Chapter Eight

Strategy and Analysis in Using Net Present Value

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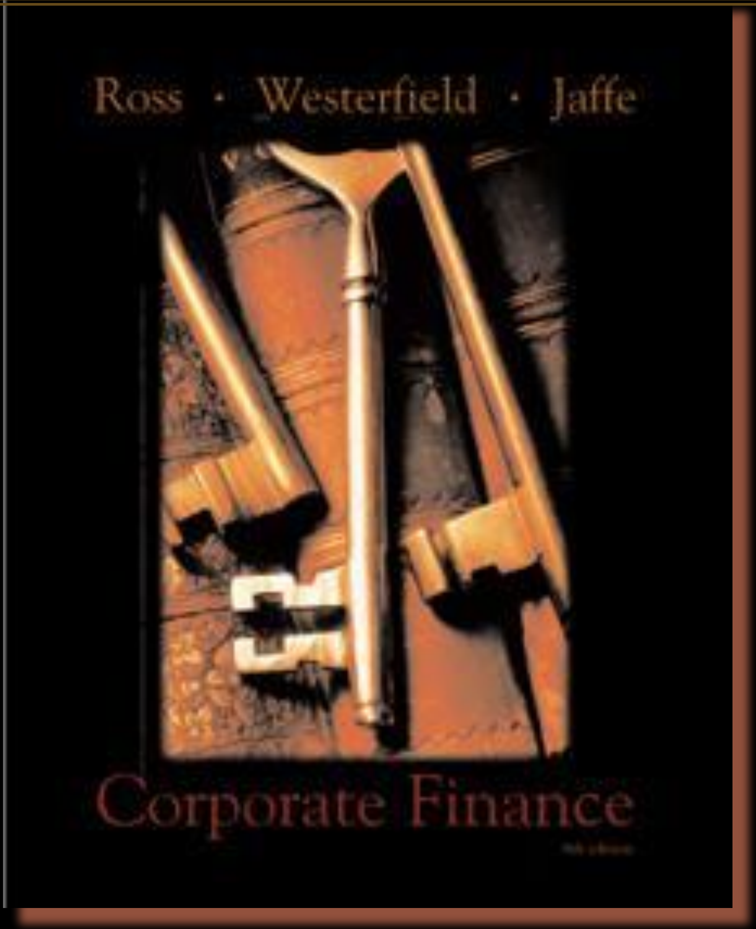
Seventh Edition



Chapter Outline

8.1 Decision Trees

8.4 Options

Stewart Pharmaceuticals

- The Stewart Pharmaceuticals Corporation is considering investing in developing a drug that cures the common cold.
- A corporate planning group, including representatives from production, marketing, and engineering, has recommended that the firm go ahead with the test and development phase.
- This preliminary phase will last one year and cost $1 billion. Furthermore, the group believes that there is a 60% chance that tests will prove successful.
- If the initial tests are *successful*, Stewart Pharmaceuticals can go ahead with full-scale production. This investment phase will cost $1.6 billion. Production will occur over the next 4 years.

Stewart Pharmaceuticals NPV of Full-Scale Production following Successful Test

Investment	Year 1	Years 2-5
Revenues		\$7,000
Variable Costs		(3,000)
Fixed Costs		(1,800)
Depreciation		(400)
Pretax profit		\$1,800
Tax (34%)		(612)
Net Profit		\$1,188
Cash Flow	-\$1,600	\$1,588

$$NPV = -\$1{,}600 + \sum_{t=1}^{4} \frac{\$1{,}588}{(1.10)^t} = \$3{,}433.75$$

Note that the *NPV* is calculated as of date 1, the date at which the investment of \$1,600 million is made. Later we bring this number back to date 0.

Stewart Pharmaceuticals NPV of Full-Scale Production following Unsuccessful Test

Investment	Year 1	Years 2-5
Revenues		$4,050
Variable Costs		(1,735)
Fixed Costs		(1,800)
Depreciation		(400)
Pretax profit		$115
Tax (34%)		(39.10)
Net Profit		$75.90
Cash Flow	-$1,600	$475

$$NPV = -\$1,600 + \sum_{t=1}^{4} \frac{\$475.90}{(1.10)^t} = -\$91.461$$

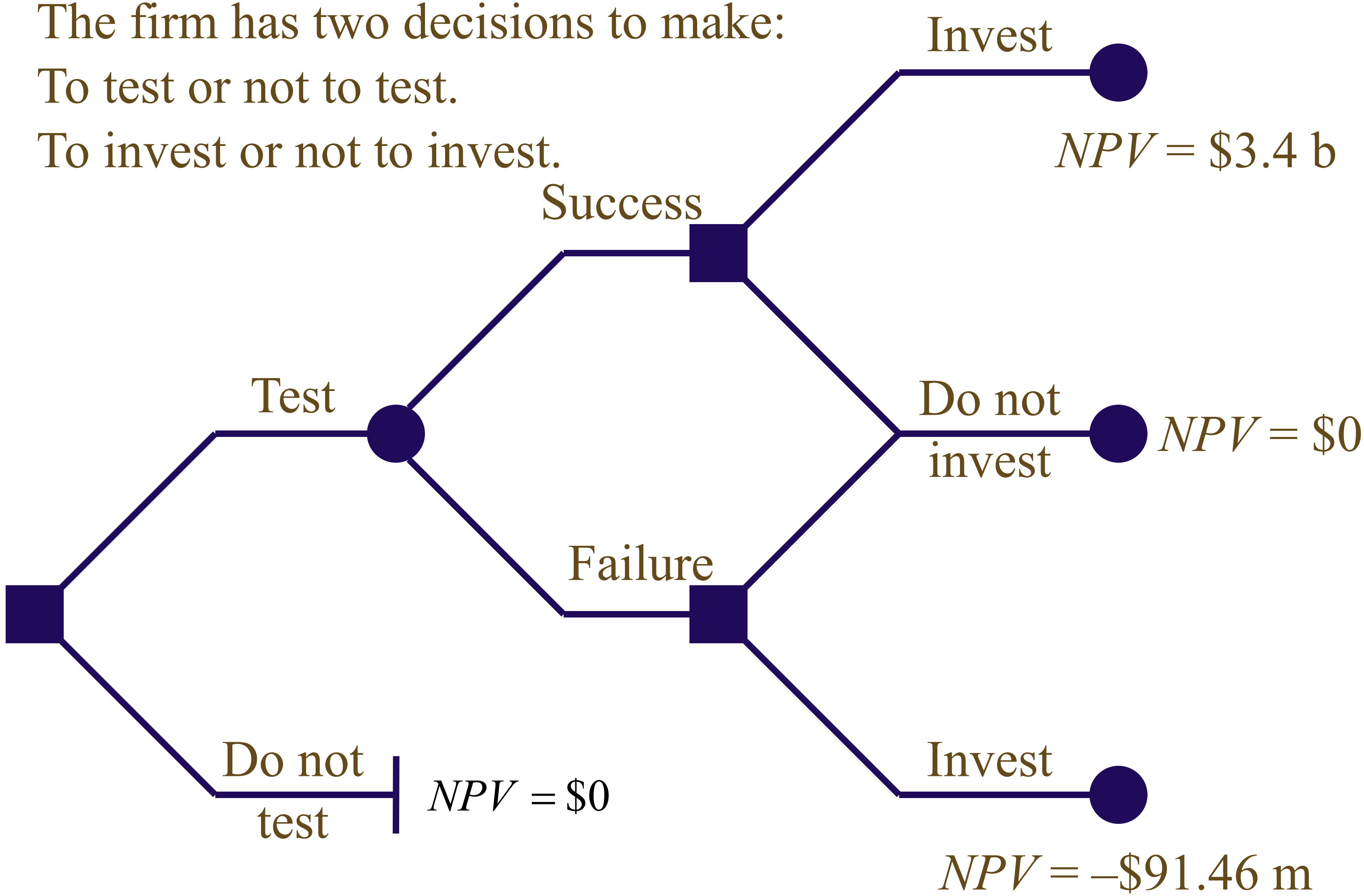
Note that the *NPV* is calculated as of date 1, the date at which the investment of $1,600 million is made. Later we bring this number back to date 0.

Decision Tree for Stewart Pharmaceutical

The firm has two decisions to make:

To test or not to test.

To invest or not to invest.



Stewart Pharmaceutical: Decision to Test

- Let's move back to the first stage, where the decision boils down to the simple question: should we invest?
- The expected payoff evaluated at date 1 is:

$$\begin{matrix}\text{Expected}\\\text{payoff}\end{matrix} = \begin{pmatrix}\text{Prob.} & \times & \text{Payoff}\\ \text{sucess} & & \text{given success}\end{pmatrix} + \begin{pmatrix}\text{Prob.} & \times & \text{Payoff}\\ \text{failure} & & \text{given failure}\end{pmatrix}$$

$$\begin{matrix}\text{Expected}\\\text{payoff}\end{matrix} = (.60 \times \$3{,}433.75) + (.40 \times \$0) = \$2{,}060.25$$

- The NPV evaluated at date 0 is:

$$NPV = -\$1{,}000 + \frac{\$2{,}060.25}{1.10} = \$872.95$$

So we should test.

8.4 Options

- One of the fundamental insights of modern finance theory is that options have value.
- The phrase "We are out of options" is surely a sign of trouble.
- Because corporations make decisions in a dynamic environment, they have options that should be considered in project valuation.

Options

- The Option to Expand
  - Has value if demand turns out to be higher than expected.
- The Option to Abandon
  - Has value if demand turns out to be lower than expected.
- The Option to Delay
  - Has value if the underlying variables are changing with a favorable trend.

The Option to Expand

- Imagine a start-up firm, Campusteria, Inc. which plans to open private (for-profit) dining clubs on college campuses.
- The test market will be your campus, and if the concept proves successful, expansion will follow nationwide.
- Nationwide expansion, if it occurs, will occur in year four.
- The start-up cost of the test dining club is only $30,000 (this covers leaseholder improvements and other expenses for a vacant restaurant near campus).

Campusteria *pro forma* Income Statement

Investment	Year 0	Years 1-4
Revenues		$60,000
Variable Costs		($42,000)
Fixed Costs		($18,000)
Depreciation		($7,500)
Pretax profit		($7,500)
Tax shield 34%		$2,550
Net Profit		–$4,950
Cash Flow	–$30,000	$2,550

$$NPV = -\$30{,}000 + \sum_{t=1}^{4} \frac{\$2{,}550}{(1.10)^t} = -\$21{,}916.84$$

We plan to sell 25 meal plans at $200 per month with a 12-month contract.

Variable costs are projected to be $3,500 per month.

Fixed costs (the lease payment) are projected to be $1,500 per month.

We can depreciate our capitalized leaseholder improvements.

The Option to Expand: Valuing a Start-Up

- Note that while the Campusteria *test site* has a negative NPV, we *are* close to our break-even level of sales.
- *If* we expand, we project opening 20 Campusterias in year four.
- *The value of the project is in the option to expand.*
- If we hit it big, we will be in a position to score large.
- We won't know if we don't try.

Discounted Cash Flows and Options

- We can calculate the market value of a project as the sum of the NPV of the project without options and the value of the managerial options implicit in the project.

$$M = NPV + Opt$$

- A good example would be comparing the desirability of a specialized machine versus a more versatile machine. If they both cost about the same and last the same amount of time the more versatile machine is more valuable because it comes with options.

The Option to Abandon: Example

- Suppose that we are drilling an oil well. The drilling rig costs $300 today and in one year the well is either a success or a failure.
- The outcomes are equally likely. The discount rate is 10%.
- The *PV* of the successful payoff at time one is $575.
- The *PV* of the unsuccessful payoff at time one is $0.

The Option to Abandon: Example

Traditional NPV analysis would indicate rejection of the project.

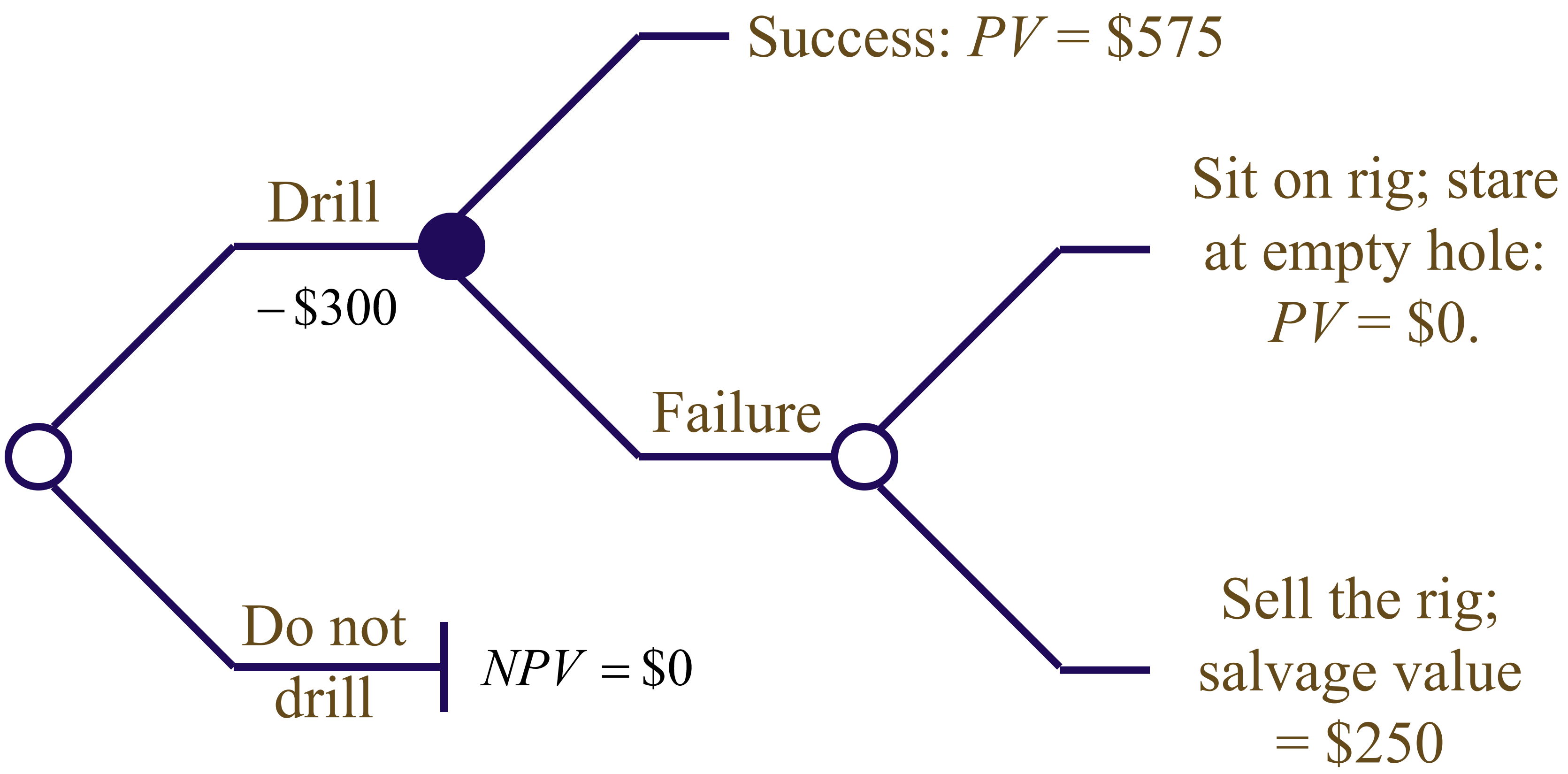
$$\text{Expected Payoff} = \text{Prob. Success} \times \text{Successful Payoff} + \text{Prob. Failure} \times \text{Failure Payoff}$$

$$\text{Expected Payoff} = (0.50 \times \$575) + (0.50 \times \$0) = \$287.50$$

$$NPV = -\$300 + \frac{\$287.50}{1.10} = -\$38.64$$

The Option to Abandon: Example

Traditional NPV analysis overlooks the option to abandon.



The firm has two decisions to make: drill or not, abandon or stay.

The Option to Abandon: Example

- When we include the value of the option to abandon, the drilling project should proceed:

$$\text{Expected Payoff} = \text{Prob. Success} \times \text{Successful Payoff} + \text{Prob. Failure} \times \text{Failure Payoff}$$

$$\text{Expected Payoff} = (0.50 \times \$575) + (0.50 \times \$250) = \$412.50$$

$$NPV = -\$300 + \frac{\$412.50}{1.10} = \$75.00$$

Valuation of the Option to Abandon

- Recall that we can calculate the market value of a project as the sum of the NPV of the project without options and the value of the managerial options implicit in the project.

$$M = NPV + Opt$$

$$\$75.00 = –\$38.61 + Opt$$

$$\$75.00 + \$38.61 = Opt$$

$$Opt = \$113.64$$

The Option to Delay: Example

Year	Cost	PV	NPV_t	NPV_0
0	$ 20,000	$ 25,000	$ 5,000	$ 5,000
1	$ 18,000	$ 25,000	$ 7,000	$ 6,364
2	$ 17,100	$ 25,000	$ 7,900	$ 6,529
3	$ 16,929	$ 25,000	$ 8,071	$ 6,064
4	$ 16,760	$ 25,000	$ 8,240	$ 5,628

$$\$6{,}529 = \frac{\$7{,}900}{(1.10)^2}$$

- Consider the above project, which can be undertaken in any of the next 4 years. The discount rate is 10 percent. The present value of the benefits at the time the project is launched remain constant at $25,000, but since costs are declining the NPV at the time of launch steadily rises.
- The best time to launch the project is in year 2—this schedule yields the highest NPV when judged today.