internal Rate of Return (IRR)

For an investment project that requires only one investment outlay that is made at inception, IRR is the discount rate that equates the sum of the present values of future after-tax cash flows to the initial investment outlay.

- A company should invest in a project if its IRR is *greater* than the required rate of return. When the IRR is greater than the required return, NPV is positive.

Profitability Index

The profitability index (PI) of an investment equals the present value (PV) of a project's future cash flows divided by the initial investment. Therefore, the PI is the *ratio* of future discounted cash flows to the initial investment. The PI indicates the value that a company receives in exchange for one unit of currency invested. It is also known as the "benefit-cost" ratio.

- A company should invest in a project if its PI is *greater* than 1. The PI is greater than 1 when NPV is positive.

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NPV Profiles

An NPV profile is a graphical illustration of a project's NPV at different discount rates. NPV profiles are downward-sloping because as the cost of capital increases, the NPV of an investment falls.

- The discount rate at which the NPVs of two projects are the same (their NPV profiles intersect) is called the *crossover* rate.
- A project's NPV profile intersects the x-axis at its IRR.

NPV versus IRR

For independent projects, the NPV and IRR criteria for acceptance lead to the same result:

- Accept the project if NPV is greater than zero.
- Accept the project if IRR is greater than the cost of capital.

For mutually exclusive projects, NPV and IRR may offer different recommendations. In such a situation, a company should select the project with the *higher* NPV. NPV is a better criterion because of its more realistic reinvestment rate assumption.

- IRR assumes that interim cash flows received during the project are reinvested at the IRR. This assumption is sometimes rather inappropriate, especially for projects with high IRRs.
- NPV makes a more realistic assumption that interim cash flows are reinvested at the required rate of return.

NPV and IRR may give conflicting project rankings because of *differences in project size* and *cash flow timing differences.*

Problems with the IRR

It is possible for a project's cash flow stream to have no IRR or even multiple IRRs. This may occur even though the project has a positive NPV.

NPV, Company Value, and Stock Price

If a company invests in a positive NPV project, the expected addition to shareholders' wealth should lead to an increase in the company's stock price.

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LESSON 2: CASH FLOW PROJECTIONS

LOS 23a: Calculate the yearly cash flows of expansion and replacement capital projects and evaluate how the choice of depreciation method affects those cash flows. Vol 3, pp 27–38

EXPANSION PROJECTS

An expansion project is an independent investment that does not affect the cash flows for the rest of the company. For any particular project, the cash flows can be broken down into:

- Investment outlays.
- After-tax operating cash flows over the project's life.
- Terminal year after-tax nonoperating cash flow.

Let's work with the following example to illustrate the different types of cash flows for a project:

Mega Builders is evaluating a new 5-year project. The project requires an initial fixed capital investment of $550,000 (Nondepreciable land = $100,000; PP&E = $450,000). PP&E is depreciated on a straight-line basis (with zero salvage value) over a 5-year period. At the end of 5 years all fixed capital assets (including land) are expected to be sold for $150,000. The project will also require $60,000 in current assets and will generate $20,000 in current liabilities. It is expected to generate annual sales of $300,000 and requires cash operating expenses of $100,000 each year. Given a required rate of return of 10% and a marginal tax rate of 40%, calculate the NPV of the project.

We have illustrated three approaches to this problem here. For exam purposes you should focus on Approach III.

Approach I: Table Format with Cash Flows Collected by Year

One approach to this problem requires all cash flows to be collected by year. After annual cash flows have been determined, they are discounted at the cost of capital to determine the project's NPV. Table 2-1 lists all the project's cash flows by year:

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Table 2-1: Cash Flows Collected by Year

Year	0	1	2	3	4	5
Investment Outlays						
Fixed capital	–550,000					
Net working capital	–40,000					
Total Investment Outlays[1]	–590,000					
Annual After-Tax Operating Cash Flows						
Sales		300,000	300,000	300,000	300,000	300,000
Cash operating expenses		100,000	100,000	100,000	100,000	100,000
Depreciation[2]		90,000	90,000	90,000	90,000	90,000
Operating income before taxes		110,000	110,000	110,000	110,000	110,000
Taxes on operating income (40%)		44,000	44,000	44,000	44,000	44,000
Operating income after taxes		66,000	66,000	66,000	66,000	66,000
Add back: Depreciation[3]		90,000	90,000	90,000	90,000	90,000
After-tax operating cash flow		156,000	156,000	156,000	156,000	156,000
Terminal Year After-Tax Nonoperating Cash Flows						
After-tax salvage value[4]						130,000
Return of net working capital[5]						40,000
Total						**170,000**
Total after-tax cash flow	–590,000	156,000	156,000	156,000	156,000	326,000
Net present value at 10%[6]	**106,919**					
IRR	**16.12%**					

1. Initial investment outlay = FCInv + NWCInv = 550,000 + (60,000 – 20,000) = $590,000
2. Annual depreciation (PP&E) = (450,000 – 0)/5 = $90,000
3. Depreciation is added back to operating income after taxes to determine after-tax operating cash flow.
4. At the end of Year 5, fixed capital assets are sold for $150,000, which represents a gain of $50,000 on book value (land is carried at $100,000, while PP&E is carried at 0). This gain is taxed at 40%, resulting in a tax payment of $20,000. Therefore, cash inflow upon sale of fixed capital assets equals $150,000 – $20,000 = $130,000.
5. It is typically assumed that net working capital investments are recovered at the end of the project. This results in a cash inflow of $40,000 at the end of Year 5.
6. Discounting annual after tax cash flows at the cost of capital (10%) yields an NPV of **$106,919**. The IRR of the investment equals **16.12%**.

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NPV = $106,919.36
IRR = 16.12%

Both the NPV and IRR suggest that the company should undertake the project.

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Approach II: Table Format with Cash Flows Collected by Type

A second approach collects cash flows by type (e.g., sales, operating expenses, etc.) and calculates the NPV of each type of cash flow. The NPVs of the different types of cash flows are then summed to determine the project's NPV.

Table 2-2 calculates the NPV of the project by summing the present values of each type of cash flow.

Table 2-2: Cash Flows Collected by Type

Year	Type of Cash Flow	Before-Tax Cash Flow	After-Tax Cash Flow	PV at 10%
0	Fixed capital investment[1]	–550,000	–550,000	–550,000
0	Working capital investment[1]	–40,000	–40,000	–40,000
1-5	Sales minus cash expenses[2]	300,000 – 100,000 = 200,000	200,000(1 – 0.4) = 120,000	454,894
1-5	Depreciation tax savings[3]	None	90,000(0.4) = 36,000	136,468
5	After-tax salvage value[4]	150,000	150,000 – [(150,000 – 100,000) × 0.4] = 130,000	80,720
5	Return of working capital[5]	40,000	40,000	24,837
	NPV[6]			**106,919**

1. Outlays in fixed capital and net working capital at t=0 amount to $590,000.
2. For Years 1-5, the company realizes after tax cash flows from sales minus cash expenses with a total present value of $454,894. (PMT = –120,000; N = 5; I/Y= 10; CPT PV)
3. For Years 1-5, depreciation charges result in tax savings with a total present value of $136,468. (PMT = –36,000; N = 5; I/Y = 10; CPT PV)
4. The present value of the Year 5 after-tax salvage value equals $80,720. (FV = –130,000; N = 5; I/Y = 10; CPT PV)
5. The present value of the Year 5 return of working capital equals $24,837. (FV = –40,000; N = 5; I/Y = 10; CPT PV)
6. NPV (Project) = –590,000 + 454,894 +136,468 + 80,720 + 24,837 = **$106,919**

Approach III: Equation Format for Organizing Cash Flows

Instead of using a table, cash flows can be determined using various equations.

1. Initial investment outlay for a new investment = FCInv + NWCInv
   - *Fixed capital investment (FCInv)* includes the cost of new equipment as well as expenditures necessary to get the equipment in workable condition (e.g., shipping and installation).

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- *Net working capital investment (NWCInv):* Investment in a new project may lead to a proportionate increase in inventories, accounts receivable, accounts payable, accruals, etc. Investment in net working capital is defined as the difference between changes in noncash current assets and changes in nondebt current liabilities.

$$\text{NWCInv} = \Delta\text{Noncash current assets} - \Delta\text{Nondebt current liabilities}$$

  - If NWCInv is positive, it means that the company is making additional investment in working capital (cash outflow).
  - If NWCInv is negative, it means that working capital is being freed up (cash inflow).
  - It is usually assumed that investment in net working capital is recovered at the termination of the project.

Working capital is defined in this use as current assets (excluding cash and equivalents) minus current liabilities (excluding short-term debt).

Initial investment outlay for Mega = FCInv + NWCInv
= 550,000 + (60,000 − 20,000) = **$590,000**

2. Annual after-tax operating cash flows (CF) are incremental operating cash flows generated by the project and are calculated as:

$$CF = (S - C - D)(1 - t) + D \text{ or } CF = (S - C)(1 - t) + tD$$

where:
S = Sales
C = Cash operating expenses
t = Tax rate
D = Depreciation

Although depreciation is a noncash expense, it has an impact on operating cash flow as it reduces the amount of taxes paid by the company. The higher the depreciation charged by the company, the higher the resulting tax savings. Therefore, the depreciation method applied by a company has important implications on the amount and timing of a project's after-tax cash flows.

CF for Mega = (S − C)(1 − t) + tD
= (300,000 − 100,000) (1 − 0.4) + (0.4 × 90,000) = **$156,000**

3. Terminal year after-tax nonoperating cash flow (TNOCF) includes:
   - The selling price of fixed capital assets (Sal_T) on termination date (T).
   - Recovery of working capital investment (NWCInv).
   - Taxes on gain on sale ($Sal_T - BV_T$) of fixed capital assets (cash outflow).

$$TNOCF = Sal_T + NWCInv - t(Sal_T - BV_T)$$
$$= 150,000 + 40,000 - [0.4\ (150,000 - 100,000)] = \textbf{\$170,000}$$

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590,000 [+/-]
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326,000 [ENTER]
[NPV]
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[CPT]
NPV = $106,919.36

The NPV of the project can be calculated as the sum of the present values of:

- An initial investment outlay of $590,000 at t = 0
- An annuity of $156,000 for 5 years from t = 1 to t = 5
- A single payment of $170,000 received at t = 5

$$\text{NPV} = -590{,}000 + \sum_{t=1}^{5} \frac{156{,}000}{(1.1)^t} + \frac{170{,}000}{(1.1)^5} = \$\mathbf{106{,}919}$$

The Impact of Depreciation Methods on Cash Flow Projections

Companies can choose between a variety of depreciation methods including the straight-line, sum-of-years digit, double-declining balance, and units-of-production methods. Further, certain jurisdictions allow companies to use different depreciation methods for financial and tax reporting purposes. Companies in those jurisdictions prefer to use accelerated depreciation methods for tax reporting purposes as they result in lower taxes payable in the early years of an asset's life. The MACRS (modified accelerated cost recovery system) is an accelerated depreciation method commonly used in the United States. Table 2-3 presents depreciation rates for different MACRS classes.

Table 2-3: Depreciation Rates under U.S. MACRS

	Recovery Period Class		
Year	**3-Year**	**5-Year**	**7-Year**
1	33.33%	20.00%	14.29%
2	44.45%	32.00%	24.49%
3	14.81%	19.20%	17.49%
4	7.41%	11.52%	12.49%
5		11.52%	8.93%
6		5.76%	8.93%
7			8.93%
8			4.45%

- MACRS uses the double-declining balance method (150% declining balance for the 15- and 30-year classes) for the initial years of the asset's life.
- MACRS switches to straight-line depreciation when optimal (i.e., when straight-line depreciation would be at least as large as depreciation under the declining balance method used in the initial years).
- MACRS uses the half-year convention, which means that the asset is placed in service in the middle of the first year.

Table 2-4 calculates the present value of tax savings for Mega if it were to use MACRS 3-year class depreciation:

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Table 2-4: MACRS 3-Year Depreciation for Mega

Year	Depreciation Expense	Tax Savings	PV at 10%
1	450,000 × 33.33% = $149,985[2]	149,985 × 0.4 = $59,994	$54,540
2	450,000 × 44.45% = $200,025[2]	200,025 × 0.4 = $80,010	$66,124
3	450,000 × 14.81% = $66,645	66,645 × 0.4 = $26,658	$20,029
4	450,000 × 7.41% = $33,345	33,345 × 0.4 = $13,338	$9,110
5	Zero		
Total	**$450,000**[1]	**$180,000**[3]	**$149,803**[4]

1. Total depreciation expense is the same under straight-line and MACRS depreciation ($450,000).
2. However, MACRS allocates a larger proportion of total depreciation expense over the life of the asset to the early years of its useful life.
   - Year 1 MACRS dep = $149,985 versus Year 1 straight-line dep = $90,000
   - Year 2 MACRS dep = $200,025 versus Year 2 straight-line dep = $90,000
3. Total depreciation tax savings are identical under both methods ($180,000).
4. The PV of tax savings is higher under MACRS depreciation.
   - PV tax savings MACRS = $149,803 versus PV tax savings straight line = $136,468.
5. Therefore, NPV and IRR are higher when MACRS depreciation is used.
   - NPV MACRS = $120,254 versus NPV straight-line method = $106,919
   - IRR MACRS = 17.35% versus IRR straight-line method = 16.12%

Accelerated depreciation methods result in greater tax savings in the early years of a capital project compared to the straight-line method. Therefore, all other factors remaining the same, accelerated depreciation methods result in a greater net present value (NPV) for a project compared to straight-line depreciation.

REPLACEMENT PROJECTS

Cash flow analysis for a replacement project is more complicated because analysts must deal with the differences between cash flows that occur with the new investment and cash flows that would have occurred from the old investment (the one being replaced).

Cash Flows for a Replacement Project

Let's work with the following example to illustrate capital budgeting decisions for a replacement project:

The management of Mega Builders is considering replacing an old piece of equipment. The following information is provided:

- The equipment it wants to replace (old equipment) was purchased 5 years ago for $1.5m. It had a useful life of 15 years and the company applies straight-line depreciation with zero salvage value. The equipment's current market value is $1.2m. If the company keeps using it, this piece of equipment will generate annual sales of $200,000 and incur annual cash operating expenses of $120,000. At the end of its useful life, the company expects to sell the equipment for $125,000.

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- The new equipment will cost $2.5m and will be depreciated on a straight-line basis over 10 years with zero salvage value. The company expects to be able to sell it for $600,000 after 10 years. The new equipment will require an additional investment of $200,000 in working capital (on top of the working capital invested in the old equipment). It is expected to generate annual sales of $600,000 and require annual cash operating expenses of $300,000.

The company's marginal tax rate is 40%. Given a required rate of return of 10%, determine whether the company should replace the old equipment with new one.

Investment outlays

The initial investment (cash outflow) for a replacement project is reduced by the salvage value of the equipment being replaced (cash inflow) and increased by taxes paid on any gain on sale of the equipment being replaced (cash outflow).

The current book value (BV) of old equipment (5 years into its useful life) equals $1.5m – (100,000 × 5) = **$1,000,000**

$$\text{Initial investment for a replacement project} = FCInv + NWCInv - Sal_0 + t(Sal_0 - BV_0)$$

$$\text{Initial investment} = 2{,}500{,}000 + 200{,}000 - 1{,}200{,}000 + [0.4 \times (1{,}200{,}000 - 1{,}000{,}000)]$$
$$= \mathbf{\$1{,}580{,}000}$$

Annual after-tax operating cash flow

When calculating after-tax operating cash flow for replacement projects, we only consider the changes in cash flow that result from the replacement.

Annual depreciation on the new equipment will be $2.5m/10 = **$250,000.**

$$\Delta CF = (\Delta S - \Delta C)(1 - t) + t\Delta D$$

$$\Delta CF = \{[(600{,}000 - 200{,}000) - (300{,}000 - 120{,}000)] \times (1 - 0.4)\} + [(250{,}000 - 100{,}000) \times 0.4]$$
$$\Delta CF = 132{,}000 + 60{,}000 = \mathbf{\$192{,}000}$$

Terminal year after-tax nonoperating cash flow

At the end of the project, fixed capital is sold and taxes are paid on any gain on sale. Since only incremental cash flows are relevant in the analysis of a replacement project, terminal year after-tax non operating cash flow consists of:

- Incremental cash flow over the selling price of old equipment:
  - $600,000 – $125,000 = $475,000
- Recovery of additional investment in net working capital, $200,000.
- Incremental cash flow from taxes on gains on disposal:
  - 0.4(600,000 – 0) – 0.4(125,000 – 0) = $190,000

$$TNOCF = Sal_T + NWCInv - t(Sal_T - B_T)$$

$$TNOCF = 475{,}000 + 200{,}000 - 190{,}000 = \mathbf{\$485{,}000}$$

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$$\text{The NPV of the project equals: NPV} = -1{,}580{,}000 + \sum_{t=1}^{10} \frac{192{,}000}{(1.1)^t} + \frac{485{,}000}{(1.1)^{10}}$$

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NPV = –$213,254.62
IRR = 7.18%

NPV = –$213,254.62
IRR = 7.18%

Conclusion: It does not make sense for the company to replace the equipment as NPV of the replacement decision is negative and IRR is less than the cost of capital.

Spreadsheet Modeling

Capital budgeting makes heavy use of spreadsheets such as Microsoft Excel® because:

- They provide an effective way for building very complex models.
- They have a lot of built-in functions that are easy to use.
- Model assumptions can be changed and solved for easily.
- They can be shared with others and can be used for making presentations.

LOS 23b: Explain how inflation affects capital budgeting analysis. Vol 3, pp 38–39

Effects of Inflation on Capital Budgeting Analysis

- Analysts must decide whether to perform the analysis in nominal terms or in real terms. Nominal cash flows reflect the effects of inflation, while real cash flows are adjusted to remove the effects of inflation. While the analysis may be undertaken in nominal or real terms, analysts should be careful to use the nominal discount rate to discount nominal cash flows and the real discount rate to discount real cash flows.

$$(1 + \text{Nominal rate}) = (1 + \text{Real rate}) \times (1 + \text{Inflation rate})$$

- Expected inflation is accounted for in discounted cash flow analysis. If inflation is higher than expected, the real value of future cash flows will be lower, reducing the profitability of the project.

- Higher-than-expected inflation increases real taxes as it reduces the value of the depreciation tax shelter (unless the tax system adjusts depreciation for inflation).

- Inflation also affects the value of fixed payments to bondholders. If inflation is higher than expected, the value of real payments to bondholders is lower than expected, shifting wealth from bondholders to issuing companies.

- Inflation does not affect all revenues and costs uniformly. The overall impact on a company's after-tax cash flow depends on how sales quantities and different cost items are affected by inflation.

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LESSON 3: PROJECT ANALYSIS AND EVALUATION

LOS 23c: Evaluate capital projects and determine the optimal capital project in situations of 1) mutually exclusive projects with unequal lives, using either the least common multiple of lives approach or the equivalent annual annuity approach, and 2) capital rationing. Vol 3, pp 39–43

Mutually Exclusive Projects with Unequal Lives

When faced with mutually exclusive projects, a company should choose the project with the highest positive NPV as it would lead to the greatest increase in shareholder wealth. However, if the projects have unequal lives the analysis is a bit more complicated. With unequal lives, analysis of a one-shot (one time only) investment differs from that of an investment chain (in which the project is continuously replicated in the future).

Let's work with an example. Assume that a company can invest in either of the following projects:

	Project A	Project B
Initial investment	$2,000	$1,000
Life of project	4 years	3 years
Annual after-tax cash flows	Year 1: $600	Year 1: $500
	Year 2: $800	Year 2: $800
	Year 3: $1,000	Year 3: $800
	Year 4: $1,200	
Cost of capital	10%	10%
NPV	$777.54	$716.75
IRR	24.89%	44.07%

Project A: Timeline 1

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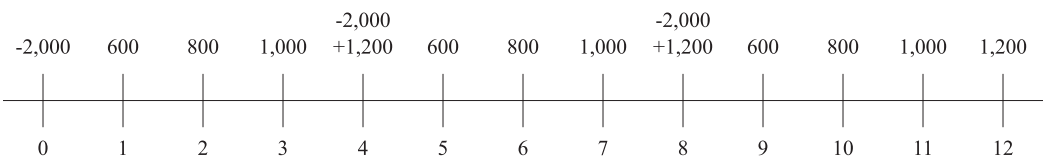
[CPT]
NPV = $1,671.34
[IRR] [CPT]
IRR = 24.89%

Given that the two projects are mutually exclusive, if these were one-shot investments, the company should choose Project A since it has the higher positive NPV. If however, the company needs to replace both projects every time they wear out (i.e., if they are replacement projects) there are two methods that can be used to compare the projects.

1. Least Common Multiple of Lives Approach

In this approach, both projects are repeated until their "chains" extend over the same time horizon. Given equal time horizons, the NPVs of the two project chains are compared and the project with the higher chain NPV is chosen. In the example above, Project A has a life of 4 years, while Project B has a life of 3 years. The least common multiple of 4 and 3 is 12, which means that in order to compare the two projects (over an identical time horizon) we would need to replicate Project A 3 times and Project B 4 times.

Timeline 1: Project A



NPV (Project A 12-year chain) = $1,671.34

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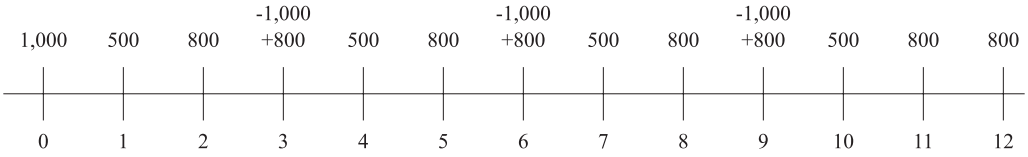
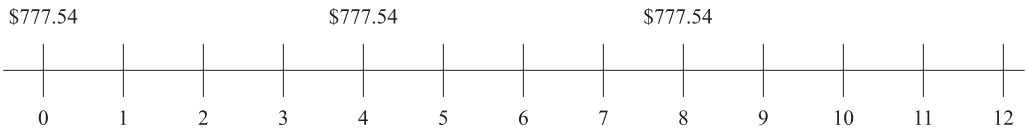
Timeline 2: Project B



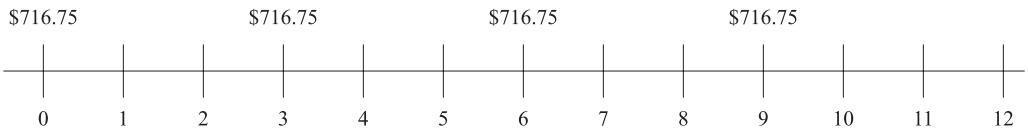
NPV (Project B 12-year chain) = $1,963.82

Timeline 3: Project A



NPV (Project A 12-year chain) = $1,671.34

Timeline 4: Project B



NPV (Project B 12-year chain) = $1,963.82

Over an identical horizon, the replacement chain for Project B has a higher NPV than the replacement chain for Project A. Therefore, the company should choose Project B. Note that this decision is the reverse of the one the company would have made were these projects one-shot investments.

Project A: Timeline 3

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[ENTER] [↓] [CPT]
NPV = $1,671.34

The NPV of a single investment represents the present values of its cash flows. Therefore, you can think of the NPV of a replacement chain as the present value of each link in the chain. This line of thinking is represented in Timelines 3 and 4.

2. Equivalent Annual Annuity Approach (EAA)

This approach calculates the annuity payment (equal annual payment) over the project's life that is equivalent in present value (PV) to the project's NPV. The project with the higher EAA is chosen. For our example, the EAAs of the two projects are calculated as:

Project A: N = 4; I/Y = 10; PV = –777.54; FV = 0; CPT PMT ⇒ **PMT = $245.29**

Project B: N = 3; I/Y = 10; PV = –716.75; FV = 0; CPT PMT ⇒ **PMT = $288.22**

Since Project B has a higher EAA, it should be chosen over Project A.

Capital Rationing

In an ideal world, companies would be able to invest in all available positive-NPV projects and maximize shareholder wealth. However, companies typically have limited amounts of capital so they must choose between projects and invest the capital budget in a manner that maximizes shareholder wealth given the budgetary constraint. This is known as capital rationing.

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Under capital rationing, a situation may arise where a company chooses a project that has a lower NPV over a project that has a higher NPV in order to maximize shareholder wealth given the budget constraint. Example 3-1 illustrates this.

$$PI = 1 + \frac{NPV}{IO}$$

Example 3-1: Capital Rationing

The management of RVP Builders has a capital budget of $2,000 that it can use to invest in the following projects.

Project	Investment Outlay ($)	NPV ($)	PI	IRR (%)
A	1,200	250	1.21	12
B	200	30	1.15	13
C	600	–45	0.93	7
D	400	80	1.20	11
E	500	150	1.30	10
Total Investment	**2,900**			

Assuming that the projects are not divisible, which project(s) should the company invest in?

Solution:

If the company had an unlimited capital budget, it would invest in Projects A, B, D, and E (all positive-NPV projects). However, given the fixed capital budget ($2,000) the company must choose which project(s) to prioritize, given the aim of shareholder wealth maximization.

When a company has a fixed capital budget, the profitability index (PI) is extremely useful as it measures profitability per unit of investment. If we rank the projects based on their PI's, Project E has the highest PI, followed by Projects A, D and B. Given the fixed budget, the company would definitely invest in Projects E and A (combined investment: $1,700; combined NPV = $400), but would only have $300 left over, which is insufficient to undertake Project D (the next most-lucrative project). However, it can accept Project B, and maximize NPV (given the budget constraint) at $430 with a total capital investment of $1,900.

It is important for you to understand that the company would prefer Project D over Project B as it has a higher NPV. Unfortunately however, investing in Projects A, D, and E would require a combined investment of $2,100, which exceeds the fixed budget. In this respect, capital rationing may result in outcomes that violate market efficiency (which requires the allocation of funds to their highest and best uses).

There are two types of capital rationing:

- Under hard capital rationing, the budget is fixed. In such situations, managers should use the NPV and PI capital budgeting methods. Note that choosing the optimal combination of capital projects can be computationally intensive.
- Under soft capital rationing, managers may be allowed to exceed their budgets if they can convince senior management that the projects will enhance shareholder wealth.

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LOS 23d: Explain how sensitivity analysis, scenario analysis, and Monte Carlo simulation can be used to assess the stand-alone risk of a capital project. Vol 3, pp 43–49

Stand-Alone Risk

The stand-alone risk of a capital project is measured in terms of the dispersion of its outcomes (the project's possible NPVs or IRRs). Stand-alone risk depends on the variation of the project's cash flows. Methods of evaluating stand-alone risk include sensitivity analysis, scenario analysis, and simulation analysis. We will work with the following base-case numbers for Contour Builders to illustrate the different approaches for evaluating stand-alone risk (see Table 3-1):

Table 3-1: Contour Builders – Base-Case Scenario

	Base Value
Unit price	$10
Annual unit sales	20,000
Variable costs per unit	$4.00
Investment in fixed capital	$250,000
Investment in working capital	$30,000
Project life	5 years
Annual depreciation	$50,000
Expected salvage value	$40,000
Tax rate	40%
Required rate of return	10%

Sensitivity Analysis

Sensitivity analysis determines the impact on NPV of changes in one input variable at a time holding all other input variables constant. This enables an analyst to identify the most significant variables in the analysis in terms of their effect on NPV, and their influence on the success/failure of the project.

Let's evaluate the impact of a 15% change in unit price, annual unit sales, variable cost per unit, and salvage value on the NPV of the project.

We first calculate the base-case NPV using the base-case scenario provided. We then proceed to evaluate the impact of a change in each of the input variables (one by one) by changing its value by 15% and calculating revised NPVs. For example, in order to evaluate the impact of a change in unit price, we decrease it by 15% (to $8.50) and increase it by 15% (to $11.50) and calculate NPVs holding all other input variables constant. Table 3-2 summarizes the results of the sensitivity analysis.

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This value has been calculated with unit price = $8.50 and all other variables taking their base-case values.

This value has been calculated with unit price = $11.50 and all other variables taking their base-case values.

Table 3-2: Sensitivity of Project NPV to Changes in Input Variables

Variable	NPV if Value Decreases 15%	Base-Case NPV	NPV if Value Increases 15%	Range of NPV Estimates
Annual sales	$61,341.64	$102,282.13	$143,222.63	±40.03%
Unit price	$34,047.97	$102,282.13	$170,516.30	±66.71%
Variable costs per unit	$129,575.80	$102,282.13	$74,988.47	±26.68%
Expected salvage value	$100,046.82	$102,282.13	$104,517.45	±2.19%

- Unit price has the most impact on the NPV of the project as changes in unit price result in the broadest range of NPV estimates (±66.7%).
- Changes in expected salvage value have the least significant impact on NPV (±2.19%).

Scenario Analysis

While sensitivity analysis allows us to evaluate the impact of a change in one input variable on NPV, scenario analysis calculates the NPV of a project in a number of different scenarios where each scenario consists of changes in several input variables. The greater the dispersion in NPV across the given scenarios, the higher the risk of the project.

Let's evaluate the risk of Contour's project by examining NPVs under the three scenarios presented in Table 3-3.

Table 3-3: Contours Project – Possible Scenarios

	Pessimistic Scenario	Most Likely Scenario	Optimistic Scenario
Unit price ($)	8.50	10.00	11.50
Annual sales (units)	17,000	20,000	23,000
Variable costs per unit ($)	4.60	4.00	3.40
Investment in fixed capital ($)	250,000	250,000	250,000
Investment in working capital ($)	30,000	30,000	30,000
Project life (years)	5	5	5
Annual depreciation ($)	50,000	50,000	50,000
Expected salvage value ($)	34,000	40,000	46,000
Tax rate (%)	40	40	40
Required rate of return (%)	10	10	10

The project's NPV in each of the three scenarios is provided in Table 3-4.

Table 3-4: Contour-Scenario Analysis

	Pessimistic Scenario	Most Likely Scenario	Optimistic Scenario
Investment Outlays	$280,000	$280,000	$280,000
ATOCF	$59,780	$92,000	$131,780
TNOCF	$50,400	$54,000	$57,600
NPV	–$22,092.33	$102,282.13	$255,314.95
Change in NPV	–121.60%	**IRR = 22.54%**	+149.62%

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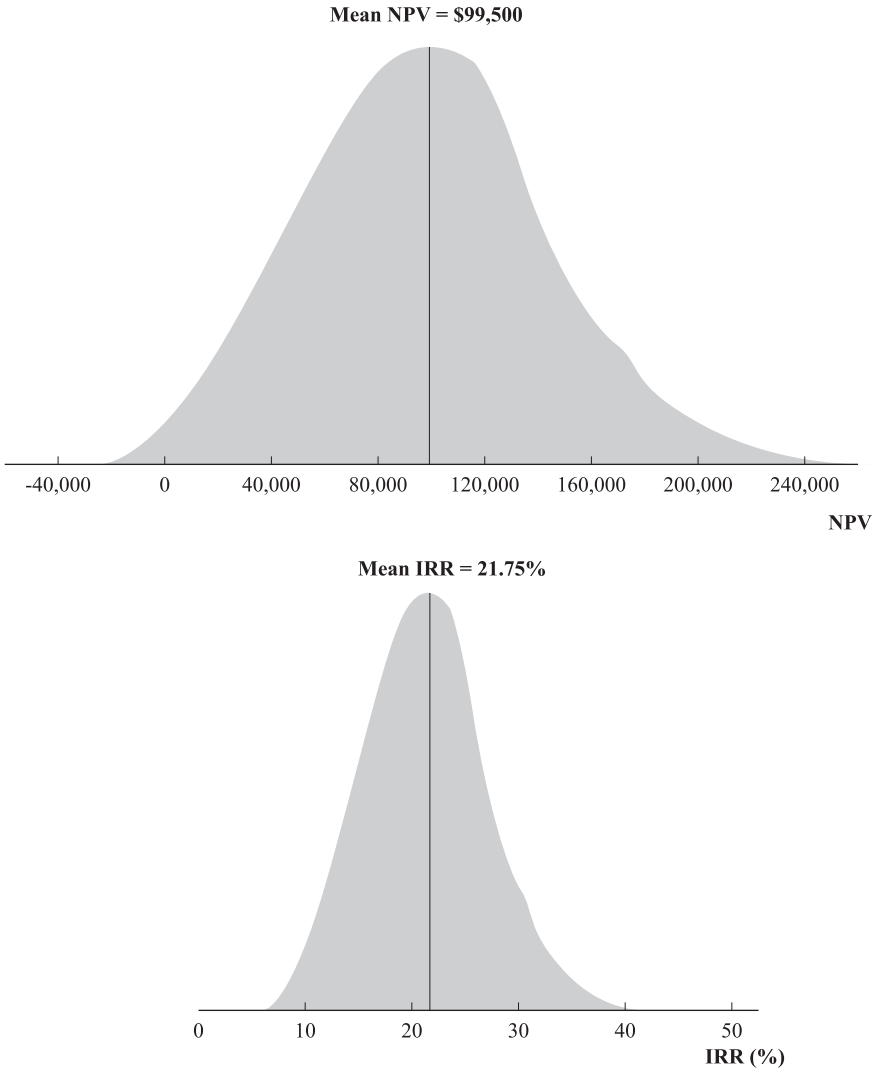
- The scenario analysis reflects the possibility of an unprofitable (negative-NPV) investment.
- The range of NPVs is very large relative to the initial outlay, which suggests that the investment is quite risky.
- Note that we have only evaluated three scenarios in this example. Management can expand the analysis to include other scenarios as well.

Simulation (Monte Carlo) Analysis

In simulation analysis, we estimate a probability distribution of outcomes for a project's NPV and IRR. Instead of using point estimates for input variables (as is the case in sensitivity and scenario analysis) we can define probability distributions for each of them. The simulation can be run thousands of times to come up with a distribution for possible values of NPV and IRR. Figure 3-1 illustrates the probability distributions for NPV and IRR for Contour's project.

Figure 3-1: Probability Distributions for NPV and IRR



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- Both the curves resemble the normal distribution. As the number of observations (iterations) increases, the distribution of outcomes approaches the normal distribution.
- Both the curves are skewed to the right (positive skewness).
- The mean NPV and IRR values from the simulation are fairly close to the base-case/most likely scenario NPV and IRR (calculated based on point estimates of input variables) of $102,282.13 and 22.54%, respectively. Note that this need not be the case all the time.
- The distributions show how the project's NPV and IRR vary under different assumptions. They offer management more information than simple mean NPV and IRR figures.
- Statistical output may include correlations between different input variables and NPV (and IRR). These correlations can be interpreted as sensitivity factors. The higher the correlation between an input variable and NPV, the more significant the impact of the variable on NPV.

LOS 23e: Explain and calculate the discount rate, based on market risk methods, to use in valuing a capital project. Vol 3, pp 49–52

Market Risk

Our approach to capital budgeting is to discount expected cash flows at a risk-adjusted cost of capital. An alternative approach, which is also conceptually sound, is the "certainty-equivalent method." In this method, certainty-equivalent cash flows (expected cash flows that are reduced to certainty equivalents) are valued by discounting them at a risk-free discount rate. However, the use of risk-adjusted discount rates is more intuitive and much more popular.

Market risk depends not only on the variation of a project's cash flows but also on how those cash flows correlate with market returns. When using market risk measures, the applicable discount rate should reflect the rate of return required by a diversified investor, and the risk premium should only reflect factors that are priced in the marketplace (as opposed to those that can be diversified away). Analysts typically use the capital asset pricing model (CAPM) to calculate this discount rate (although others like the APT can also be used). The CAPM breaks down total risk into:

- Systematic risk that is related to the market and is nondiversifiable. It is typically measured by beta (ß). Only systematic risk is priced in the market. Diversified investors demand a risk premium for bearing systematic risk.
- Unsystematic risk is nonmarket risk that can be diversified away.

The security market line (SML) expresses the asset's required rate of return as a function of ß (systematic risk).

$$\text{SML: } R_i = R_F + ß_i\,[E(R_M) - R_F]$$

Stand-alone risk measures (such as the dispersion of a project's expected NPVs and IRRs) are inappropriate when the company is diversified or when its shareholders are diversified investors.

where:
R_i = Required return for project or asset i

R_F = Risk-free rate of return
$ß_i$ = Beta of project or asset i
$[E(R_M) - R_F]$ = Market risk premium

According to the SML, the required rate of return (or hurdle rate) varies with each project according to its systematic risk (beta). The required rate of return can be used to calculate NPVs and to evaluate IRRs, and then to make capital budgeting decisions. See Example 3-2.

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Example 3-2: Using the SML to Find the Required Rate of Return for a Project

The management of Beta Construction is provided with the following information regarding a new investment. Determine whether the company should invest in the project.

- Initial outlay = $500,000
- Annual after-tax operating cash flows = $120,000
- Project life = 5 years
- Terminal year after-tax nonoperating cash flow = $230,000
- Risk-free rate = 5.5%
- Expected market return =10.5%
- Project beta=1.10

Solution

First, we use the SML to determine the required rate of return for the project.

$R_i = R_F + ß_i[E(R_M) - R_F] = 5.5\% + 1.1[(10.5\% - 5.5\%)] = 11\%$

Given a hurdle rate of 11%, NPV equals $80,001.45. The IRR equals 16.18%. Both these capital budgeting techniques indicate that the company should invest in the project.

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350,000 [ENTER]
[NPV]
11 [ENTER] [↓]
[CPT]
NPV = $80,001.45
IRR = 16.18%

Using project betas to determine hurdle rates is particularly important when a project's risk differs from the company's overall level of risk. The cost of capital (WACC) reflects the riskiness of the company's assets and its financial structure. It represents the average risk of all projects undertaken by the company. Using the WACC as the discount rate will result in an overstated NPV for a relatively risky project, and an understated NPV for a relatively conservative project.

LOS 23f: Describe types of real options and evaluate a capital project using real options. Vol 3, pp 52–56

Real options are capital budgeting options that give managers the right but not the obligation to make a capital budgeting decision in the future. These decisions have the potential to alter the value of capital budgeting decisions made today. Real options are options on real assets and are contingent upon future events. They offer greater business flexibility to managers and increase the NPV of projects.

Types of Real Options

- Timing options give the company an option to delay making an investment (until hopefully, improved information becomes available that facilitates better decision making).
- Sizing options include:
  - Abandonment options, which give the company an option to abandon the project. An abandonment option will typically be exercised if the cash flow from abandoning the project exceeds the present value of the cash flows from continuing it.

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    - Growth options, which give the company an option to expand a project. A growth option is typically exercised if future financial performance is expected to be strong.
- Flexibility options give managers choices regarding certain operational aspects of the project. They include:
    - Price-setting options, which give the company an option to change prices.
    - Production-flexibility options, which give the company an option to change output quantities (e.g., by paying workers overtime wages).
- Fundamental options are essentially options embedded in the project itself. For example, for a company that owns an oil well, the decision to drill is governed by the price of oil. If oil prices are too low, the company will choose not to drill; if oil prices are high enough, the company will go ahead and drill.

Approaches to Evaluating Projects with Real Options

- Use DCF analysis without considering real options. If the NPV of the project is positive without considering real options, then it is safe to assume that the project will be even more profitable after accounting for the value of the real option, so the project should be accepted.
- Adjust the project's NPV for the net value of real options. Calculate the NPV of the project without considering real options and then evaluate whether the option value net of its cost is adequate to make the investment feasible. For example, if a project's NPV (based on DCF analysis) equals −$25 million, the company should accept the project only if the net value of any embedded real options is expected to exceed $25 million.
- Use decision trees. While they are not as useful for calculating the value of a real option, decision trees improve decision making by clearly describing the sequence of events along a project's life.
- Use option-pricing models. Although they may be used to value options, option-pricing models typically involve complex calculations which may require the services of special consultants. See Example 3-3.

Example 3-3: Evaluating a Project with Real Options

Consider a project with the following details:

- Initial outlay = $550,000
- Project life = 5 years
- Salvage value at termination = $0
- Required rate of return = 10%
- There is a 50% probability that annual after-tax operating cash flows will be $90,000 and a 50% probability that they will equal $180,000.
- At the end of Year 1, the company will be able to decide whether to abandon the project or to continue. If it decides to abandon the project, the company will receive a salvage value of $400,000.

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1. Calculate the value of the project without the abandonment option.
2. Calculate the value of the project with the abandonment option and determine the value of the option.

Solution:

1. Expected annual after-tax cash flows = $(90{,}000 \times 0.5) + (180{,}000 \times 0.5) = \$135{,}000$
   The NPV of the project equals:

$$\text{NPV} = -550{,}000 + \sum_{t=1}^{5} \frac{135{,}000}{(1.1)^t} = -\$\mathbf{38{,}243.79}$$

   Without considering the real option, the project has a negative NPV so it should be rejected.

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[CPT]
NPV = –$38,243.79

2. At the end of one year, if the project generates $90,000, it should be abandoned. The present value of the remaining cash flows forgone if the project is abandoned (PV of 4 annual payments of $90,000 discounted at 10% = $285,288) is less than the salvage value at the end of Year 1 ($400,000).

   However, if the project generates $180,000 in Year 1, it should be continued as the present value of the remaining cash flows (PV of 4 annual payments of $180,000 discounted at 10% = $570,576) is greater than the salvage value at the end of Year 1 ($400,000).

   The NPV of the project if it is abandoned at the end of Year 1 can be calculated as:

$$\text{NPV} = -550{,}000 + \frac{90{,}000}{(1.1)^1} + \frac{400{,}000}{(1.1)^1} = -\$\mathbf{104{,}545.45}$$

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490,000 [ENTER]
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NPV = –$104,545.45

   The NPV of the project if it is continued can be calculated as:

$$\text{NPV} = -550{,}000 + \sum_{t=1}^{5} \frac{180{,}000}{(1.1)^t} = \$\mathbf{132{,}341.62}$$

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180,000 [ENTER]
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5 [ENTER] [NPV]
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[CPT]
NPV =$132,341.62

   Expected NPV with abandonment option:

$$\text{NPV} = [0.5 \times (-104{,}545.45)] + (0.5 \times 132{,}341.62) = \$\mathbf{13{,}898.08}$$

   After accounting for the abandonment option, the project has a positive NPV so it should be accepted.

If the value of the real option exceeds its cost, the NPV of the project increases.

   Value of the abandonment option:

   = NPV (with abandonment option) – NPV (without abandonment option)
   = 13,898.08 – (–38,243.78)
   = **$52,141.871**

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LOS 23g: Describe common capital budgeting pitfalls. Vol 3, pp 56–57

Common Capital Budgeting Pitfalls

- Not incorporating economic responses of other market participants into the analysis. For example, an investment may initially appear to be very successful, but if low barriers to entry allow rival firms to enter the market, the resulting loss in market share would hurt profitability in the long run.
- Misusing capital budgeting templates. Use of a standardized template to make capital budgeting decisions may be inappropriate if the project under consideration is different in certain material aspects from the average project considered by the company. Another possible error is using inaccurate input values in the analysis.
- Pet projects of senior managers. These projects may not be scrutinized too thoroughly and may be pushed through by influential managers to satisfy personal interests.
- Basing investment decisions on EPS, net income, or return on equity instead of incremental cash flows. A manager's compensation is often linked to a company's earnings, which may encourage her to concentrate on the company's reported net income rather than on overall shareholder wealth. As a result, some projects with positive NPVs may not be undertaken if they have an adverse impact on earnings in the short run.
- Using IRR instead of NPV to make investment decisions. For mutually exclusive projects, basing capital budgeting decisions on IRR may result in the company choosing smaller, short-term projects with high IRRs at the expense of larger, long-term, high-NPV projects. The IRR only works for independent projects with conventional cash flow patterns. NPV is the capital budgeting technique that is most economically sound.
- Bad accounting for cash flows. Common mistakes include omitting relevant cash flows, double counting cash flows, and mishandling taxes.
- Over- or underestimation of overhead costs. It is very difficult to accurately estimate the proportion of overhead costs (including costs of IT support, management time, and financial systems) applicable to a particular project, so managers often misestimate these costs.
- Not using the appropriate risk-adjusted discount rate. The discount rate used to evaluate a project should reflect the risk associated with that particular project. High-risk projects should not use the WACC as the discount rate as the WACC only reflects the risk of the average-risk project of the firm.

For example, even if a project is financed entirely with debt, its cash flows should be discounted at the required rate of return for the project, not the firm's cost of debt.

- Over-/underspending the investment budget. Some managers tend to spend their entire budgets just so that they can ask for more funds in the future. Ideally, a manager should leave the capital budget underutilized if she fails to identify profitable investment opportunities, and should make a compelling case for more funds if the budget is too small.
- Failure to consider investment alternatives. The first step in the capital budgeting process is to identify good investment opportunities. However, once a manager finds a good enough investment, she may rule out the possibility of an even better one.
- Handling sunk costs and opportunity costs incorrectly. Managers may incorrectly include sunk costs in analyzing a particular project, or ignore the opportunity costs of a project in their analysis.

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LESSON 4: OTHER INCOME MEASURES AND VALUATION MODELS

LOS 23h: Calculate and interpret accounting income and economic income in the context of capital budgeting. Vol 3, pp 58–62

Evaluation of capital projects may also be based on:

- Economic income and accounting income
- Economic profit valuation
- Residual income valuation
- Claims valuation

We will use the following information to illustrate each of these methods:

Jupiter Inc. is considering a project that requires an initial investment of $500,000. Sales will amount to $300,000 in the first year, and are expected to increase by 3% every year. Variable cash operating expenses are expected to equal 50% of sales each year, while fixed cash operating expenses will be $25,000 a year. The project will be depreciated on a straight-line basis to zero over its 5-year useful life. However, the company expects the market value of fixed capital at the end of 5 years to be $150,000. The company's marginal tax rate and the required rate of return are 40% and 10%, respectively.

Given this information, we can calculate the NPV of the project as follows in Table 4-1:

Table 4-1: Capital Budgeting Example for Jupiter Inc.

Year	0	1	2	3	4	5
Fixed capital investment	–500,000					
Sales		300,000	309,000	318,270	327,818	337,653
Variable cash expenses		150,000	154,500	159,135	163,909	168,826
Fixed cash expenses		25,000	25,000	25,000	25,000	25,000
Depreciation		100,000	100,000	100,000	100,000	100,000
Operating income before taxes		25,000	29,500	34,135	38,909	43,826
Taxes at 40%		10,000	11,800	13,654	15,564	17,531
Operating income after taxes		15,000	17,700	20,481	23,345	26,296
Add back: Depreciation		100,000	100,000	100,000	100,000	100,000
After-tax operating cash flow		115,000	117,700	120,481	123,345	126,296
Salvage value						150,000
Taxes on salvage value						60,000
After-tax salvage value						90,000
Total after-tax cash flow	**–500,000**	**115,000**	**117,700**	**120,481**	**123,345**	**216,296**
NPV at 10%	**10,886**					
IRR	**10.77%**					

An NPV of $10,886 means that the value of the project/ asset equals $500,000 + $10,886 = **$510,886**

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Economic Income

Economic income equals the profit realized from an investment. For a given year, economic income equals the sum of after-tax operating cash flow and the change in the investment's market value.

Economic income = After-tax operating cash flow + Increase in market value
Economic income = After-tax operating cash flow + (Ending market value – Beginning market value)
Economic income = After-tax operating cash flow – (Beginning market value – Ending market value)
Economic income = After-tax cash flows – Economic depreciation

Note that interest expense is ignored in the calculation of after-tax operating cash flows that are used to determine economic income. Financing costs are reflected in the discount rate.

We have already calculated annual after-tax operating cash flows for Jupiter in Table 4-1. The market value of the investment at a given point in time equals the sum of the present values of remaining cash flows discounted at the required rate of return. We calculate economic income for Jupiter in Table 4-2.

Table 4-2: Jupiter's Annual Economic Income

Year	1	2	3	4	5
Beginning market value	510,887	446,975	1373,973	290,889	196,633
Ending market value	446,975	373,973	290,889	196,633	0
Change in market value	–63,911	–73,002	–83,084	–94,257	–196,633
After-tax cash flow	115,000	117,700	120,481	123,345	216,296
Economic income	**51,089**	**44,698**	**37,397**	**29,089**	**19,663**
Economic rate of return	10%	10%	10%	10%	10%

For example, the ending market value at the end of Year 2 is calculated as the PV of the 3 remaining after-tax cash flows.
[CF] [2ND] [CE|C] [ENTER] [↓] 120,481 [ENTER] [↓][↓] 123,345 [ENTER] [↓][↓] 216,296 [ENTER] [↓][↓] [I/Y] 10 [ENTER] [↓] [CPT]
NPV = $373,972.58

The economic rate of return is calculated as economic income divided by beginning market value. Notice that the economic rate of return equals the required rate of return from the project (10%). This should make sense because the required return is used to determine the market value of the company.

Accounting Income

Accounting income refers to a company's net income. It differs from economic income in the following ways:

- Economic income ignores interest expenses, whereas accounting income subtracts interest expenses to arrive at net income.
- Economic depreciation is based on changes in the market value of the investment, whereas accounting depreciation is based on the original cost of the investment.

Table 4-3 calculates Jupiter's accounting income assuming that half of the company's beginning market value of $510,887 is financed with debt at a cost of 6%. Table 4-4 lists aggregate values for balance sheet elements and Table 4-5 presents the calculation of annual cash flows.

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Table 4-3: Jupiter's Annual Net Accounting Income

Year	1	2	3	4	5
Sales	300,000	309,000	318,270	327,818	337,653
Variable expenses	150,000	154,500	159,135	163,909	168,826
Fixed expenses	25,000	25,000	25,000	25,000	25,000
Depreciation	100,000	100,000	100,000	100,000	100,000
EBIT	25,000	29,500	34,135	38,909	43,826
Interest expense[1]	15,327	13,409	11,219	8,727	5,899
Earnings before tax	9,673	16,091	22,916	30,182	37,927
Taxes at 40%	3,869	6,436	9,166	12,073	15,171
Net income before salvage value	5,804	9,654	13,749	18,109	22,756
After-tax salvage value					90,000
Net (accounting) income	**5,804**	**9,654**	**13,749**	**18,109**	**112,756**

Table 4-4: Balance Sheet

Year	0	1	2	3	4	5
Assets[2]	500,000	400,000	300,000	200,000	100,000	0
Liabilities[3]	255,443	223,488	186,986	145,445	98,316	0
Net worth	244,557	176,512	113,014	54,555	1,684	0

Table 4-5: Cash Flow Statement

Year	1	2	3	4	5
Net income	5,804	9,654	13,749	18,109	112,756
Depreciation	100,000	100,000	100,000	100,000	100,000
Total[4]	105,804	109,654	113,749	118,109	212,756

1. Interest expense is deducted before calculating accounting net income. Interest expense for Year 1 is calculated as $0.06 \times 255{,}443 = 15{,}327$
2. The book value of assets is based on historical cost less accumulated depreciation.
3. Each year the company retires enough debt to ensure that liabilities equal half of the year-end **market value** of assets. For example:
   - In Year 2, the company retires $223{,}488 - 186{,}986 = \$36{,}502$ worth of liabilities.
   - Year 1 liabilities ($223,488) equal half of Year 1 ending market value of assets ($446,975)
   - Year 2 liabilities ($186,986) equal half of Year 2 ending market value of assets ($373,973)
4. The company uses its annual cash flow to make principal repayments on liabilities and distributes the remainder to shareholders in the form of share repurchases/dividends. For example:
   - Cash flow for Year 2 equals $109,654
   - Principal repayment on debt over Year 2 amounts to: $36,502
   - Therefore, distributions to shareholders for Year 2 amount to: $109{,}654 - 36{,}502 = \$73{,}152$

Make sure you understand each of these points and the calculations performed here. These calculations provide the inputs used in the models described in the next LOS. Annual distributions to shareholders are listed in Table 4-8.

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Note:

- Accounting and economic income are substantially different.
- Over the 5 years, economic income is lower than accounting income and their patterns also differ.

LOS 23i: Distinguish among the economic profit, residual income, and claims valuation models for capital budgeting and evaluate a capital project using each.

Vol 3, pp 62–65

Economic Profit

Economic profit measures the profit earned by the company above and beyond the cost of capital invested in the project. The cost of capital reflects the amount that the company must earn in order to pay debt and equity holders their required rates of return.

$$\text{Economic profit} = [\text{EBIT}(1 - \text{Tax rate})] - \$\text{WACC}$$

$$\text{Economic profit} = \text{NOPAT} - \$\text{WACC}$$

where:
EBIT = Earnings before interest and tax
NOPAT = Net operating profit after tax
$WACC = Dollar cost of capital = Cost of capital (%) × Invested capital

For illustrative purposes, we calculate economic profit for Jupiter for Year 1 below:

$$\text{NOPAT} = \text{EBIT}(1 - \text{Tax rate}) = 25{,}000(1 - 0.4) = \$15{,}000$$
$$\$\text{WACC} = 0.10 \times \$500{,}000 = \$50{,}000$$
$$\text{EP} = 15{,}000 - 50{,}000 = -\$35{,}000$$

Jupiter's economic profit for each year of the project is calculated in Table 4-6.

Table 4-6: Jupiter's Annual Economic Profit

Year	1	2	3	4	5
Capital	500,000	400,000	300,000	200,000	100,000
NOPAT	15,000	17,700	20,481	23,345	116,296
$WACC	50,000	40,000	30,000	20,000	10,000
Economic Profit	**–35,000**	**–22,300**	**–9,519**	**3,345**	**106,296**

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22,300 [+/-]
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9,519[+/-] [ENTER]
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3,345 [ENTER]
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106,296 [ENTER]
[NPV]
10 [ENTER] [[↓]
[CPT]
NPV = $10,886.43

Under this approach, a project's NPV is calculated as the sum of the present values of economic profit earned over its life discounted at the cost of capital.

$$\text{NPV} = \text{MVA} = \sum_{t=1}^{\infty} \frac{\text{EP}_t}{(1 + \text{WACC})^t}$$

This NPV is also known as market value added (MVA). For Jupiter, the MVA equals $10,886. The total value of the asset equals MVA plus the original cost of the asset ($500,000) which gives us a total project valuation of **$510,886**.

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Residual Income

Residual income focuses on returns to equity. It is calculated as:

Residual income = Net income for the period – Equity charge for the period

Equity charge for the period = Required return on equity × Beginning-of-period book value of equity

For illustrative purposes, we calculate residual income for Jupiter for Year 1 below:

RI = 5,804 – 0.164(244,557) = –$34,303.35

- Given a cost of capital of 10%, a cost of debt of 6%, a tax rate of 40%, and a debt-asset ratio of 50%, the cost of equity equals 16.4%.
- Given total assets at Year 0 of $500,000 and beginning liabilities as $255,443, beginning equity at Year 0 equals 500,000 – 255,443 = $244,557 (see Table 4-4).

The residual income for all 5 years for Jupiter is calculated in Table 4-7.

Table 4-7: Jupiter's Annual Residual Income

Year	1	2	3	4	5
Net income	5,804	9,654	13,749	18,109	112,756
Equity (beginning)	244,557	176,512	113,014	54,555	1,684
Required return on equity	40,107	28,948	18,534	8,947	276
Residual income	**–34,303**	**–19,294**	**–4,785**	**9,162**	**112,480**

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19,294 [+/-]
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4,785 [+/-] [ENTER]
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9,162 [ENTER]
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112,480 [ENTER]
[NPV]
16.4 [ENTER] [↓]
[CPT]
NPV = $10,886

The RI approach calculates value from the perspective of equity holders only. Therefore, future residual income is discounted at the **required rate of return on equity** to calculate NPV.

$$NPV = \sum_{t=1}^{\infty} \frac{RI_t}{(1+r_E)^t}$$

NPV = $10,886

The value of the asset/project is calculated as the sum of the equity investment ($244,557), debt investment ($255,443), and present value of residual income ($10,886), which is **$510,886**.

Claims Valuation

This approach values a firm as the sum of the values of claims of debt and equity holders against the firm's assets. First, we separate the cash flows available to debt and equity holders, and then discount them at their respective required rates of return. Cash flows available to debt holders are discounted at the cost of debt, while cash flows available to equity holders are discounted at the cost of equity. The present values of the two cash flow streams are added to calculate the total value of the company/asset.

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Table 4-8 identifies the future cash flows to debt and equity holders.

Table 4-8: Cash Flows to Jupiter's Debt and Equity Holders

Year	1	2	3	4	5
Interest payments	15,327	13,409	11,219	8,727	5,899
Principal payments	31,955	36,502	41,541	47,129	98,316
Total debt payments	47,282	49,911	52,760	55,856	104,215
Equity distributions	73,849	73,153	72,208	70,980	114,440

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52,761 [ENTER] [↓][↓]
55,855 [ENTER] [↓][↓]
104,215 [ENTER] [NPV]
6 [ENTER] [↓] [CPT]
NPV = $255,443

- Debt payments equal the sum of interest and principal payments
- All cash flows after making principal repayments are distributed to equity holders. (See Point 4 under Table 4-5 for details.)

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73,848 [ENTER] [↓][↓]
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72,208 [ENTER] [↓][↓]
70,981 [ENTER] [↓][↓]
114,440 [ENTER] [NPV]
16.4 [ENTER] [↓] [CPT]
NPV = $255,443

NPV (cash flows on debt) = $255,443

NPV (cash flows on equity) = $255,443

Value of company = **$510,886**

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