Overview and Learning Objectives

Overview

To compute NPV, we must estimate future cash flows (**size** and **timing**) and determine the appropriate discount rate corresponding to the risk level of future cash flows. This chapter provides a detailed discussion on the guidelines for estimating future cash flows and introduces two factors (**inflation** and **risk**) that should be considered when determining the appropriate discount rate. We also consider how we choose among mutually exclusive machines/projects that have different lives.

Learning Objectives

After reading course materials on this chapter, students should be able to:

- Correctly apply the guidelines of cash flow estimation in the capital budgeting analysis on a project.
- Differentiate nominal versus real cash flows and discount rates, and hence treat the inflation effect in capital budgeting analysis in a consistent manner.
- Differentiate riskless and risky cash flows and discount rates, and hence treat the risk effect in capital budgeting analysis in a consistent manner.
- Explain the biases in investment decision resulted from inconsistent treatments of the inflation and risk effects in capital budgeting analysis.
- Use the Equivalent Annual Cost (EAC) method to choose among mutually exclusive machines/projects with unequal lives, and to decide on the timing of replacing a machine.
- Work through capital budgeting analysis independently.

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Guidelines on Cash Flow Estimation (Ref: Sections 6.1 & 6.4)

Let us first go over the concept of **incremental (or relevant) cash flows**. The easiest way to determine whether a cash flow item is incremental (or relevant) is by asking two questions:

- What will this cash flow be with the project?
- What will this cash flow be without the project?

If the answers differ then this cash flow item is incremental (or relevant), otherwise, it is irrelevant.

A. Incremental (or Relevant) Cash Flows – not accounting earnings – That Should Be Included

1. Incremental (but **not** total) Cash Flows
   - The changes in the firm's future cash flows that are resulted from the acceptance of the project.
2. Opportunity Costs
   - The foregone cash flows due to the acceptance of the project.
   - If at all possible, use the market value of the most valuable foregone alternative to determine the opportunity costs for the project under consideration.
3. Side (or Spillover or Cannibalization) Effects
   - Both **positive** and **negative** impacts of the acceptance of the project on the changes in the future cash flows of other parts of the firm.
   - Remember that the goal is to add value to the firm, not just your division.
4. Net Working Capital (NWC) Investment
   - Cash flows that are associated with changes in net working capital as a result of accepting the project.
   - Recall that NWC investment is for supporting the production and sales activities of the project. Thus, it should be recaptured (recovered) at the termination of the project.

B. Irrelevant Cash Flows That Should NOT be Included

1. Sunk (or Historical) Costs
   - Should **not** include cash flows that have already been incurred and cannot be removed, regardless of the decision on the project.
   - Just because "we have come this far" does not mean that we should continue to throw good money after bad.
2. Financing Costs
   - Should **not** include any cash flows associated with the financing of the project because they are captured in the cost of capital (or discount rate) of the project.
   - For example, dividends payments, principal repayments, etc.
   - Note: Due to the fact that interest expenses are tax deductible, the impacts of using debt financing on cash flow analysis and valuation analysis of a project will be discussed in a later chapter when the topic on interactions between financing and investment decisions is presented.

C. Other Considerations

1. Tax Effects
   - Do the analysis on the after-tax basis!

- Use accelerated depreciation methods to capture tax savings on non-cash charges, e.g., depreciation, as soon as possible!
  - Note that even though depreciation is a non-cash charge, it is included in the cash flow estimation because it generates cash flow in the form of depreciation tax shield (depreciation * marginal tax rate).
- Include the tax effect in sale transactions of assets,
  - Tax effect = (market value − book value) * marginal tax rate

2. Consistent Treatment of Inflation and Risk Effects
   - Discount nominal (or real) risky cash flows with the appropriate, i.e., risk-adjusted, nominal (or real) discount rate.
   - Discount nominal (or real) riskless cash flows with the nominal (or real) riskless discount rate.

D. Computation of Cash Flows for Project Evaluation

1. Cash Flow = Operating Cash Flow (OCF) − Capital Spending (CE) − Change in Net Working Capital (ΔNWC)
   - Recall (Chapter 2): CF(A) = OCF − CE − ΔNWC
   - We usually use income statement information to estimate operating cash flows, i.e., OCF = EBIT − Taxes + Depreciation
     Sometimes the income statement is not available and we can estimate cash flows from operations as follows:
     - Operating Cash Flow = After-tax revenues − After-tax costs + Tax Shield from Depreciation
       Note: Tax Shield from Depreciation=depreciation expense*tax rate
       i.e., OCF = (1 − T) * R − (1 − T) * C + T * Dep
       or OCF = (1 − T) * (R − C) + T * Dep
2. Capital Spending, CE
   - CE = Change in (gross) fixed assets, or
     CE = Change in net fixed assets + Change in accumulated depreciation, or
     CE = Change in net fixed assets + annual depreciation
   - Don't forget including the after-tax salvage value, i.e., sale price of the asset – tax effect of the sale transaction, at the termination of the project!
3. Change in Net Working Capital, ΔNWC
   - NWC = Current Assets − Current Liabilities
   - Recall that an increase (or a decrease) in NWC represents a cash outflow (or inflow).

When applying the cash flow from assets equation (CF(A)) to estimate the incremental (or relevant) cash flow for the project, we should not include any variable related to financing in the estimation.

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The Baldwin Company: An Example (Ref: Section 6.2)

Data and Information:

- Costs of test marketing that were paid last year: $250,000.
- Current market value of proposed factory site (which we purchased at $120,000 five years ago): $150,000.
- Cost of bowling ball machine: $100,000 (depreciated according to ACRS five-year life).
- Estimated the market value of the machine at the end of Year 5: $30,000.
- Production (in units) by year during five-year life of the machine: 5,000, 8,000, 12,000, 10,000, and 6,000.
- Price during first year is $20; price increases 2% per year thereafter.
- Production costs during first year are $10 per unit and increase 10% per year thereafter.
- Annual inflation rate: 5%.
- Net Working Capital: initially $10,000; then it varies with sales (set at 10% of annual sale revenues).
- Corporate tax rate: 34%.
- Discount rate: 10%.

Depreciation for the Baldwin Company

	Recovery Period Class		
Year	3 Years	5 Years	7 Years
1	33.34%	20.00%	14.28%
2	44.44%	32.00%	24.49%
3	14.81%	19.20%	17.49%
4	7.41%	11.52%	12.50%
5		11.52%	8.92%
6		5.76%	8.92%
7			8.92%
8			4.48%

Initial Investment Cash Outlay (CF_0 or IO) at t=0: Download table in Microsoft Excel Spreadsheet

- OCF = 0
- CE = $150,000 + $100,000 = $250,000
- NWC = $10,000
  → CF_0 = 0 − $250,000 − $10,000 = -$260,000

  Note that we exclude the costs of test marketing ($250,000) because it is a sunk cost. We use the current market value of proposed factory site ($150,000 but not $120,000) because it is an example of the opportunity costs.

Cash Flow during the life of the project, say, for Year 3 (CF_3):

- Revenues = 12,000 * $20 * $(1+2\%)^2$ = $249,696
- Costs = 12,000 * $10 * $(1+10\%)^2$ = $145,200
- Depreciation = $100,000 * 19.20% = $19,200
  - EBIT = $(249,696 − 145,200 - 19,200) = $85,296
  - Taxes = 34% * $85,296 = $29,000.64
- OCF = $(85,296 − 29,000.64 + 19,200) = $75,495.36

- CE = 0
- NWC = 10% * $249,696 − 10% * $163,200 = $8,649.60
- CF_3 = $(75,495.36 − 0 − 8,649.60) = $66,845.76

Cash Flow for the terminal year of the project (CF_5):

- Revenues = 6,000 * $20 * $(1+2\%)^4$ = $129,891.86
- Costs = 6,000 * $10 * $(1+10\%)^4$ = $87,846
- Depreciation = $100,000 * 11.52% = $11,520
  - EBIT = $(129,891.86 − 87,846 − 11,520) = $30,525.86
  - Taxes = 34% * $30,525.86 = $10,378.79
- OCF = $(30,525.86 − 10,378.79 + 11,520) = $31,667.07
- Recapture of opportunity cost for factory site = $150,000
- Sale price of the machine = $30,000
- Book value of the machine = $100,000*(1-20%-32%-19.2%-11.52%-11.52%) = $5,760
- Tax effect of the sale transaction = $(30,000 − 5,760) * 34% = $8,241.6
  - After-tax salvage value of the machine = $(30,000 − 8,241.6) = $21,758.4
- CE = $(150,000 + 21,758.4) = $171,758.4
- Recapture of NWC = 0 − 10% * $212,241.60 = -$21,224.16
- **CF_5 = $(31,667.07 + 171,758.40 + 21,224.16) = $224,649.63**

Refer to slides 12-21 for additional illustration of the estimation of cash flow for Baldwin Company. Slides 14-15 focus on the estimation of non-operating cash flows, while slides 16-19 focus on the estimation of operating cash flows. The estimation of cash flows and the net present value analysis are presented in slides 20-21. **Note:** the slight discrepancies in numbers between the above analyses and those on the slides are due to rounding errors.

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Inflation and Capital Budgeting (Ref: Section 6.3)

The relationship between nominal interest rates, real interest rates, and inflation, i.e., the Fisher equation, is:

> **(1 + nominal interest/growth/discount rate) = (1 + real interest/growth/discount rate) * (1 + inflation rate)**

NOTES - (i) The Fisher Equation can be used to convert real growth or interest rate into nominal growth or interest rate. (ii) The nominal growth or interest rate has accounted for the inflation rate according to the Fisher Equation. (iii) The nominal growth rate, which accounts for both real growth rate and inflation rate, should be used to convert real cash flow into nominal cash flow, i.e., nominal CF = real CF * (1 + nominal growth rate).

The important lesson in choosing the appropriate discount rate is to be consistent. Nominal cash flows must be discounted at the nominal interest rate and real cash flows must be discounted at the real interest rate. Similarly, higher risk cash flows should be discounted at the higher risk-adjusted discount rate. Cash flows with the same risk should be discounted at the same interest rate.

Since inflation may affect each cash flow item differently (e.g. depreciation expense does not change with inflation) and the risk of each cash flow may differ, we may want to discount each cash flow item with its appropriate discount rate. The NPV of the project will be the sum of the present value of each cash flow item. In practice, it is often infeasible to take into account varying risk within the same project. With regards to accounting for the effects of inflation, many companies estimate cash flows in nominal terms. Industry trade groups, consulting companies, and the government often provide inflation estimates for specific industries and products.

Example of Capital Budgeting under Inflation – Sony International

Data and Information:

- The required investment on January 1 of this year is $32 million.
- The firm will depreciate the investment to zero using the straight-line method.
- The firm is in the 34% tax bracket.
- The inflation rate is 5%.
- The price of the product on January 1 will be $400 per unit. The price will stay constant in real terms, implying a nominal growth rate of 5% according to the Fisher Equation. Nominal growth rate = (1+0%)*(1+5%)-1 = 5%!
- Labor costs will be $15 per hour on January 1. The will increase at 2% per year in real terms, implying an annual nominal growth rate of 7.1% according to the Fisher Equation. Nominal growth rate = (1+2%)*(1+5%)-1 = 7.1%!
- Energy costs will be $5 per TV; they will increase 3% per year in real terms, implying an annual nominal growth rate of 8.15% according to the Fisher Equation. Nominal growth rate = (1+3%)*(1+5%)-1 = 8.15%!
- The real discount rate for costs and revenues is 8%, implying a nominal discount rate of 13.4% according to the Fisher Equation. Nominal discount rate = (1+8%)*(1+5%)-1 = 13.4%!

Input and Output Unit Data

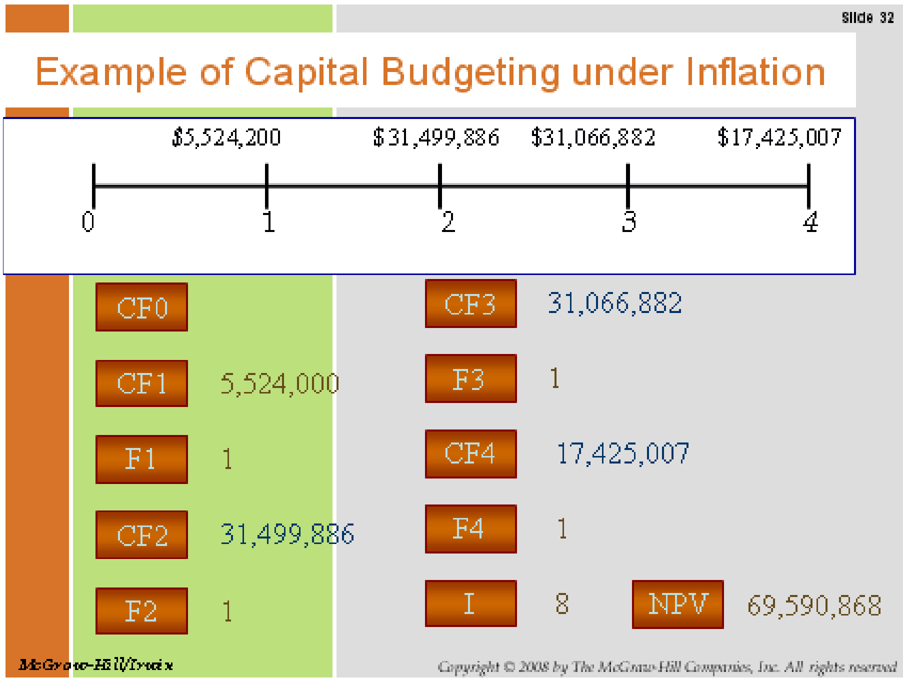
	Year 1	Year 2	Year 3	Year 4

Physical Production (units)	100,000	200,000	200,000	150,000
Labor Input (hours)	2,000,000	2,000,000	2,000,000	2,000,000
Energy Input (physical units)	200,000	200,000	200,000	200,000

Note that the annual depreciation tax shield of $2,720,000 (= $8M * 34%), which is by nature in nominal term, is discounted at the nominal discount rate of 13.4%. This gives us the PV of depreciation tax shield = $8,023,779. (Slide)

The other cash flow components of this project are stated in real term. As such, the cash flows associated with costs and revenues are discounted at the real discount rate of 8%.

- Real Cash Flows
  - Price: $400 per unit with zero real price increase
  - Labor: $15 per hour with 2% real wage increase
  - Energy: $5 per unit with 3% real energy cost increase
- Year 1 After-tax Real Cash Flows:
  After-tax revenues =
  $\$400 \times 100{,}000 \times (1 - .34) = \$26{,}400{,}000$
  After-tax labor costs =
  $\$15 \times 2{,}000{,}000 \times 1.02 \times (1 - .34) = \$20{,}196{,}000$
  After-tax energy costs =
  $\$5 \times 200{,}000 \times 1.03 \times (1 - .34) = \$679{,}800$
  After-tax net operating CF =
  $\$26{,}400{,}000 - \$20{,}196{,}000 - \$679{,}800 = \$5{,}524{,}200$
- Years 2-4 After-tax Real Cash Flows (Slide)



Note that we use the alternative OCF equation (see Page 1.1.1), i.e., **OCF = [(1 − T) * R − (1 − T) * C] + (T * Dep)** that separates the depreciation tax shield from the other operating cash flow components in our analysis. Similarly, we separate the computation of PV of the depreciation tax shield from the computation of PV of real OCF components in determining the NPV of the project.

The project NPV can now be computed as the sum of the PV of the cost, the PV of the real cash flows discounted at the real discount rate and the PV of the nominal cash flows discounted at the nominal discount rate.

NPV = -\$32,000,000 + \$69,590,868 + \$8,023,779 = \$45,614,647

It is critical to be consistent in treating the inflation effect in capital budgeting analysis. As illustrated in this example, we discount nominal cash flows (depreciation tax shield) with the nominal discount rate, and real cash flows with the real discount rate.

Alternatively, we can convert all cash flows into nominal terms, i.e., using the respective annual nominal growth rates to convert real costs and real revenues into nominal costs and nominal revenues, and discount them with the nominal discount rate. In this numerical illustration, we keep the separation of the depreciation tax shield from other components in order to demonstrate that these two approaches are equivalent.

Nominal Cash Flows during the life of the project, say, for Year 3:

- Revenues = 200,000 * \$400 * $(1+5\%)^3$ = \$92,610,000
- Labor Costs = 2,000,000 * \$15 * $(1+7.1\%)^3$ = \$36,854,427
- Energy Costs = 200,000 * \$5 * $(1+8.15\%)^3$ = \$1,264,968
  → R − C = \$(92,610,000 − 36,854,427 − 1,264,968) = \$54,490,605
  → After-tax (R − C) = (1 − 34%) * \$54,490,605 = \$35,963,799

For your reference,

- After-tax (R − C) for Year 1 = \$5,800,410
- After-tax (R − C) for Year 2 = \$34,728,624
- After-tax (R − C) for Year 4 = \$21,180,205

By applying the nominal discount rate of 13.4% to these cash flow components, we get PV = \$69,590,868

With the conversion of real cash flows into nominal cash flows (with the respective annual nominal growth rates) and the application of the nominal discount rate, we get the same *NPV* for the project as -

NPV = -\$32,000,000 + \$69,590,868 + \$8,023,779 = \$45,614,647

For your further reference, here is the **EBIT - Taxes + Depreciation** expression of OCF calculation (see Page 1.1.1) with all cash flows stated in nominal term as we wrap up the discussion of this topic. As you can see in this insert, we come to the same answer for the NPV of Sony International project as NPV = \$45,614,647! (Insert)

You are recommended to reference slides 28 through 32 for further details on the calculations of the yearly real cash flows and their valuation of this Sony project.

In addition to the two detailed numerical illustrations discussed in this section and the previous section (The Baldwin Company), you are strongly encouraged to work through the details on the Dorm Beds example that can be found on slides 50 through 55.

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Investments of Unequal Lives (Ref: Section 6.5)

There are times when application of the NPV rule can lead to the wrong decision. Consider a factory that must have an air cleaner. The equipment is mandated by law, so there is no "doing without."

There are two choices:

- The "Cadillac cleaner" costs $4,000 today, has annual operating costs of $100 and lasts for 10 years.
- The "cheap cleaner" costs $1,000 today, has annual operating costs of $500 and lasts for 5 years.

Which one should we choose?

- The NPV method will lead us to choose the "cheap cleaner" because it has a higher NPV (less negative) than the "Cadillac cleaner."

  At first glance, the cheap cleaner has the lower NPV (r = 10%):

$$NPV_{\text{Cadillac}} = -\$4{,}000 - \sum_{t=1}^{10} \frac{\$100}{(1.10)^t} = -4{,}614.46$$

$$NPV_{\text{cheap}} = -\$1{,}000 - \sum_{t=1}^{5} \frac{\$500}{(1.10)^t} = -2{,}895.39$$

  This overlooks the fact that the Cadillac cleaner lasts twice as long. When we incorporate *that*, the Cadillac cleaner is actually cheaper. However, the NPV analysis does not consider the difference in lives of these two cleaners. As such, the comparison is invalid.

Nature of the Problem

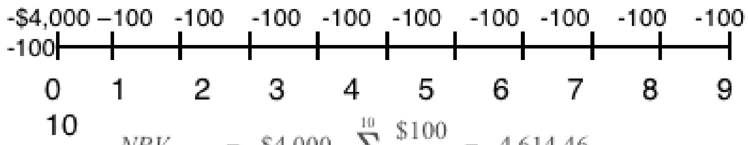
- Choose among mutually exclusive machines that have UNEQUAL lives.

Solutions for the Problem

Investments of unequal lives must be put on a comparable basis, either through matching cycles or through the Equivalent Annual Cost (EAC) method.

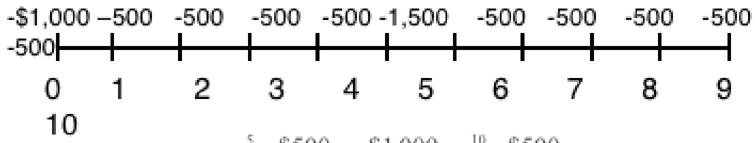
The Matching Cycle Method

- Repeat projects until they begin and end at the same time.
  - Find the least common multiple (LCM) of the respective lives of the projects.
- Compute the NPV for the "repeated projects."
  The Cadillac cleaner time line of cash flows:



$$NPV_{\text{Cadillac}} = -\$4{,}000 - \sum_{t=1}^{10} \frac{\$100}{(1.10)^t} = -4{,}614.46$$

The "cheap cleaner" time line of cash flows *over ten years:*



$$NPV_{\text{cheap}} = -\$1{,}000 - \sum_{t=1}^{5} \frac{\$500}{(1.10)^t} - \frac{\$1{,}000}{(1.10)^5} - \sum_{t=6}^{10} \frac{\$500}{(1.10)^t} = -\$4{,}693.20$$

The Equivalent Annual Cost (EAC) Method

- Applicable to a much more robust set of circumstances than the replacement chain.
- The EAC is the value of the level payment annuity that has the same *PV* as our original set of cash flows.
  - For example, the EAC for the Cadillac air cleaner is $750.98.
  - The EAC for the Cheapskate air cleaner is $763.80, which confirms our earlier decision to reject it.
- EAC is the level payment in the 'equivalent' annuity that has the same PV as our original set of cash flows.
- **Procedures:**
  - **Step 1: Compute the NPV of each alternative.**
  - **Step 2: Compute the equivalent annual cost (EAC) of each alternative such that the present value of EAC's over the life of the alternative will equal the NPV of the alternative.**
    Note: The NPV corresponds to the PV of an annuity while the EAC corresponds to the PMT in an annuity!
- **Criterion:**
  - Select the alternative with the lowest EAC!
- **Example:**
  - For "Cheap Cleaner,"
    Input: CF = -1,000; C01 = … = C05 = -500; I = 10
    → NPV = -2,895.39
    -- Input: N = 5; I/Y = 10; PV = 2,895.39; FV = 0
    → PMT = -763.80 → EAC = **$763.80**
  - For "Cadillac Cleaner,"
    Input: CF = -4,000; C01 = ……… = C10 = -100; I = 10
    → NPV = -4,614.46
    -- Input: N = 10; I/Y = 10; PV = 4,614.46; FV = 0
    → PMT = -750.98 → EAC = **$750.98**
    Choose "Cadillac Cleaner" because it has a lower EAC!

Another Application of the EAC Method (Slide)

- When should we replace the existing equipment?
  - When it is less costly to use the new equipment than to use the old equipment!