

**Chapter 10 - Project Analysis** (Pages 259 - 268, Figure 10-7, 281 - 282)

In this chapter we will discuss other methods of assessing project risk. In particular, we will:

- 1) Define stand-alone risk and within-firm risk.
- 2) Emphasize that well-diversified investors are only concerned with non-diversifiable risk (beta risk).
- 3) Identify decision makers who are concerned about stand-alone risk and within-firm risk.
- 4) Learn how to measure stand-alone risk and learn the benefits of knowing a project's stand-alone risk.
- 6) Briefly discuss sensitivity analysis, scenario analysis, break-even analysis, Monte-Carlo simulations, and using decision-trees.

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**Chapter 10 - Project Analysis**

In the previous chapter we learned that **beta** is the appropriate measure of risk used to determine the discount rate for a project's cash flows. [This assumes that the CAPM is the correct model in calculating expected (and required) returns for assets.]

Beta is the portion of a project's risk that affects a well-diversified investor.

Project beta is estimated by averaging the asset betas of other firms doing business in a similar industry.

Computer spreadsheet programs can be used to provide additional information regarding project risk - particularly an assessment of **stand-alone** risk.

**Stand-alone** risk reflects the **total riskiness** of the project (without consideration of any diversification benefits). It is measured by examining the uncertainty of the project NPV. Example:

Project X (beta = 0.0, the risk-free rate is 5% and the market risk premium is 8.4%, discount rate = 5%)

Initial investment = -\$1000  
 Time one cash flow (50% chance) = \$1165.50  
 Time one cash flow (50% chance) = \$1144.50

NPV =

Project Y (beta = 0.0, the risk-free rate is 5% and the market risk premium is 8.4%, discount rate = 5%)

Initial investment = -\$1000  
 Time one cash flow (50% chance) = \$1302  
 Time one cash flow (50% chance) = \$1029

NPV =

Side note: Obviously there is risk with these two projects, but the beta is zero. How come?

	Lowest Possible NPV (50% chance)	Highest Possible NPV (50% chance)	NPV
Project X			
Project Y			

Which of the two projects has the higher stand-alone risk?

Which of the two projects has the higher NPV?

**Important.** There is only **one** NPV for a project. It is determined by discounting the project's *expected* cash flows at the opportunity cost of capital.

We will call the highest and lowest NPVs in the above example 'what-if' NPVs.

"What-if" NPVs tell us how acceptance of the project will affect our firm if the worst set (or best set) of assumptions were realized.

The two extreme values for the 'what-if' NPV give one measure for a project's stand-alone risk. More calculation methods are discussed later.

**Within-firm risk** measures how the project contributes to the overall riskiness of the firm.

Within-firm risk is related to the correlation of the new project's returns with the returns of the existing assets of the firm.

It is possible that a project with high stand-alone risk might actually **reduce** firm risk. Can you give an example of when this would occur?

**Well-diversified investors** are concerned with non-diversifiable risk (beta risk).

The **beta risk** of the project is not necessarily related to the **stand-alone risk** (or **within-firm risk**) of a project.

For instance, a project with high stand-alone risk and high within-firm risk might (depending on the correlation of the project's returns with the market's returns) have a beta close to zero, or even have a negative beta.

**Who is concerned about a project's stand-alone risk, within firm risk, or beta risk?** Consider the following set of concerned individuals:

- 1) The project manager and other employees that work on the project.
- 2) Firm employees that work on other projects.
- 3) Managers of the firm (President, VP, Treasurer, etc.)
- 4) Investors in the firm's stock (not diversified)
- 5) Investors in the firm's stock (well-diversified)

**Consider the project manager (#1 above).** How can this project manager hurt the firm by being too concerned about the project's stand-alone risk?

**Consider the president of the firm (#3 above).** How can this president hurt the firm by being too concerned about the project's within-firm risk?

**How can we get the project manager and firm president to think more like a well-diversified stockholder?**

**Even though stand-alone risk** does not take into account diversification, it provides valuable information about the project's riskiness. For example, it might force managers to make better estimates or find ways to prevent bad outcomes.

**Methods of Assessing Stand-Alone Risk:**

- Sensitivity Analysis
- Scenario Analysis
- Break-Even Analysis
- Monte Carlo Simulations

**Sensitivity Analysis** - How much does project NPV change when a single variable is changed? **Example:** Consider the impact on NPV when the sale's price of a product is changed.

**Assumptions** - Assume that a firm will purchase a product for resale to the public. The time zero initial investment is \$3770. Perform a sensitivity analysis on the project's sales price using three possible sales prices: \$14.50, \$14.00, or \$13.50. Expected values for the other inputs into the project: purchase price = \$10 per unit, product demand = 1000 units in one year. There are no other revenue or expense items. The beta of the time one expected cash flow = 0.0, the risk-free rate is 5% and the market risk premium is 8.4%. Use the CAPM.

*(You should be able to calculate the numbers in italics from the other numbers in the table)*

	Prob.	Sale's Price	Cost	Units	Net CF	PV	Invest	NPV	Decision
Optimistic	20%	\$14.50	-\$10.00	1000	<i>\$4500</i>	<i>\$4285.71</i>	-\$3770	<i>\$515.71</i>	
Most Likely	50%	\$14.00	-\$10.00	1000	<i>\$4000</i>	<i>\$3809.52</i>	-\$3770	<i>\$39.52</i>	
Pessimistic	30%	\$13.50	-\$10.00	1000	<i>\$3500</i>	<i>\$3333.33</i>	-\$3770	<i>-\$436.67</i>	
Expected		<i>\$13.95</i>	<i>-\$10.00</i>	<i>1000</i>	<i>\$3950</i>	<i>\$3761.90</i>	-\$3770	<i>-\$8.10</i>	<i>Reject</i>

- What is the **most likely** sale's price?
- What is the expected sale's price?
- What are the highest and lowest possible ('what if') NPVs for the project?
- What is the NPV of the project?

**The value (and costs) of gathering more information.**

Should the project described above be rejected? *Not necessarily!* Perhaps you can hire a firm to do a marketing survey.

What are the costs and benefits of a marketing survey?

Costs = The fee charged by the marketing research firm and other costs incurred by your firm. (Assume this amount is \$100.)

Benefits = Assume that the marketing survey will reveal the exact sale's price for the product. (Typically, the marketing survey will not reveal a precise solution.) How would this benefit your firm?

You know whether the project will be good or bad prior to investing the \$3770 initial investment.

Another potential benefit is from a reduction in risk. This could mean a reduction in discount rate. Is this a benefit in this problem?

**Analysis**

1. Project NPV (no purchase of information) = -\$8.10
2. Purchase information (pay \$100 at t = 0)

Possible survey results

- \$14.50 sale's price (20% chance)  
Decision: Accept project  
Impact on firm value: \$4285.71 - \$3770 = \$515.71

- \$14.00 sale's price (50% chance)  
Decision: \_\_\_\_\_  
Impact on firm value: \_\_\_\_\_
- \$13.50 sale's price (30% chance)  
Decision: \_\_\_\_\_  
Impact on firm value: \_\_\_\_\_

Project NPV (purchase information) = - \$100 +  $(\$515.71)(0.20)$  + (\_\_\_\_\_) (\_\_\_\_) + (\_\_\_\_\_) (\_\_\_\_) =

3. Compare the two NPVs and decide if your firm should purchase information

Project NPV (no purchase of information) = -\$8.10  
Project NPV (purchase information) =

Should your firm purchase information?  
Should the firm accept the project?

**Some more examples:**

1. NPV (no purchase of information) = \$50. NPV (purchase information) = \$60.

Should you survey?  
Should the firm accept the project?

2. NPV (no purchase of information) = \$50. NPV (purchase information) = \$40.

Should you survey?  
Should the firm accept the project?

3. NPV (no purchase of information) = -\$50. NPV (purchase information) = -\$40.

Should you survey?  
Should the firm accept the project?

4. NPV (no purchase of information) = -\$50. NPV (purchase information) = \$10.

Should you survey?  
Should the firm accept the project?

**Scenario analysis** - here the manager is asked to supply several sets of assumptions (scenarios), such as pessimistic, most-likely, and optimistic scenarios, with probabilities of each.

Unlike sensitivity analysis, assumptions are not changed one at a time, but all assumptions are modified to fit a particular scenario.

**Advantage:** variables are likely to be interrelated. Therefore, it often doesn't make sense to analyze variables one-at-a-time.

The pessimistic scenario will provide the worse case NPV. What if the worst-case NPV is positive?

**Break-even analysis** is similar to sensitivity analysis. Variables are adjusted (one-at-a-time) up or down to determine what value produces a \$0 NPV.

In the example above, you would determine the sale's price that makes the NPV exactly equal to zero.

The break-even point is in terms of NPV, not accounting income (accounting income ignores time value of money - see example in book on pages 265-266). Break-even analysis is well suited to a graphical presentation.

**Monte Carlo Simulations** is a more sophisticated technique of estimating the probability distribution (or frequency distribution) of possible project cash flows based on the probability distributions of the assumptions. This is used to help assess the riskiness of the project. The book's discussion (in section 10.2) goes beyond the scope of this course. We will not discuss this topic further.

**Decision Tree analysis** can be used to evaluate projects that require decisions over several time periods or over several stages. See figure 10.7 for an example. Again, the discussion in the book goes beyond the scope of this course. However, it is important to understand that a project with several stages gives managers a valuable **real option**.

A **financial option** gives the owner the right to buy (or sell) a financial asset at a certain price for a certain period of time. **Example:** An option to purchase IBM stock at \$100 per share at any time for the next three months. This (call) option has value even if IBM stock is currently selling for less than \$100 per share. Why - because IBM stock *might* have a price of greater than \$100 before the end of the three-month period.

A **real option** gives the owner a similar right to do something (or not do something). Just like a financial option has value, a real option also has value.

**Example:** Project X will use of a pilot program that permits the company to evaluate a scaled down version of the project before funds are spent on a full-scale project.

Therefore, at time 0, the decision is not whether the expensive full-scale project should be accepted, but whether the pilot program should be accepted (at a much lower cost). The decision to undertake the full-scale project can be decided after you determine whether the pilot program is successful or unsuccessful.

The decision of whether to go immediately with the full-scale version or with a two-step acceptance (pilot / full scale) depends on the cost of the pilot project versus the value of the real option (the option to abandon).

Pilot projects with hard (tangible) assets will usually generate more cash flow to the firm upon abandonment than pilot projects with intangible assets. Therefore, it is more likely a firm will undertake a pilot project with tangible assets. However, your competitors are also more likely to undertake such a pilot project.

We performed a simple two-step problem earlier in this chapter's notes. What was it?

We will not discuss this topic further.

## Chapter 10 Review Questions

1. Understand the difference between a project's stand-alone risk, within-firm risk, and beta risk. Be able to determine whether the different groups of individuals listed towards the beginning of the Chapter 10 notes would be concerned or unconcerned with these various types of risk.
2. What factors would cause a project's within-firm risk to be low in relation to its stand-alone risk? What factors would cause a project's beta risk to be low in relation to its stand-alone risk (or within-firm risk)?
3. Know the methods used to calculate stand-alone risk: sensitivity analysis, scenario analysis, and break-even analysis. (We skipped the discussion of how Monte-Carlo simulations could be used to evaluate stand-alone risk).
4. Understand the difference between a project's "most likely" outcome and its "expected outcome" for a particular variable. Know how to use expected outcomes to calculate the NPV of a project. Know how to use pessimistic, most likely, and optimistic outcomes to calculate "what-if" NPVs.

5. Understand how to determine the benefits of obtaining additional information.
6. Understand how a decision tree analysis can assist a manager in analyzing projects that require decisions to be made in several steps. What are the factors that would make it beneficial (or detrimental) for a firm to use a pilot project?

### Chapter 10 Practice Problems

1. Assume that Project XYZ has a beta = 0.0, the risk-free rate is 5%, and the market risk premium is 8.4%. Therefore, the discount rate for Project XYZ = 5%.

Initial investment = -\$1350

Highest possible time one cash flow (60% chance) = \$1650

Lowest possible time one cash flow (40% chance) = \$1100

What is the NPV for Project XYZ? *\$11.905*

What is the highest possible 'what-if' NPV for Project XYZ? *\$221.429*

2. ABC Corporation is considering Project Z. Identify which measure of risk is the most relevant measure of risk for each of the following individuals.

- A. Project Z's stand alone risk
- B. Project Z's within firm risk
- C. Project Z's beta risk

- The chairman of the board of directors of ABC Corporation. The chairman does not receive any salary or other benefits from the corporation and only owns a small amount of the stock of ABC Corporation. The vast majority of the chairman's wealth is invested in a well-diversified mutual fund. *Answer = Project Z's beta risk*
  - A stockholder that has most of her wealth invested in the stock of the corporation. *Answer = Project Z's within-firm risk*
  - An employee that works in the firm's Treasury department (and does not work on Project Z). This employee does not have any investments besides the stock she owns in ABC Corporation. *Answer = Project Z's within-firm risk*
3. Similar to the example given in the notes, the following project requires an initial investment of \$3500 and will end in one year. The project's beta is 0. What is the NPV of the project using a 5% (risk-free) opportunity cost of capital? *Expected sale's price = \$13.40. NPV = -\$261.90. Therefore, reject the project.*

	Prob.	Sale's Price	Cost	Units	Net CF	PV	Invest	NPV	Decision
Optimistic	20%	\$18.00	(\$10.00)	1000	\$8,000	\$7,619.05	-3500	\$4,119.05	
Most Likely	50%	\$13.00	(\$10.00)	1000	\$3,000	\$2,857.14	-3500	(\$642.86)	
Pessimistic	30%	\$11.00	(\$10.00)	1000	\$1,000	\$952.38	-3500	(\$2,547.62)	
Expected		\$13.40	(\$10.00)	1000	\$3,400	\$3,238.10	-3500	(\$261.90)	<i>Reject</i>

4. Similar to the example given in the notes, the project described above requires an initial investment of \$3500 and will end in one year. The firm has the opportunity to pay \$200 for a marketing survey that will indicate what the sales price will be (with 100% accuracy). What is the NPV of the project (after considering the cost of the survey and actions of management after seeing the results of the survey)? Again, the project beta is 0, so use a 5% opportunity cost of capital.

Possible survey results

- \$18.00 sale's price (20% chance)  
Decision: Accept project  
Impact on firm value:  $\$7619.05 - \$3500 = \$4119.05$
- \$13.00 sale's price (50% chance)  
Decision: Reject project  
Impact on firm value: \$0
- \$11.00 sale's price (30% chance)  
Decision: Reject project  
Impact on firm value: \$0

$$\text{Project NPV (purchase information)} = -\$200 + (\$4119.05)(0.20) + (\$0)(0.50) + (\$0)(0.30) = \$623.81$$

5. In each situation, determine if the firm should spend money on a marketing survey. As in class, assume that this marketing survey will provide management of the firm with the information on such things as product demand and sales price of the product.
- NPV (no purchase of information) = -\$5000. NPV (purchase information) = -\$2000. Should management conduct the survey? *No*
  - NPV (no purchase of information) = \$5000. The project is so profitable that even in the worst-case scenario the NPV is +\$1000. Should management conduct the survey? *No*
  - NPV (no purchase of information) = \$100. NPV (purchase information) = \$90. Should management conduct the survey? *No*
  - NPV (no purchase of information) = \$100. NPV (purchase information) = \$110. Should management conduct the survey? *Yes*
  - NPV (no purchase of information) = -\$100. NPV (purchase information) = -\$90. Should management conduct the survey? *No*
6. ABC Corporation is considering Project ZZZ. (Project ZZZ involves the sale of UK souvenir basketballs.) You have calculated the NPV of Project ZZZ using an opportunity cost of capital of 10% and the project's expected cash flows. The NPV is +\$1000. Determine if the breakeven point for the following variables is above or below each of these variables' expected values.
- The expected sale's price for UK basketballs is \$20. *Answer: The breakeven point is **below** \$20*
  - The expected cost of purchasing the UK basketballs from the manufacturer is \$10. *Answer: The breakeven point is **above** \$10*