CHAPTER 15
Project Risk Assessment and Incorporation

- The source of project risk
- Types of project risk
  - Stand-alone
  - Corporate
  - Market
- Risk assessment techniques
- Risk incorporation
Risk in Capital Budgeting

- In capital budgeting, financial risk is related to *uncertainty* about a project’s profitability.
- If any of the forecasted cash flows are not known with certainty, the project’s forecasted profitability is uncertain, and hence risk is present.
- As in all investments, risk is the *primary determinant* of a project’s required rate of return (discount rate).
Three different types of project risk can be defined and, at least in theory, measured.

- Stand-alone
- Corporate
- Market

The risk that is relevant to a particular analysis depends on the situation at hand.
Stand-Alone Risk

- **Stand-alone risk** assumes that the project will be operated in *isolation*, and hence ignores any portfolio effects.

- It is measured by the amount of uncertainty in forecasted profitability—the greater the uncertainty, the greater the risk.

- Often, **standard deviation** ($\sigma$) [or **coefficient of variation** (CV)] is used as the measure of stand-alone risk.
Corporate Risk

- Corporate risk is the contribution of the project to the overall riskiness of the *business* (standard deviation of the business’s ROE).

- It depends on:
  - The project’s stand-alone risk ($\sigma$).
  - The correlation of the project’s returns to the overall returns of the *business*.

- It is measured (at least conceptually) by a project’s corporate beta.
Market Risk

Market risk is the contribution of the project to the overall riskiness (standard deviation) of a well-diversified stock portfolio.

It depends on:
- The project’s stand-alone risk (\(\sigma\)).
- The correlation of the project’s returns to the returns of the market portfolio.

It is measured (at least conceptually) by a project’s market beta.
Risk Type Relevancy

- **Stand-alone risk** is relevant only to very small not-for-profit businesses.

- **Corporate risk** is most relevant to large not-for-profit businesses.

- **Market risk** is most relevant to investor-owned businesses. However, corporate risk is relevant to nonowner stakeholders and affects bankruptcy potential. Thus, corporate risk is also relevant within investor-owned businesses.
However, stand-alone risk generally is the *only risk* that is somewhat measurable, and it is most intuitive.

Fortunately, most projects under consideration have returns that are *highly correlated* with the overall returns on the business and with market returns.

Why are such correlations important?
Consider Midtown Clinic’s evaluation of new diagnostic equipment presented in the Chapter 14 slideshow.

- **Cost**
  - $200,000 purchase price
  - $40,000 shipping and installation

- **Expected life** = *four* years.

- **Salvage value** = $25,000.
Utilization = 5,000 scans/year.
Net revenue = $80 per scan.
Supplies costs = $40 per scan.
Labor costs = $100,000.
Neutral inflation rate = 5%.
Corporate cost of capital = 10%.
NPV = $117,000.

IRR = 29.7%.

MIRR = 21.4%.

Imbedded in these CFs:
- Unit sales = 5,000.
- Labor costs = $100,000.
There are two techniques most commonly used to measure a project’s stand-alone risk:

- Sensitivity analysis
- Scenario analysis

In addition, Monte Carlo simulation can be used (not discussed here).

Note that risk measurement (and incorporation) is not a precise process.
Sensitivity analysis shows how changes in an input variable such as utilization affect profitability.

Every input variable is held at its base case (expected) value except one. Then, the variable being analyzed typically is changed from its base case value by set percentages, say, ±10%, ±20%, and ±30%.

For ease of illustration, we will focus on only two input variables: unit sales and labor costs.
## Sensitivity Analysis Illustration with Two Uncertain Variables

<table>
<thead>
<tr>
<th>Change from Base Level</th>
<th>NPV (000s)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Unit Sales</td>
</tr>
<tr>
<td>-30%</td>
<td>-$87</td>
</tr>
<tr>
<td>-20</td>
<td>-19</td>
</tr>
<tr>
<td>-10</td>
<td>49</td>
</tr>
<tr>
<td>0</td>
<td>117</td>
</tr>
<tr>
<td>+10</td>
<td>185</td>
</tr>
<tr>
<td>+20</td>
<td>252</td>
</tr>
<tr>
<td>+30</td>
<td>320</td>
</tr>
</tbody>
</table>
Graphical Results

NPV ($000s) vs. % Change from Base Case

- Unit Sales
- Labor Costs

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Steep lines show greater risk, because small forecasting errors will result in large changes in NPV.

The unit sales line is steeper than the labor costs line, so NPV is more sensitive to changes in sales volume than to changes in fixed (labor) costs.

Historically, projects with steep lines were assumed to have greater risk than projects with flat lines.
Advantages of Sensitivity Analysis

- Identifies the variables that are most critical to the analysis; that is, the variables that, if forecasts are wrong, have the most influence on profitability.

- Provides some basic breakeven information.
Discussion Item

Why is it important for managers to know the critical input variables?
Disadvantages of Sensitivity Analysis

- Does not consider the amount by which the input variables could actually change.
- Does not consider any interaction among the input variables.
- Provides no quantitative measure of risk, so it is difficult to make a supportable judgment about the riskiness of the project.
Scenario analysis examines several possible profitability outcomes, usually three:
- Worst case
- Most likely case
- Best case

Provides a range of possible outcomes, which can be used to obtain a quantitative measure of risk.
### Scenario Analysis Illustration

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Prob.</th>
<th>Unit Sales</th>
<th>Labor Costs</th>
<th>NPV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Worst</td>
<td>0.25</td>
<td>4,000</td>
<td>$120,000</td>
<td>-$ 86,000</td>
</tr>
<tr>
<td>ML</td>
<td>0.50</td>
<td>5,000</td>
<td>100,000</td>
<td>117,000</td>
</tr>
<tr>
<td>Best</td>
<td>0.25</td>
<td>6,000</td>
<td>80,000</td>
<td>320,000</td>
</tr>
</tbody>
</table>

$$E(\text{NPV}) = \$117,000.$$  
$$\text{SD} = \$144,000.$$  
$$\text{CV} = \frac{\$144}{\$117} = 1.2.$$
Advantages of Scenario Analysis

- Considers *more* than one variable at a time.
- Provides information about the worst possible results.
- Provides a *quantitative measure* of stand-alone risk.
Discussion Items

Why is it important for managers to know the worst possible outcome? (Hint: Consider risk versus the ability of a business to bear that risk.)

Does the size (scale) of an investment affect its risk? Or, put another way, is a $10,000 investment in HMA stock riskier than a $1,000 investment?
Disadvantages of Scenario Analysis

- Only considers a *limited number* of outcomes, whereas the real world is much more complex.

- Forces all best case and worst case input values to occur together, so it may push the “extreme” values out farther than they should be.
Final Project Risk Assessment

- Suppose Midtown Clinic’s average project has a CV of 0.5–1.0.
- CV = 1.2 for this project, so it has high risk as judged quantitatively.
- We measured the project’s standalone risk. However, it is likely that the returns on this project will be highly correlated with the business’s overall returns and with the general economy.
Assume that the firm adds or subtracts 3 percentage points to account for risk.

Project cost of capital:

\[ 10\% + 3\% = 13\%. \]

Now, NPV = $93,000, so the project remains highly profitable (expectationally) even after adjusting for its high risk.
Would it make sense to classify the risk of projects as:

- Very high
- High
- Moderately high
- And so on
Objective Versus Subjective Risk

- **Objective risk** is risk measured in a quantitative way, such as using cash flow estimates to obtain a coefficient of variation (CV) of NPV.

- **Subjective risk** is the risk that the objective measurement is wrong. In other words, the cash flows estimates are worthless.

- In general, subjective risk is highest when the investment being evaluated is using *new, unproven technology* or is in a *new, unfamiliar line of business*. 
The quantitative risk assessment may be validated using the qualitative approach.

Here values (such as Y = 1; N = 0) are assigned to the answers to questions such as these:
- Does the project require new market share?
- Is it outside of current management expertise?
- Does it require hard-to-get technical expertise?
- Will there be heavy competition?
- Does it require the use of new, unproven technology?

The higher the total, the higher the risk.
Does the qualitative approach to project risk assessment have any merit, or is it just some wacky scheme developed by a liberal arts major who never learned how to use a spreadsheet?
Some Final Thoughts

- The whole process of risk assessment and incorporation is clearly fraught with both conceptual and implementation problems.
- Nevertheless, good financial practices dictate that required returns must consider the riskiness of the investment.
- Even if the process is subjective rather than numerical, project risk should play a role in the decision process.
Assume Northwest Healthcare is evaluating two alternative medical waste disposal systems. Plan W requires more workers but less capital. Plan C requires a larger up-front investment but has lower operating costs.

Both systems have three-year lives.

The choice will have no impact on Northwest’s revenues, so the decision will be based on relative costs.

Initially, both systems are judged to have average risk, so the cost of capital is 10%.
Here are the net cash flows:

<table>
<thead>
<tr>
<th>Year</th>
<th>Plan W</th>
<th>Plan C</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>($500)</td>
<td>($1,000)</td>
</tr>
<tr>
<td>1</td>
<td>(500)</td>
<td>(300)</td>
</tr>
<tr>
<td>2</td>
<td>(500)</td>
<td>(300)</td>
</tr>
<tr>
<td>3</td>
<td>(500)</td>
<td>(300)</td>
</tr>
</tbody>
</table>

\[ PV_{COSTS_W} = -$1,743. \]
\[ PV_{COSTS_C} = -$1,746. \]

Which system should be chosen?

What is the IRR of Plan W?
Now suppose Plan W is judged to be riskier than Plan C because future wage rates are difficult to forecast. Would this affect the choice?

If we add a 3% risk adjustment to the 10% CCC to get a 13% project cost of capital for W, then:

$$\text{PV}_{\text{COSTS}_W} = -$1,681.$$  

Which system should be chosen now? 
Does this make sense?
When *costs* are being discounted, use a *lower* discount rate to reflect *higher* risk. Thus, the appropriate discount rate for *W* would be $10\% - 3\% = 7\%$, which gives:

$$PV_{\text{COSTS}_W} = -$1,812.$$

With the the proper risk adjustment, $PV_{\text{COSTS}_W} > PV_{\text{COSTS}_C}$, so now *choose Plan C*. 
The Capital Budgeting Process

- First, the business estimates its corporate (divisional) cost(s) of capital.

- The riskiness of projects is assessed relative to the average project risk in the corporation (division).

- Project costs of capital are estimated by adjusting the corporate (divisional) cost(s) of capital.

- Projects are then evaluated using a differential risk-adjusted cost of capital.
Under **capital rationing**, a business has more acceptable projects than it has investment capital.

From a purely financial perspective, the set of projects that creates the greatest financial value should be chosen.
Is there a profitability measure that is especially helpful when capital rationing applies?
This concludes our discussion of *Chapter 15* (Project Risk Assessment and Incorporation).

Although not all concepts were discussed in class, you are responsible for all of the material in the text.

Do you have any questions?