Chapter Objective:
This chapter discusses the methodology that a multinational firm can use to analyze the investment of capital in a foreign country.

Chapter Outline
• Review of Domestic Capital Budgeting
• The Adjusted Present Value Model
• Capital Budgeting from the Parent Firm’s Perspective
• Risk Adjustment in the Capital Budgeting Process
• Sensitivity Analysis
• Real Options

Review of Domestic Capital Budgeting

1. Identify the SIZE and TIMING of all relevant cash flows on a time line.
2. Identify the RISKINESS of the cash flows to determine the appropriate discount rate.
3. Find NPV by discounting the cash flows at the appropriate discount rate.
4. Compare the value of competing cash flow streams at the same point in time.

The basic net present value equation is

\[ NPV = \sum_{t=0}^{T} \frac{CF_t}{(1 + K)^t} + \frac{TV_T}{(1 + K)^T} - C_0 \]

Where:
- \( CF_t \) = expected incremental after-tax cash flow in year \( t \),
- \( TV_T \) = expected after-tax terminal value including return of net working capital,
- \( C_0 \) = initial investment at inception,
- \( K \) = weighted average cost of capital,
- \( T \) = economic life of the project in years.

The NPV rule is to accept a project if \( NPV \geq 0 \)

\[ NPV = \sum_{t=0}^{T} \frac{CF_t}{(1 + K)^t} + \frac{TV_T}{(1 + K)^T} - C_0 \geq 0 \]

and to reject a project if \( NPV \leq 0 \)

\[ NPV = \sum_{t=0}^{T} \frac{CF_t}{(1 + K)^t} + \frac{TV_T}{(1 + K)^T} - C_0 \leq 0 \]
Review of Domestic Capital Budgeting

For our purposes it is necessary to expand the NPV equation.

\[ CF_t = (R_t - OC_t - D_t - I_t)(1 - \tau) + D_t + I_t (1 - \tau) \]

\( R_t \) is incremental revenue \\
\( I_t \) is incremental interest \\
\( OC_t \) is incremental operating cash flow \\
\( \tau \) is the marginal tax rate \\
\( D_t \) is incremental depreciation

Review of Domestic Capital Budgeting

We can use \( CF_t = (OCF_t)(1 - \tau) + \tau D_t \) to restate the NPV equation

\[ NPV = \sum_{t=1}^{T} \frac{CF_t}{(1 + K)^t} + \frac{TV_T}{(1 + K)^T} - C_0 \]

as:

\[ NPV = \sum_{t=1}^{T} \frac{(OCF_t)(1 - \tau) + \tau D_t}{(1 + K)^t} + \frac{TV_T}{(1 + K)^T} - C_0 \]

The Adjusted Present Value Model

\[ APV = \sum_{t=1}^{T} \frac{(OCF_t)(1 - \tau)}{(1 + K)^t} + \frac{\tau D_t}{(1 + K)^t} + \frac{\tau I_t}{(1 + K)^t} + \frac{TV_T}{(1 + K)^T} - C_0 \]

The APV model is a value additivity approach to capital budgeting. Each cash flow that is a source of value to the firm is considered individually.

Note that with the APV model, each cash flow is discounted at a rate that is appropriate to the riskiness of the cash flow.

Alternative Formulations \( CF_t \)

\[ CF_t = (R_t - OC_t - D_t - I_t)(1 - \tau) + D_t + I_t (1 - \tau) \]

\[ CF_t = (NI_t + D_t + I_t (1 - \tau)) \]

\[ CF_t = (R_t - OC_t)(1 - \tau) + D_t \]

\[ CF_t = (OCF_t)(1 - \tau) + \tau D_t \]

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The Unlevered Cost of Equity is

\[ r_u = 10\% \]

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The project would be rejected by all-equity firm.

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Consider this project, the timing and size of the incremental after-tax cash flows for an all-equity firm are:

\[ \begin{array}{cccccc}
0 & 1 & 2 & 3 & 4 \\
\$1,000 & \$125 & \$250 & \$375 & \$500 \\
\end{array} \]

\[ \text{CF}_0 = -\$1,000 \]

\[ \text{CF}_1 = \$125 \]

\[ \text{CF}_2 = \$250 \]

\[ \text{CF}_3 = \$375 \]

\[ \text{CF}_4 = \$500 \]

\[ \text{NPV} = -\$56.50 \]

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Domestic APV Example (continued)

- Now, imagine that the firm finances the project with $600 of debt at r = 8%.
- The tax rate is 40%, so they have an interest tax shield worth \( \tau \times I = 0.40 \times 600 \times 0.08 = \$19.20 \) each year.

The APV of the project under leverage is:

\[
APV = \sum_{t=1}^{T} \left[ \frac{OCF_{t}(1 - \tau)}{1 + K_u} \right] + \sum_{t=1}^{T} \left[ \frac{\tau D_{t}}{1 + (1 + \tau)^{t}} \right] + \sum_{t=1}^{T} \left[ \frac{\tau I_{t}}{1 + (1 + \tau)^{t}} \right] + TV_{t} - C_{t}
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\]

The firm should accept the project if it finances with debt.

Capital Budgeting from the Parent Firm’s Perspective

- Donald Lessard developed an APV model for a MNC analyzing a foreign capital expenditure. The model recognizes many of the particulars peculiar to foreign direct investment.

\[
APV = \sum_{i=1}^{T} \left[ \frac{OCF_{i}(1 - \tau)}{1 + K_{wd}^{i}} \right] + \sum_{i=1}^{T} \left[ \frac{\tau D_{i}}{1 + (1 + \tau)^{i}} \right] + \sum_{i=1}^{T} \left[ \frac{\tau I_{i}}{1 + (1 + \tau)^{i}} \right] + TV_{i} - C_{i}
\]

The operating cash flows must be translated back into the parent firm’s currency at the spot rate expected to prevail in each period.

The operating cash flows must be discounted at the unlevered domestic rate.

The APV model is NOT useful for a domestic firm analyzing a proposed foreign capital expenditure from the subsidiary’s viewpoint.

The APV model is useful for a domestic firm analyzing a domestic capital expenditure or for a foreign subsidiary of a MNC analyzing a proposed capital expenditure from the subsidiary’s viewpoint.

The APV model is NOT useful for a MNC in analyzing a foreign capital expenditure from the parent firm’s perspective.

\[
APV = \sum_{i=1}^{T} \left[ \frac{OCF_{i}(1 - \tau)}{1 + K_{wd}^{i}} \right] + \sum_{i=1}^{T} \left[ \frac{\tau D_{i}}{1 + (1 + \tau)^{i}} \right] + \sum_{i=1}^{T} \left[ \frac{\tau I_{i}}{1 + (1 + \tau)^{i}} \right] + TV_{i} - C_{i}
\]
Capital Budgeting from the Parent Firm’s Perspective

One recipe for international decision makers:
1. Estimate future cash flows in foreign currency.
2. Convert to the home currency at the predicted exchange rate.
   - Use PPP, IRP et cetera for the predictions.
3. Calculate NPV using the home currency cost of capital.

Capital Budgeting from the Parent Firm’s Perspective: Example

- A U.S.-based MNC is considering a European opportunity.
- It’s a simple example
  - There is no incremental debt
  - There is no incremental depreciation
  - There are no concessionary loans
  - There are no restricted funds

Capital Budgeting from the Parent Firm’s Perspective: Example

A U.S. MNC is considering a European opportunity. The size and timing of the after-tax cash flows are:

- $600 at time 0
- $200 at time 1
- $500 at time 2
- $300 at time 3

The inflation rate in the euro zone is $\pi = 3\%$, the inflation rate in dollars is $\pi = 6\%$, and the business risk of the investment would lead an unlevered U.S. based firm to demand a return of $K_w = \frac{i}{d} = 15\%$. 
Capital Budgeting from the Parent Firm’s Perspective: Example

- $600  €200  €500  €300
0  1  2  3

The current exchange rate is $S_t(\text{$/€}) = \$1.25/€.$

Is this a good investment from the perspective of the U.S. shareholders?

To address that question, let’s convert all of the cash flows to dollars and then find the NPV at $i = 15\%.$

Finding the dollar value of the initial cash flow is easy; convert at the spot rate:

$CF_0 = (€600) \times \frac{\$1.25}{€} = $750$

The exchange rate expected to prevail in the first year, $S_1(\text{$/€}),$ can be found with PPP:

$S_1(\text{$/€}) = \frac{1 + \pi_e}{1 + \pi_d} \times S_0(\text{$/€}) = \frac{1.06 \times \$1.25}{1.03} = $1.2864/€$

$CF_1 = €200 \times S_1(\text{$/€}) = €200 \times $1.2864/€ = $257.28$

Find the NPV using the cash flow menu of your financial calculator and an interest rate $i = 15\%:$

$NPV = $242.99$

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$NPV = $242.99$
Capital Budgeting from the Parent Firm’s Perspective: Example

\[
\begin{array}{cccc}
-750 & 257.28 & 661.94 & 408.73 \\
0 & 1 & 2 & 3 \\
\end{array}
\]

Without a financial calculator, the NPV can be found as:

\[
NPV = -750 + \frac{257.28}{1.15} + \frac{661.94}{(1.15)^2} + \frac{408.73}{(1.15)^3} = 242.99
\]

Capital Budgeting from the Parent Firm’s Perspective: Alternative

Another recipe for international decision makers:

1. Estimate future cash flows in foreign currency.
2. Estimate the foreign currency discount rate.
3. Calculate the foreign currency NPV using the foreign cost of capital.
4. Translate the foreign currency NPV into dollars using the spot exchange rate

Foreign Currency Cost of Capital Method

\[
\begin{array}{cccc}
-€600 & €200 & €500 & €300 \\
0 & 1 & 2 & 3 \\
\end{array}
\]

\[\pi_e = 3\% \quad \text{Let’s find } i_e \text{ and use that on the euro cash flows to find the NPV in euros.} \]
\[i_d = 15\% \quad \text{Then translate the NPV into dollars at the spot rate.} \]
\[\pi_d = 6\% \quad \text{The current exchange rate is } \frac{S_d}{€} = 1.25 \]

Finding the Foreign Currency Cost of Capital: \(i_e\)

Recall that the Fisher Effect holds that

\[
(1 + \rho_e) = (1 + \pi_d) \times (1 + i_e)
\]

real rate  inflation rate  nominal rate

So for example the real rate in the U.S. must be 8.49%

\[
(1 + \rho_e) = \frac{(1 + i_d)}{(1 + \pi_d)} \quad \text{and} \quad \rho_e = 1.15 \times 0.06 = 0.0849
\]

Finding the Foreign Currency Cost of Capital: \(i_e\)

If Fisher Effect holds here and abroad then

\[
(1 + \rho_e) = \frac{(1 + i_d)}{(1 + \pi_d)} \quad \text{and} \quad (1 + \rho_e) = \frac{(1 + i_d)}{(1 + \pi_d)}
\]

If the real rates are the same in dollars and euros \((\rho_e = \rho_d)\) we have a very useful parity condition:

\[
\frac{(1 + i_d)}{(1 + \pi_d)} = \frac{(1 + i_d)}{(1 + \pi_d)}
\]
Finding the Foreign Currency Cost of Capital: $i_e$

If we have any three of these variables, we can find the fourth:

\[
(1 + i_e) = \frac{(1 + i_d)(1 + \pi_e)}{(1 + \pi_d)}
\]

In our example, we want to find $i_e$

\[
(1 + i_e) = \frac{(1 + 0.15)(1 + 0.03)}{(1 + 0.06)} = \frac{1.15 \times 1.03}{1.06} - 1
\]

\[
i_e = 0.1175
\]

International Capital Budgeting: Example

<table>
<thead>
<tr>
<th>Year</th>
<th>Cash Flow</th>
<th>$</th>
<th>€</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>-600</td>
<td>€</td>
<td>€</td>
</tr>
<tr>
<td>1</td>
<td>200</td>
<td>€</td>
<td>€</td>
</tr>
<tr>
<td>2</td>
<td>500</td>
<td>€</td>
<td>€</td>
</tr>
<tr>
<td>3</td>
<td>300</td>
<td>€</td>
<td>€</td>
</tr>
</tbody>
</table>

Find the NPV using the cash flow menu and $i = 11.75\%$:

\[
\text{NPV} = \frac{€ 194.39 \times € \frac{1.25}{\$}}{\$ 242.99}
\]

Capital Budgeting from the Parent Firm's Perspective: Example

<table>
<thead>
<tr>
<th>Year</th>
<th>Cash Flow</th>
<th>$</th>
<th>€</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>-600</td>
<td>€</td>
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</tr>
<tr>
<td>1</td>
<td>200</td>
<td>€</td>
<td>€</td>
</tr>
<tr>
<td>2</td>
<td>500</td>
<td>€</td>
<td>€</td>
</tr>
<tr>
<td>3</td>
<td>300</td>
<td>€</td>
<td>€</td>
</tr>
</tbody>
</table>

Without a financial calculator, the NPV can be found as:

\[
\text{NPV} = -€ 600 + \frac{€ 200}{1.1175} + \frac{€ 500}{(1.1175)^2} + \frac{€ 300}{(1.1175)^3} = € 194.39
\]

\[
€ 194.39 \times $\frac{1.25}{\$} = $242.99
\]

Back to the full APV

Using the intuition just developed, we can modify Lessard’s APV model as shown above, if we find it convenient.

\[
\text{APV} = \sum_{t=1}^{T} \frac{D_t + S_t}{(1 + K_u)^t} + S_0 + \frac{\sum_{t=1}^{T} I_t}{(1 + i_d)^t} + \sum_{t=0}^{T} \frac{\sum_{t=1}^{T} P_t}{(1 + i_d)^t} - S_tC_t + S_tRF + S_tCL + S你现在需要完成的版本。
Sensitivity Analysis

- In the APV model, each cash flow has a probability distribution associated with it.
- Hence, the realized value may be different from what was expected.
- In sensitivity analysis, different estimates are used for expected inflation rates, cost and pricing estimates, and other inputs for the APV to give the manager a more complete picture of the planned capital investment.

Real Options

- The application of options pricing theory to the evaluation of investment options in real projects is known as real options.
  - A timing option is an option on when to make the investment.
  - A growth option is an option to increase the scale of the investment.
  - A suspension option is an option to temporarily cease production.
  - An abandonment option is an option to quit the investment early.

Value of the Option to Delay: Example

A French firm is considering a one-year investment in the United Kingdom with a pound-denominated rate of return of 15%.
The firm’s local cost of capital is \( i = 10\% \)
The cash flows are: 

\[
\begin{array}{c|c}
0 & -\ 1,000 \\
1 & \ 1,150 \\
\end{array}
\]

The current exchange rate is \( S_0(\text{€} | \text{£}) = \ 2.00 \) to the pound.

Value of the Option to Delay: Example

- Suppose that the bank of England is considering either tightening or loosening its monetary policy.
- It is widely believed that in one year there are only two possibilities:
  - \( S_1(\text{€} | \text{£}) = \ 2.20 \) to the pound.
  - \( S_1(\text{€} | \text{£}) = \ 1.80 \) to the pound.
- Following revaluation, the exchange rate is expected to remain steady for at least another year.

Option to Delay: Example

- If \( S_1(\text{€} | \text{£}) = \ 1.80 \) per £
  the project will have turned out to be a loser for the French firm:

\[
\begin{array}{c|c|c}
0 & -\ 2,000 & 0 \\
1 & \ 2,070 & 1 \\
\end{array}
\]
  \( \text{IRR} = 3.50\% \)

- If \( S_1(\text{€} | \text{£}) = \ 2.20 \) per £
  the project will have turned out to be a winner for the French firm:

\[
\begin{array}{c|c|c}
0 & -\ 2,000 & 0 \\
1 & \ 2,530 & 1 \\
\end{array}
\]
  \( \text{IRR} = 26.50\% \)

Option to Delay: Example

- An important thing to notice is that there is an important source of risk (exchange rate risk) that isn’t incorporated into the French firm’s local cost of capital of \( i = 10\% \).
  - That’s why there are no NPV estimates on the last slide.
- Even with that, we can see that taking the project on today entails a “win big—lose big” gamble on exchange rates.
- Analogous to buying an at-the-money call option on British pounds with a maturity of one year.
Option to Delay: Example

- The remaining slides assume a knowledge of the material contained in chapter 7.
- Especially the notion of a replicating portfolio.
- But also basic things like a call options gives the holder the right to buy a specific asset at a specific price for a specific amount of time.

The payoff in one year of portfolio consisting of an at-the-money call option written on £2,300 plus a risk-free bond with a future value of €2,070 equals the payoff of the British investment:

\[
\begin{array}{c|c|c|c|c|c}
S_1(\text{€|£}) & \text{British} & \text{Bond} & \text{Call} & \text{Option} & \text{Portfolio} \\
\hline
2.20 \text{€} & 2.530 & 2.070 + 460 & 2.530 \\
1.80 \text{€} & 2.070 & 2.070 + 0 & 2.070 \\
\end{array}
\]

So the present value of the project at time zero can be found by getting a quote from an option dealer on an at-the-money call on £2,300 and adding to that the present value of €2,070 at the euro-zone risk-free rate.

The Net Present Value of the project is that sum less the cost of the project, –€2,000:

\[
\text{NPV} = -2,000 + \text{value of option} + \frac{2,070}{1 + i}
\]

Suppose that our option dealer quotes an option premium of €0.05 per pound and our banker quotes the euro-zone risk-free rate at \(i = 6\%\).

The NPV of the project at time zero to the French firm is

\[
\text{NPV}_0 = -2,000 + 115 + \frac{2,070}{1.06} = 67.83
\]

Before we accept a positive NPV project, we should make sure that we are not bypassing alternative projects with higher NPVs.

Waiting a year to start the same project is an alternative.

If the firm can wait a year to start the project the cash flows look like

| \(S_1(\text{€|£}) = 1.80 \text{€ per £}\) | \(S_1(\text{€|£}) = 2.20 \text{€ per £}\) |
|---|---|
| –1,800 | –2,070 |
| 2,070 | 2,530 |
| 0 | 0 |
| 1 | 1 |
| IRR = 15\% | IRR = 15\% |
| \(\text{NPV}_0 = 81.82 = -1,800 + \frac{2,070}{1.10}\) | \(\text{NPV}_0 = 100\) |

Do The Right Thing

- We have a choice: to invest in the project today or to wait a year.
- If we jump in today, the \(\text{NPV}_0\) is 67.83 and the FV in one year is \(\text{NPV}_1 = 74.61 = 1.10 \times 67.83\)
- Clearly it’s better to wait a year.
  - Worst case, \(\text{NPV}_1 = 81.82\) and there is a chance that the NPV at time one is €100
  - Both of these outcomes beat €74.61
End Chapter Eighteen