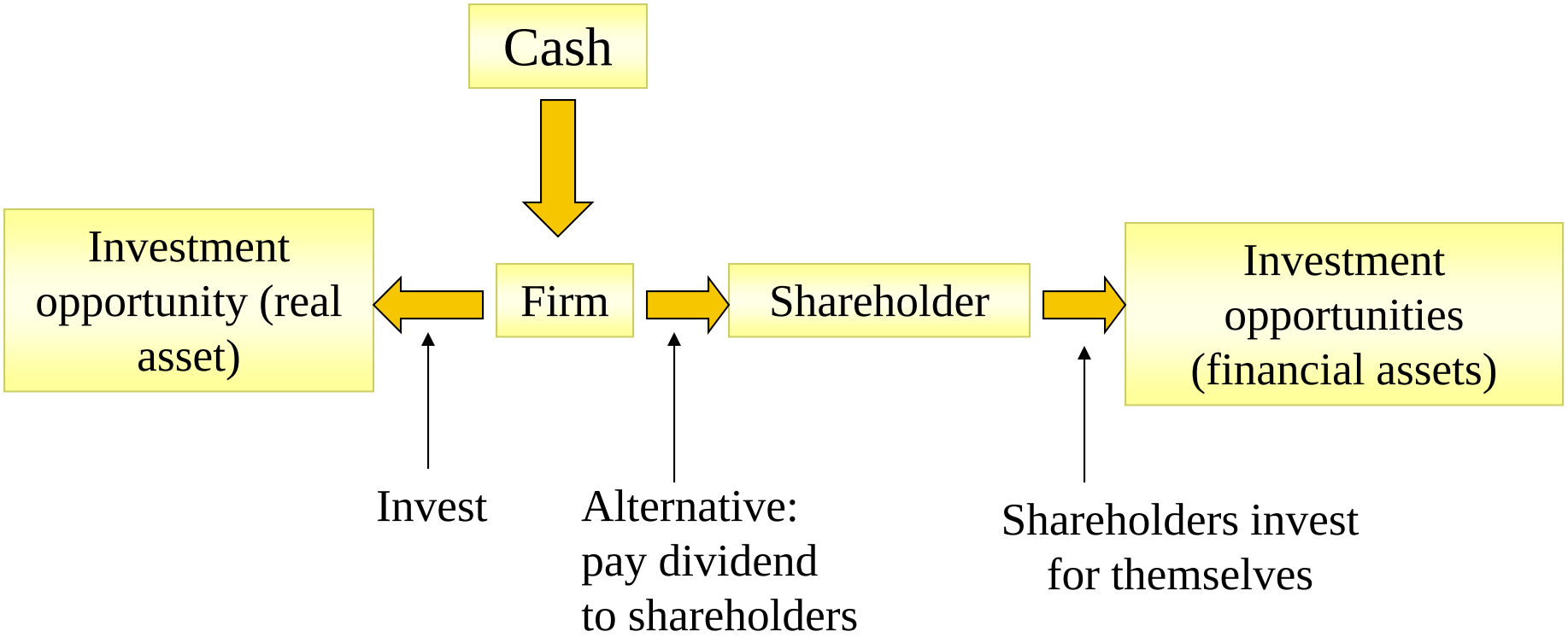
# Capital budgeting

# Net present value and other investment criteria

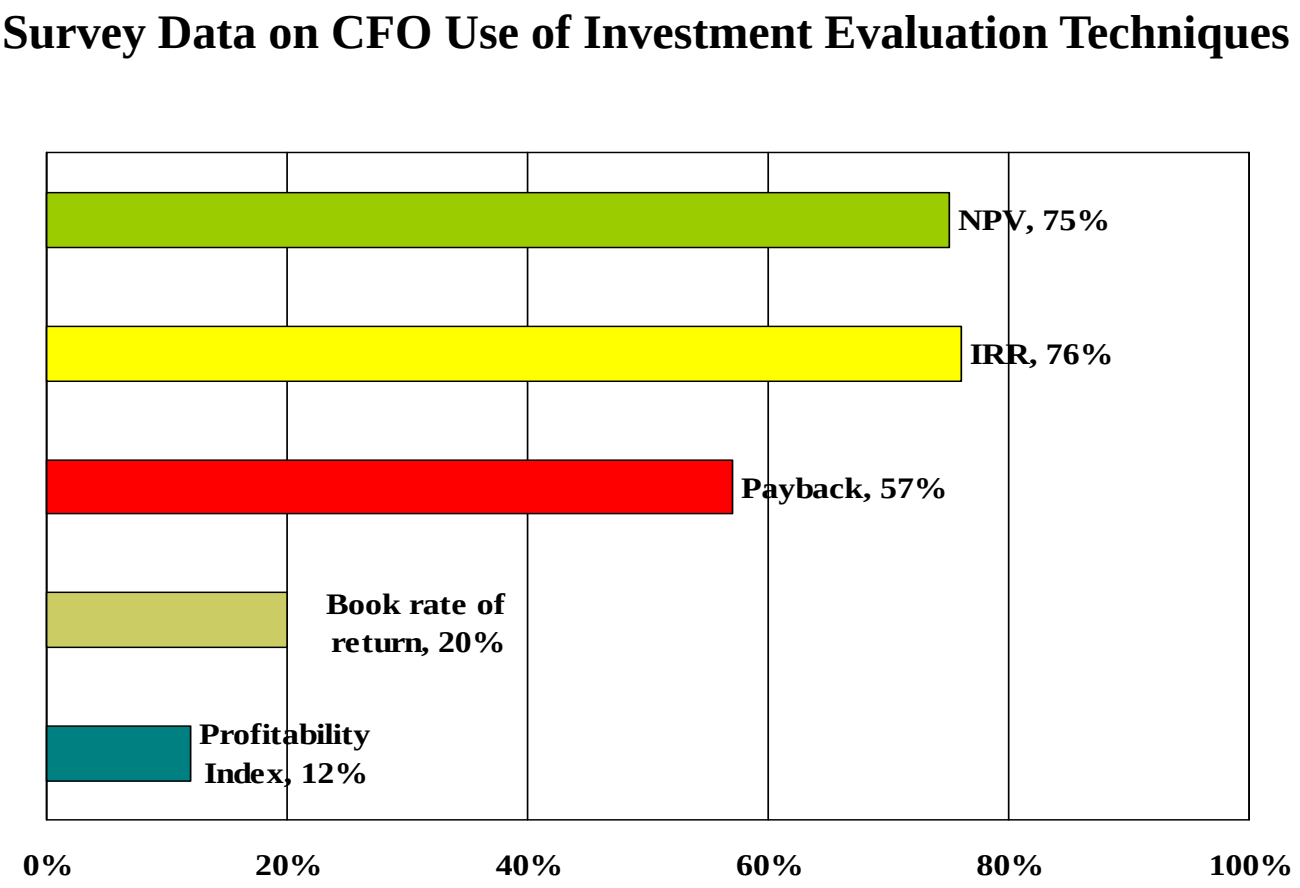
- A Review of The Basics
  - NPV and its Competitors
- The Payback Period
  - The Book Rate of Return
- Internal Rate of Return
- Capital Rationing

# NPV and Cash Transfers

- Every possible method for evaluating projects impacts the flow of cash about the company as follows.



# CFO Decision Tools




SOURCE: Graham and Harvey, "The Theory and Practice of Finance: Evidence from the Field," Journal of Financial Economics 61 (2001), pp. 187-243.

# Book Rate of Return

Book Rate of Return - Average income divided by average book value over project life. Also called *accounting rate of return*.

$$\text{Book rate of return} = \frac{\text{book income}}{\text{book assets}}$$

Managers rarely use this measurement to make decisions. The components reflect tax and accounting figures, not market values or cash flows.

# Payback

- The payback period of a project is the number of years it takes before the cumulative forecasted cash flow equals the initial outlay.
- The payback rule says only accept projects that “payback” in the desired time frame.
- This method is flawed, primarily because it ignores later year cash flows and the present value of future cash flows.

# Payback

***Example***

*Examine the three projects and note the mistake we would make if we insisted on only taking projects with a payback period of 2 years or less.*

| Project | $C_0$ | $C_1$ | $C_2$ | $C_3$ | Payback Period | NPV@10% |
|---|---|---|---|---|---|---|
| A | -2000 | 500 | 500 | 5000 | | |
| B | -2000 | 500 | 1800 | 0 | | |
| C | -2000 | 1800 | 500 | 0 | | |

# Payback

***Example***

| Project | $C_0$ | $C_1$ | $C_2$ | $C_3$ | Payback Period | NPV@10% |
|---|---|---|---|---|---|---|
| A | -2000 | 500 | 500 | 5000 | 3 | +2,624 |
| B | -2000 | 500 | 1800 | 0 | 2 | -58 |
| C | -2000 | 1800 | 500 | 0 | 2 | +50 |

| Project | $C_0$ | $C_1$ | $C_2$ | $C_3$ | Payback Period | NPV@ 10% |
|---|---|---|---|---|---|---|
| A | -2000 | 455 | 413 | 3757 | 3 | +2,624 |
| B | -2000 | 455 | 1488 | 0 | - | -58 |
| C | -2000 | 1636 | 413 | 0 | 2 | +50 |

# Internal Rate of Return

IRR is defined as the rate of discount that makes NPV = 0

***Example***

*You can purchase a turbo powered machine tool gadget for $4,000. The investment will generate $2,000 and $4,000 in cash flows for two years, respectively. What is the IRR on this investment?*

# Internal Rate of Return

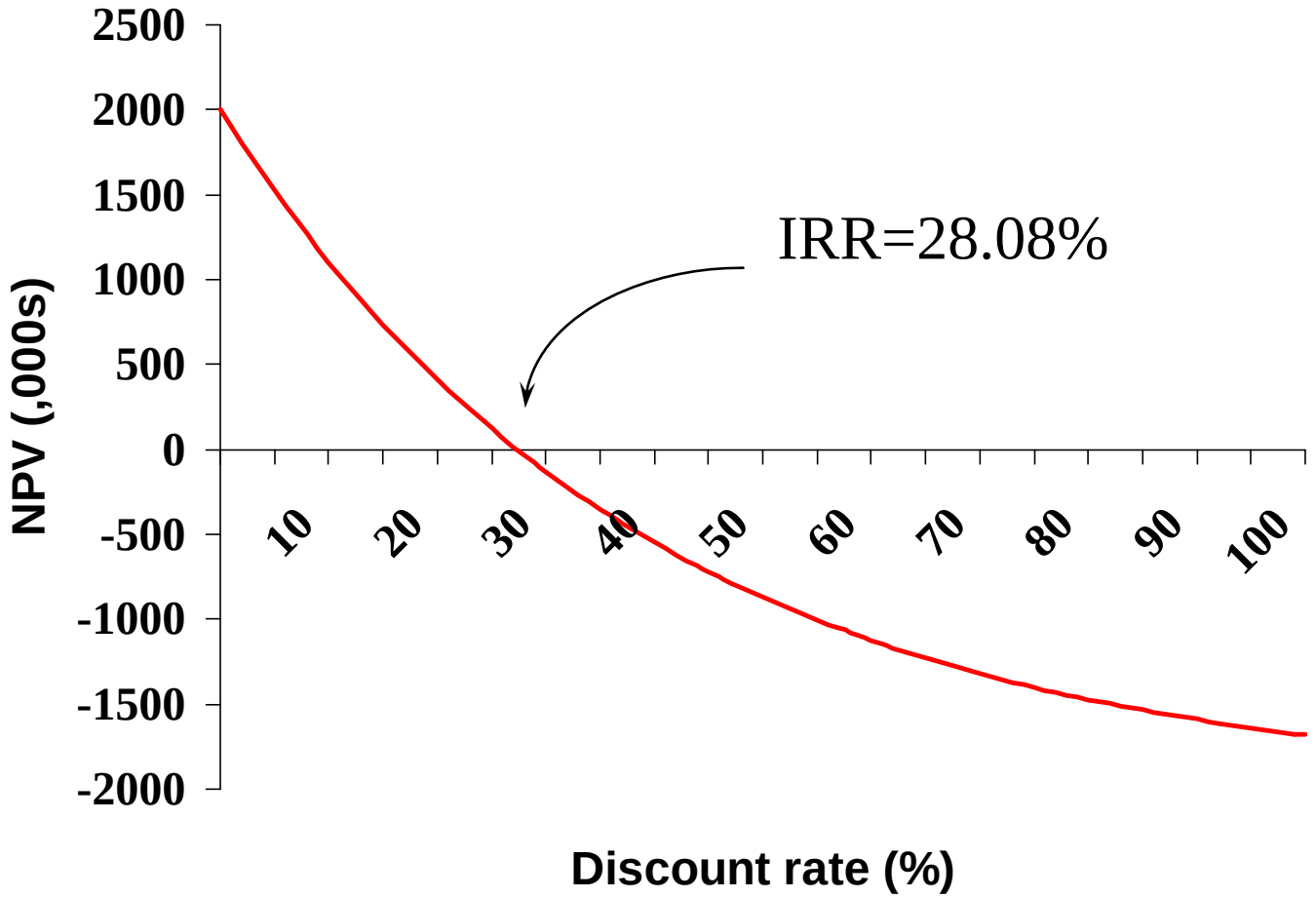
***Example***

*You can purchase a turbo powered machine tool gadget for $4,000. The investment will generate $2,000 and $4,000 in cash flows for two years, respectively. What is the IRR on this investment?*

$$NPV = -4{,}000 + \frac{2{,}000}{(1+IRR)^1} + \frac{4{,}000}{(1+IRR)^2} = 0$$

$$IRR = 28.08\%$$

# Internal Rate of Return




IRR Rule: Accept an investment project if the opportunity cost of capital is less than the IRR.

# Internal Rate of Return

- Some people confuse the IRR and the opportunity cost of capital because both appear as a discounting rate in the NPV formula.
- IRR is a profitability measure that depends solely on the amount and timing of the project cash flows
- The opportunity cost of capital is a standard profitability that we use to calculate how much the project is worth and it is established in the capital market.

# Internal Rate of Return

## Pitfall 1 - Lending or Borrowing?

- With some cash flows (as noted below) the NPV of the project increases as the discount rate increases.
- This is contrary to the normal relationship between NPV and discount rates.

| Project | $C_0$ | $C_1$ | $IRR$ | $NPV$ @ 10% |
|---|---|---|---|---|
| $A$ | $-1{,}000$ | $+1{,}500$ | $+50\%$ | $+364$ |
| $B$ | $+1{,}000$ | $-1{,}500$ | $+50\%$ | $-364$ |

# Internal Rate of Return

Pitfall 2 - Multiple Rates of Return

- Certain cash flows can generate NPV=0 at two different discount rates.

- The following cash flow generates NPV=$3.3 million at both IRR% of (-44%) and +11.6%.

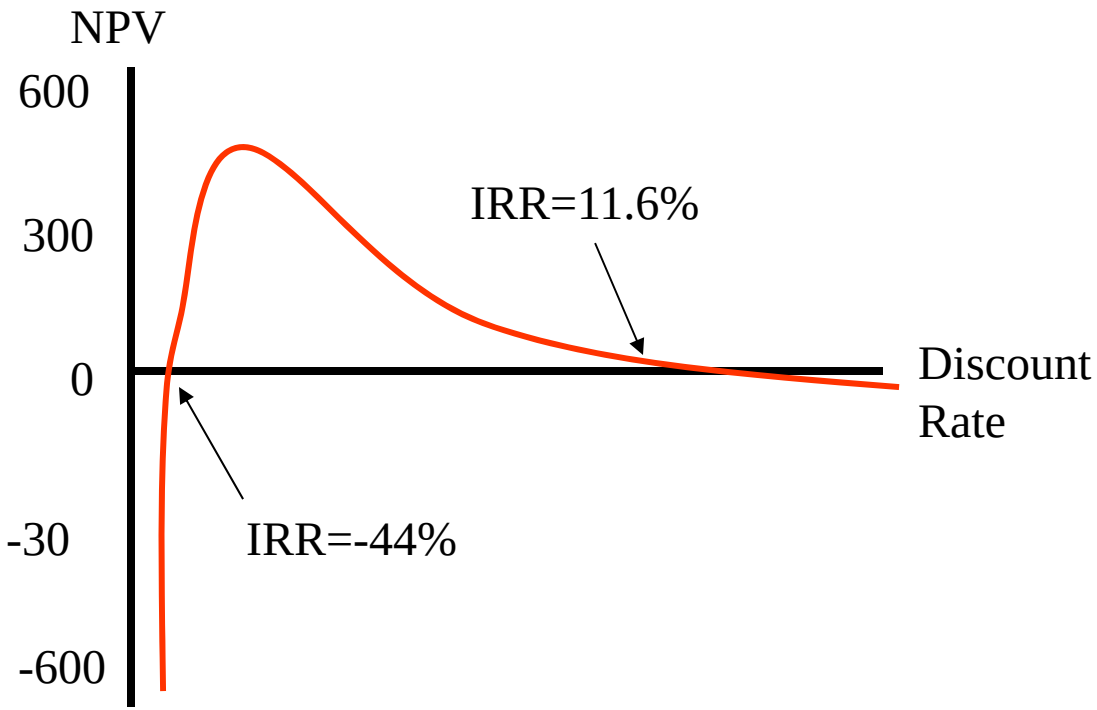
Cash Flows (millions of Australian dollars)

| $C_0$ | $C_1 \ldots\ldots$ | $\ldots\ldots C_9$ | $C_{10}$ |
|---|---|---|---|
| $-600$ | 120 | 120 | $-150$ |

# Internal Rate of Return

Pitfall 2 - Multiple Rates of Return

- Certain cash flows can generate NPV=0 at two different discount rates.
- The following cash flow generates NPV=$A 3.3 million at both IRR% of (-44%) and +11.6%.



# Internal Rate of Return

## Pitfall 2 - Multiple Rates of Return

- It is possible to have a zero IRR and a positive NPV

| Project | $C_0$ | $C_1$ | $C_2$ | $IRR$ | $NPV\ @\ 10\%$ |
|---|---|---|---|---|---|
| $C$ | $+1,000$ | $-3,000$ | $+2,500$ | $None$ | $+339$ |

# Internal Rate of Return

Pitfall 3 - Mutually Exclusive Projects

- IRR sometimes ignores the magnitude of the project.
- The following two projects illustrate that problem.

| Project | $C_0$ | $C_1$ | $IRR$ | $NPV$ @ 10% |
|---|---|---|---|---|
| $D$ | $-10{,}000$ | $+20{,}000$ | 100% | $+8{,}182$ |
| $E$ | $-20{,}000$ | $+35{,}000$ | +75% | $+11{,}818$ |

# Internal Rate of Return

Pitfall 4 - Term Structure Assumption

- We assume that discount rates are stable during the term of the project.
- This assumption implies that all funds are reinvested at the IRR.
- This is a false assumption.

# Profitability Index

- When resources are limited, the profitability index (PI) provides a tool for selecting among various project combinations and alternatives
- A set of limited resources and projects can yield various combinations.
- The highest weighted average PI can indicate which projects to select.

# Profitability Index

Cash Flows ($ millions)

| Project | $C_0$ | $C_1$ | $C_2$ | $NPV$ @ 10% |
|---|---|---|---|---|
| $A$ | $-10$ | $+30$ | $+5$ | 21 |
| $B$ | $-5$ | $+5$ | $+20$ | 16 |
| $C$ | $-5$ | $+5$ | $+15$ | 12 |
| $D$ | 0 | $-40$ | 60 | 13 |

Profitability index: The highest net present value per dollar of initial outlay

# Profitability Index

Cash Flows ($ millions)

| Project | Investment ($) | NPV ($) | Profitability Index |
|---|---|---|---|
| A | 10 | 21 | 2.1 |
| B | 5 | 16 | 3.2 |
| C | 5 | 12 | 2.4 |
| D | 0 | 13 | 0.4 |

# Profitability Index

$$\text{Profitability Index} = \frac{\text{NPV}}{\text{Investment}}$$

***Example***

*We only have $300,000 to invest. Which do we select?*

| Proj | NPV | Investment | PI |
|---|---|---|---|
| A | 230,000 | 200,000 | 1.15 |
| B | 141,250 | 125,000 | 1.13 |
| C | 194,250 | 175,000 | 1.11 |
| D | 162,000 | 150,000 | 1.08 |

# Profitability Index

***Example - continued***

| Proj | NPV | Investment | PI |
|---|---|---|---|
| A | 230,000 | 200,000 | 1.15 |
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| C | 194,250 | 175,000 | 1.11 |
| D | 162,000 | 150,000 | 1.08 |

Select projects with highest Weighted Avg PI

$$\text{WAPI (BD)} = \frac{1.13(125)}{(300)} + \frac{1.08(150)}{(300)}$$

$$= 1.01$$

# Profitability Index

***Example - continued***

| Proj | NPV | Investment | PI |
|---|---|---|---|
| A | 230,000 | 200,000 | 1.15 |
| B | 141,250 | 125,000 | 1.13 |
| C | 194,250 | 175,000 | 1.11 |
| D | 162,000 | 150,000 | 1.08 |

Select projects with highest Weighted Avg PI

WAPI (BD) = 1.01

WAPI (A) = 0.77

**WAPI (BC) = 1.12**

# Linear Programming

- Maximize Cash flows or NPV
- Minimize costs

***Example***

Max NPV = $21X_a + 16X_b + 12X_c + 13X_d$

subject to

$10X_a + 5X_b + 5X_c + 0X_d <= 10$

$-30X_a - 5X_b - 5X_c + 40X_d <= 12$

# Project Analysis

- The Capital Investment Process
- Sensitivity Analysis
- Break Even Analysis
- Monte Carlo Simulation
- Real Options and Decision Trees

# Capital Investments

- Items for consideration

Capital Budget – A list of investment projects planned for the coming year

Once the capital budget approved, most companies require “appropriation request”, which includes detailed forecast, discounted-cash-flow analyses, and back-up information

Forecasts has errors and sometimes inflated

# Capital Investments

Do not add fudge factors to the cost of capital

Postaudits – A review of the project to see how closely it met forecasts

– Identify problems that need fixing

– Suggest questions that should have been asked before the project was undertaken

# How To Handle Uncertainty

Sensitivity Analysis - Analysis of the effects of changes in sales, costs, etc. on a project.

Scenario Analysis - Project analysis given a particular combination of assumptions.

Simulation Analysis - Estimation of the probabilities of different possible outcomes.

Break Even Analysis - Analysis of the level of sales (or other variable) at which the company breaks even.

# Sensitivity Analysis

Example:

Given the expected cash flow forecasts for Otobai Company's Motor Scooter project, listed on the next slide, determine the NPV of the project given changes in the cash flow components using a 10% cost of capital. Assume that all variables remain constant, except the one you are changing.

# Sensitivity Analysis

## Example - continued

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| | Year 0 | Years 1-10 |
|---|---|---|
| Investment | -15 | |
| Sales | | 37.5 |
| Variable Costs | | 30 |
| Fixed Costs | | 3 |
| Depreciation | | 1.5 |
| Pretax profit | | 3 |
| .Taxes @ 50% | | 1.5 |
| Profit after tax | | 1.5 |
| Operating cash flow | | 3.0 |
| Net Cash Flow | -15 | 3 |

**NPV= 3.43 billion Yen**

# Sensitivity Analysis

$$NPV = -15 + \sum_{t=1}^{10} \frac{3}{(1.10)^t} = 3.43 \text{ billion}$$

Identify key variables that determine whether the project succeeds or fails

Unit sale = new product's share of market $\times$ size of scooter market

$= 0.1 \times 1$ million $=100{,}000$ scooters

Revenue = unit sales $\times$ price per unit

$= 100{,}000 \times 375{,}000 = 3.7$ billion

Variable cost = unit sales $\times$ cost per unit

$= 100{,}000 \times 300{,}000 = 30$ billion

Look out for unidentified variables

- Patent problem
- Service stations are necessary to recharge the batteries

# Sensitivity Analysis

Example - continued

***Possible Outcomes***

| | *Range* | | |
|---|---|---|---|
| *Variable* | *Pessimistic* | *Expected* | *Optimistic* |
| Market Size | .9 mil | 1.0 mil | 1.1 mil |
| Market Share | .04 | .1 | .16 |
| Unit price | 350,000 | 375,000 | 380,000 |
| Unit Var Cost | 360,000 | 300,000 | 275,000 |
| Fixed Cost | 4 bil | 3 bil | 2 bil |

# Sensitivity Analysis

Example - continued

***NPV Calculations for Optimistic Market Size Scenario***

| | Year 0 | Years 1-10 |
|---|---|---|
| Investment | -15 | |
| Sales | | 41.25 |
| Variable Costs | | 33 |
| Fixed Costs | | 3 |
| Depreciation | | 1.5 |
| Pretax profit | | 3.75 |
| .Taxes @ 50% | | 1.87 |
| Profit after tax | | 1.87 |
| Operating cash flow | | 3.38 |
| Net Cash Flow | -15 | +3.38 |

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**NPV= +5.7 bil yen**

# Sensitivity Analysis

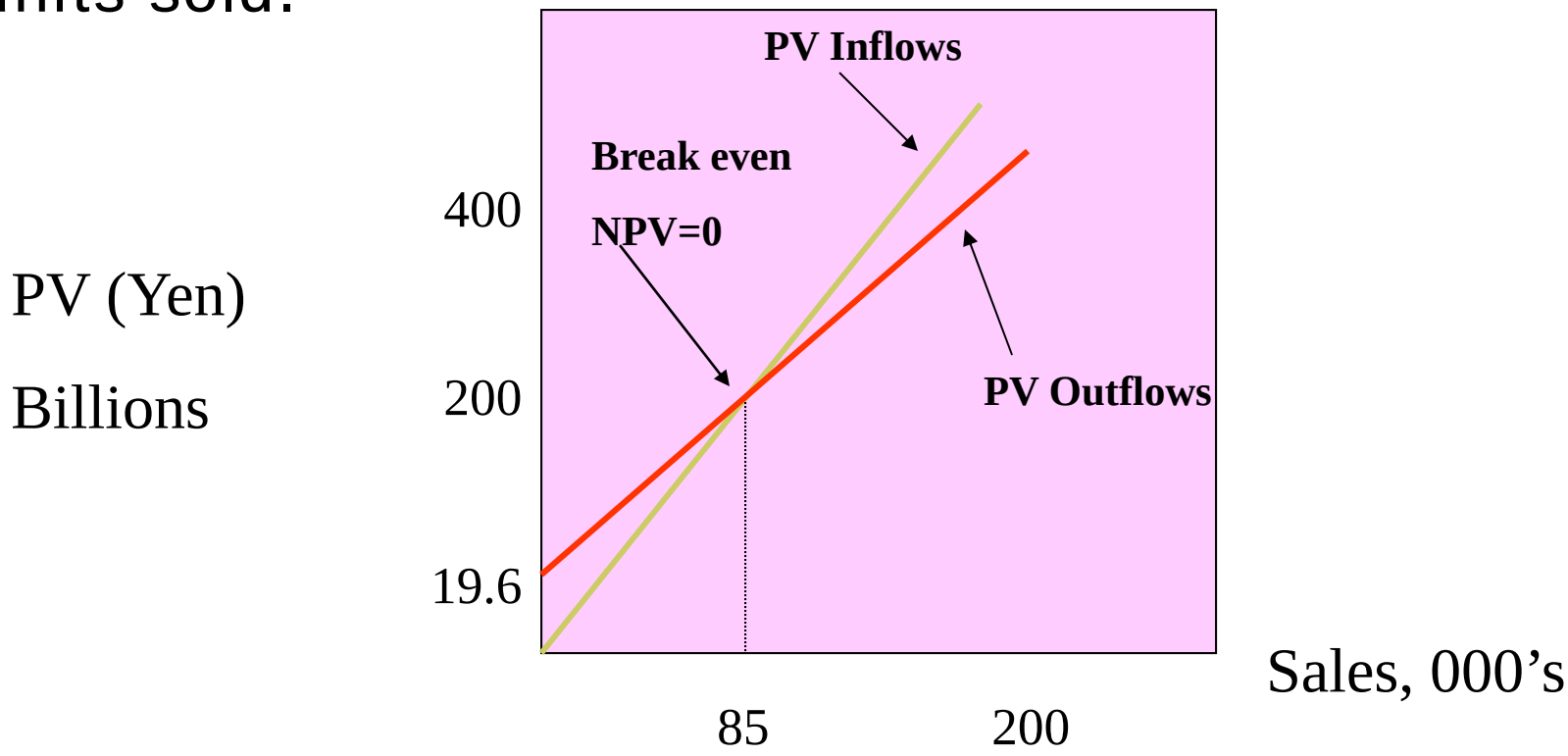
Example - continued

***NPV Possibilities (Billions Yen)***

| | *Range* | | |
|---|---|---|---|
| *Variable* | *Pessimistic* | *Expected* | *Optimistic* |
| Market Size | 1.1 | 3.4 | 5.7 |
| Market Share | -10.4 | 3.4 | 17.3 |
| Unit price | -4.2 | 3.4 | 5.0 |
| Unit Var Cost | -15.0 | 3.4 | 11.1 |
| Fixed Cost | 0.4 | 3.4 | 6.5 |

# Break Even Analysis

- Point at which the NPV=0 is the break even point
- Otobai Motors has a breakeven point of 85,000 units sold.



# Electric Scooter – Scenario Analysis

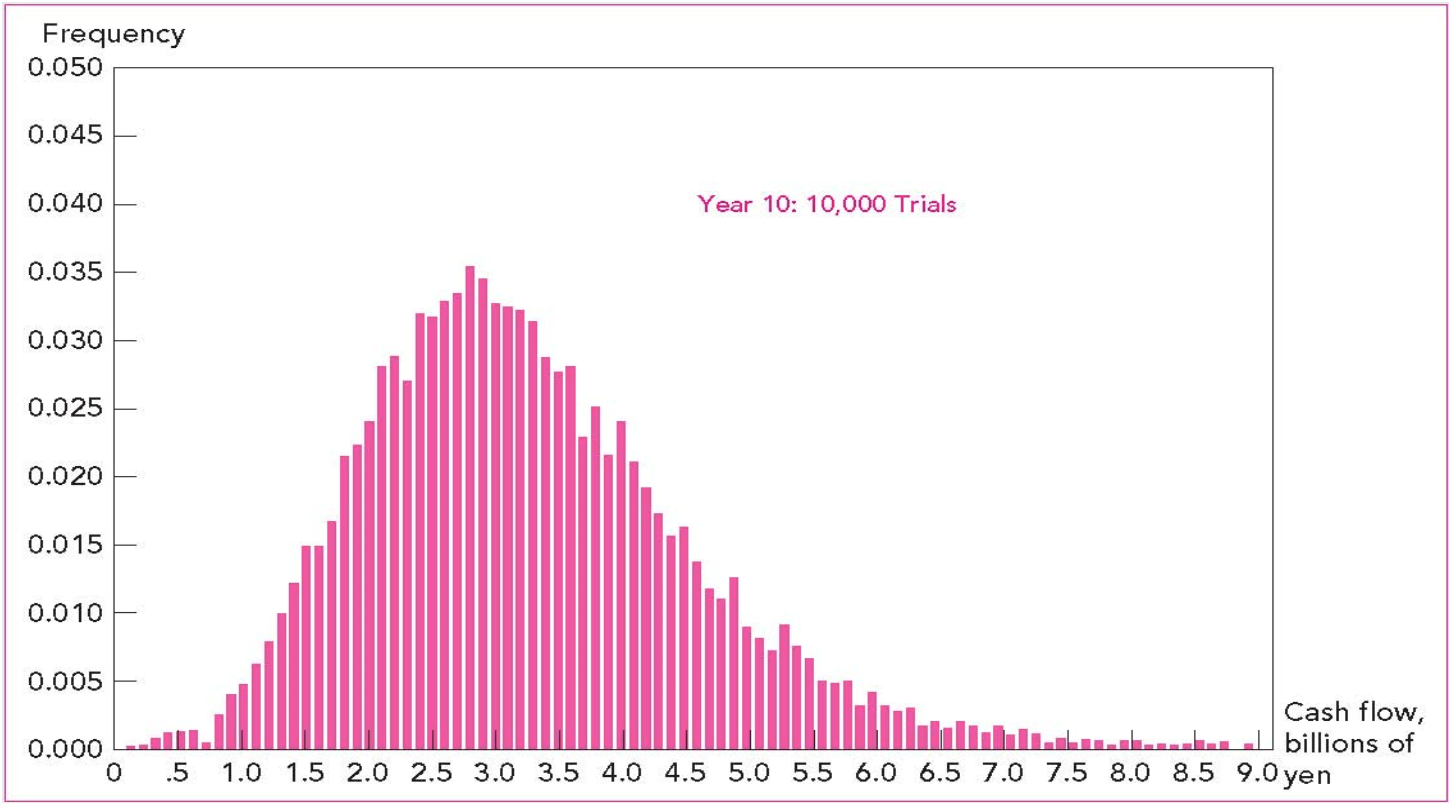
| | | Cash Flows, Years 1-10, Billions | |
|---|---|---|---|
| | | Base Case | High Oil Prices and Recession Case |
| 1 | Revenue | 37.5 | 44.9 |
| 2 | Variable cost | 30.0 | 35.9 |
| 3 | Fixed cost | 3.0 | 3.5 |
| 4 | Depreciation | 1.5 | 1.5 |
| 5 | Pretax profit (1-2-3-4) | 3.0 | 4.0 |
| 6 | Tax | 1.5 | 2.0 |
| 7 | Net profit (5-6) | 1.5 | 2.0 |
| 8 | Net cash flow (4+7) | 3.0 | 3.5 |
| PV of cash flows | | 18.4 | 21.5 |
| NPV | | 3.4 | 6.5 |

# Monte Carlo Simulation

## Modeling Process

- Step 1: Modeling the Project
- Step 2: Specifying Probabilities
- Step 3: Simulate the Cash Flows

# Monte Carlo Simulation

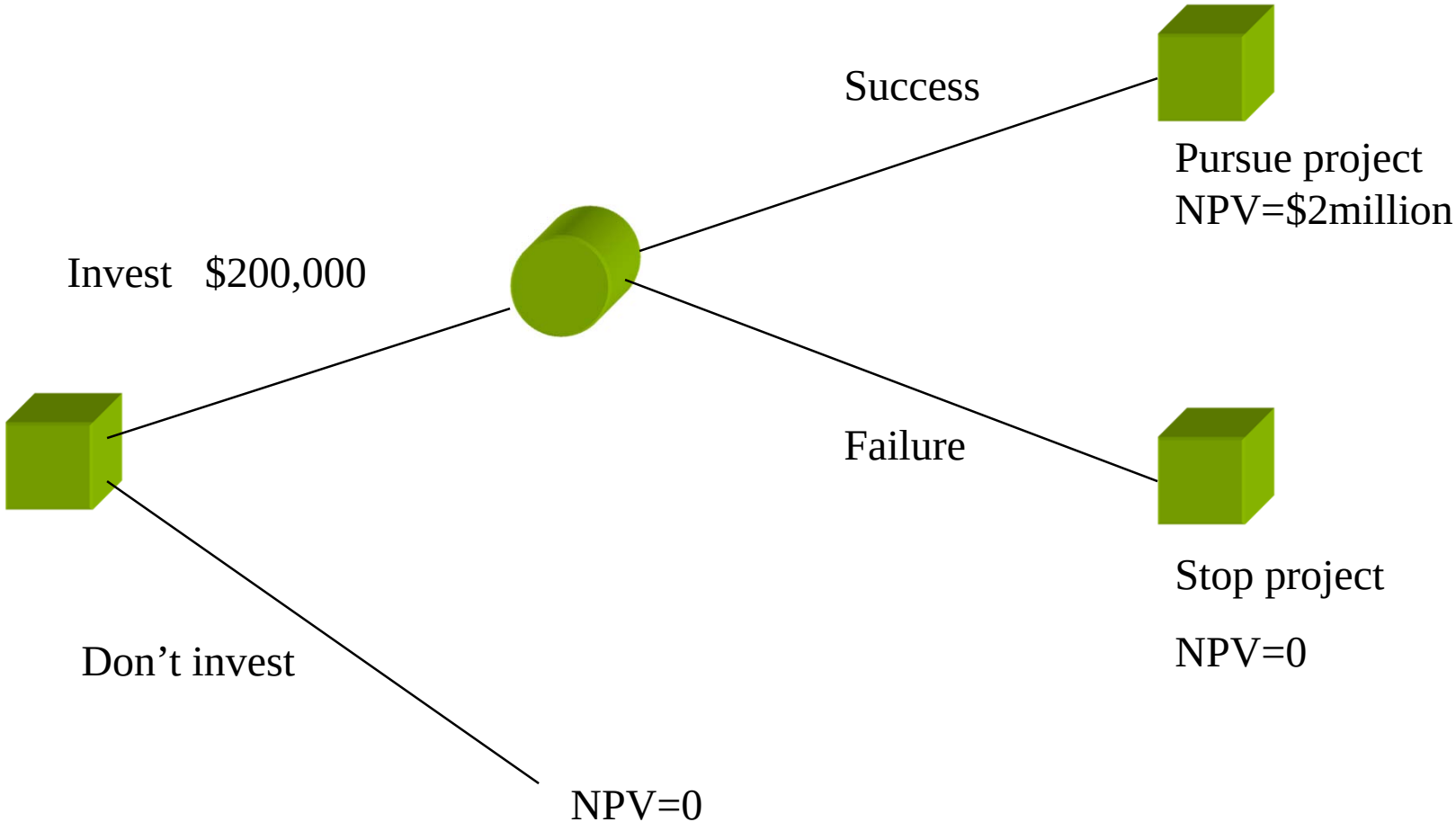


# Flexibility & Real Options

**Decision Trees** - Diagram of sequential decisions and possible outcomes.

- Decision trees help companies determine their Options by showing the various choices and outcomes.
- The Option to avoid a loss or produce extra profit has value.
- The ability to create an Option thus has value that can be bought or sold.

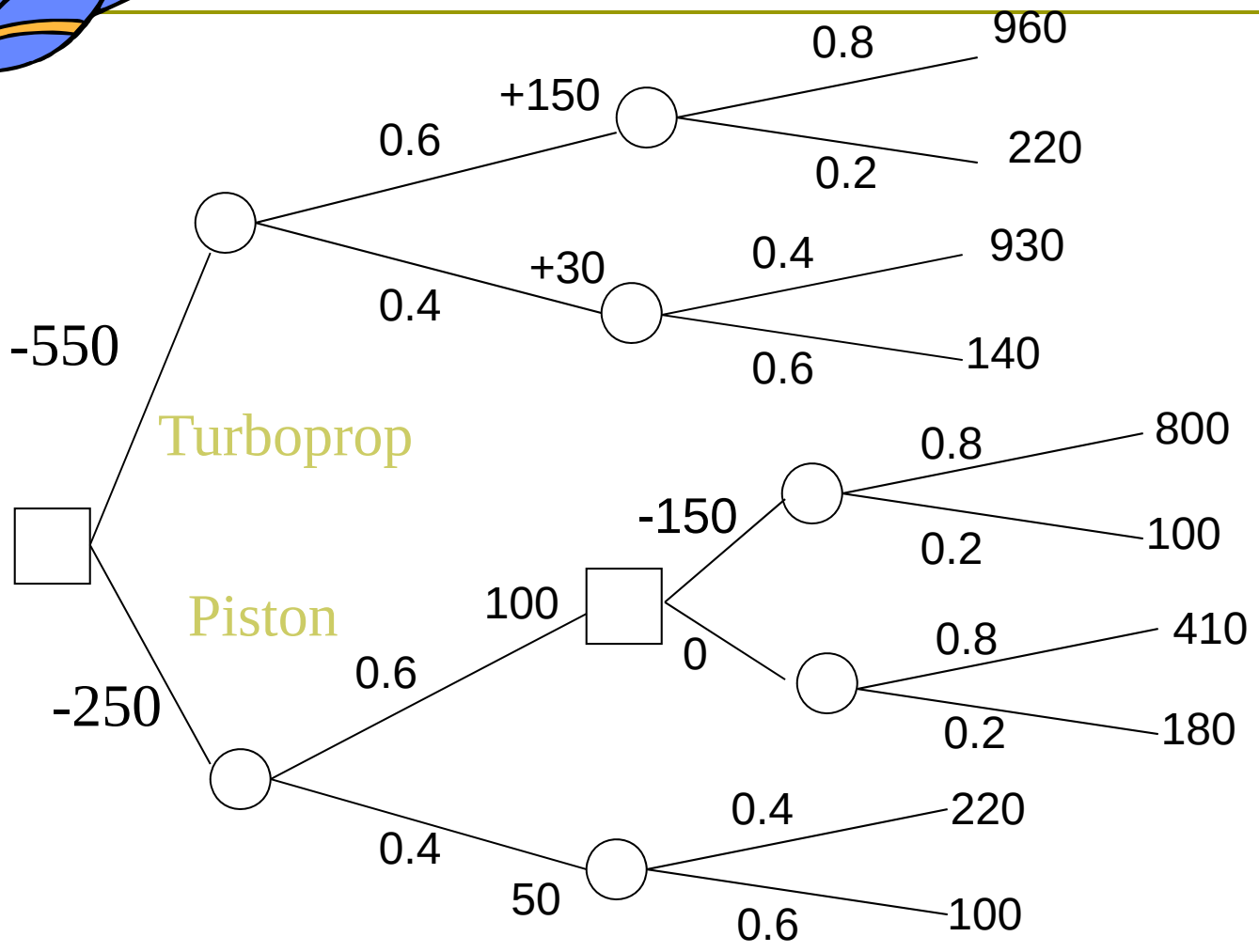
# Decision Trees



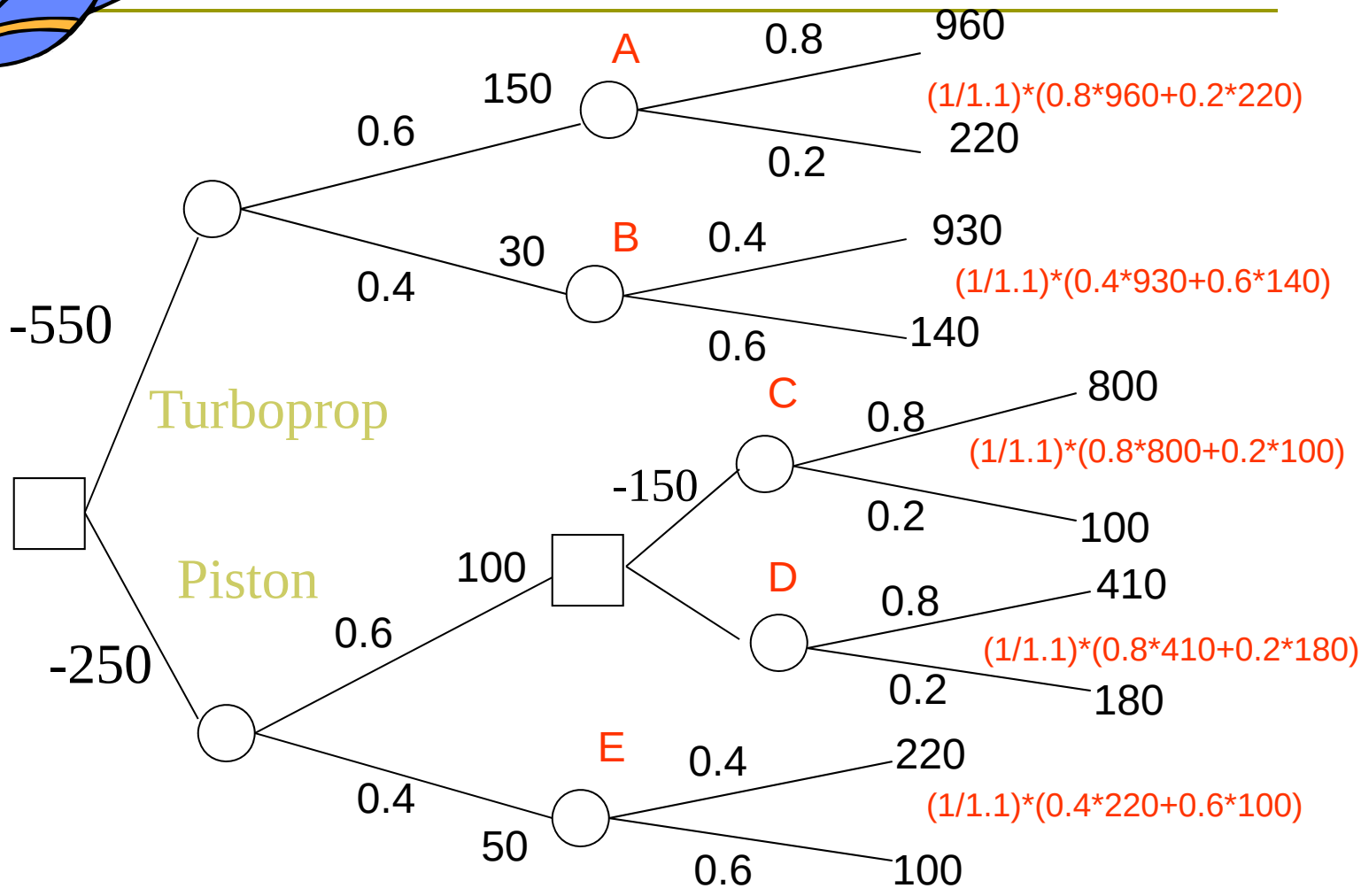
# Real Options

1. **Option to expand**
2. **Option to abandon**
3. **Timing option**
4. **Flexible production facilities**

# Decision Trees



# Decision Trees



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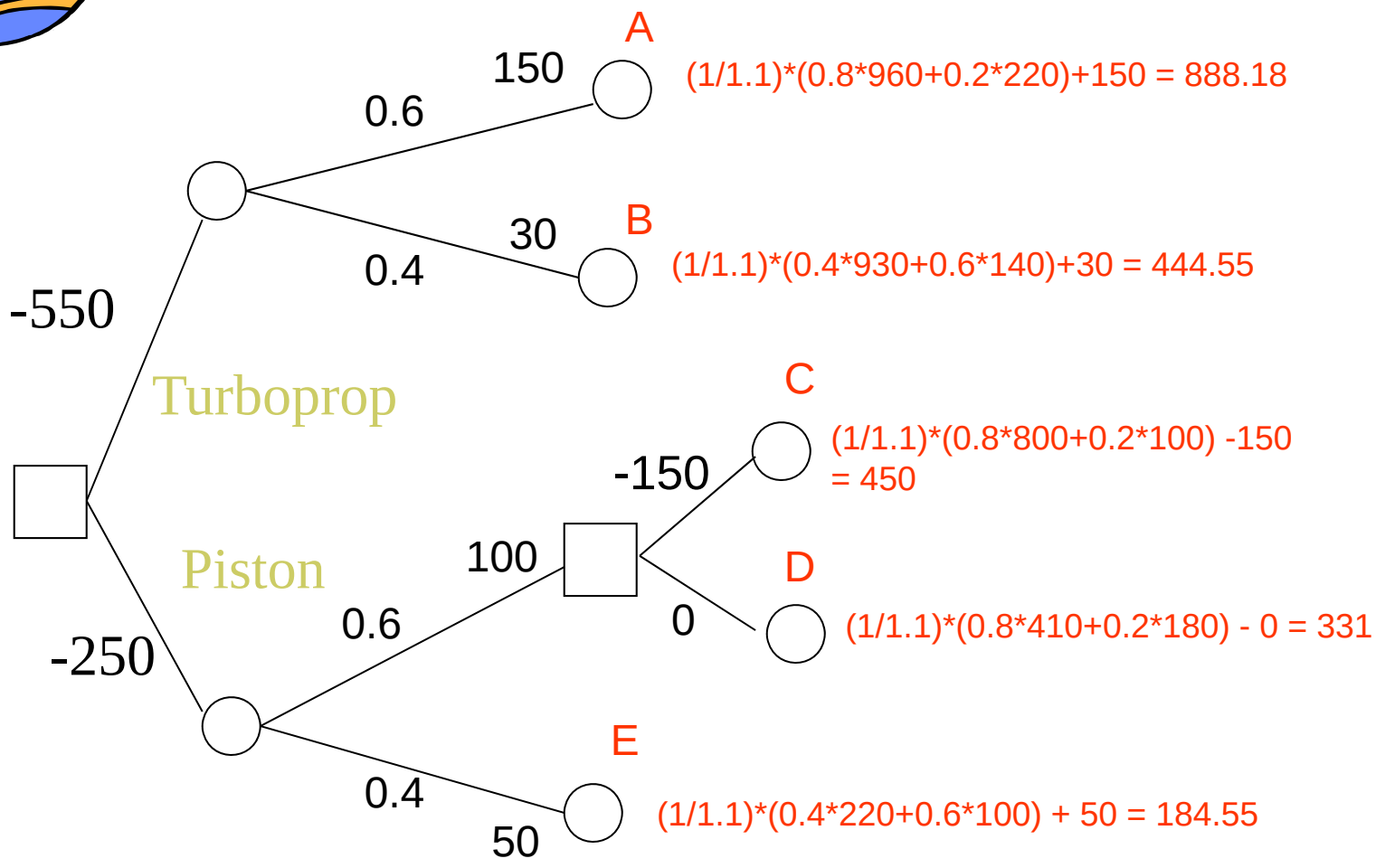

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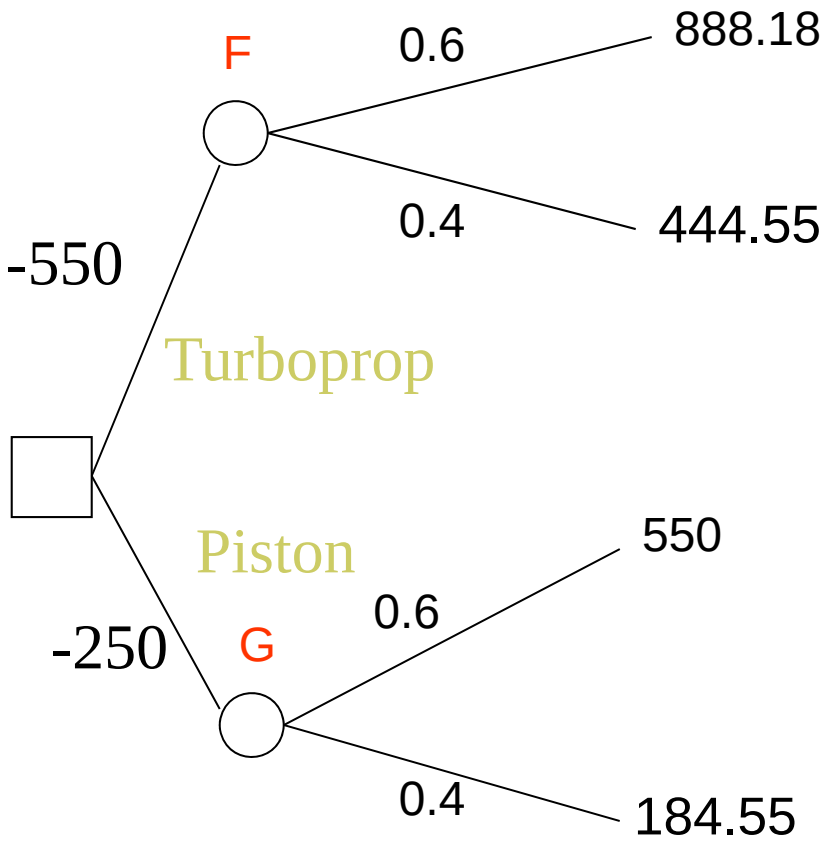

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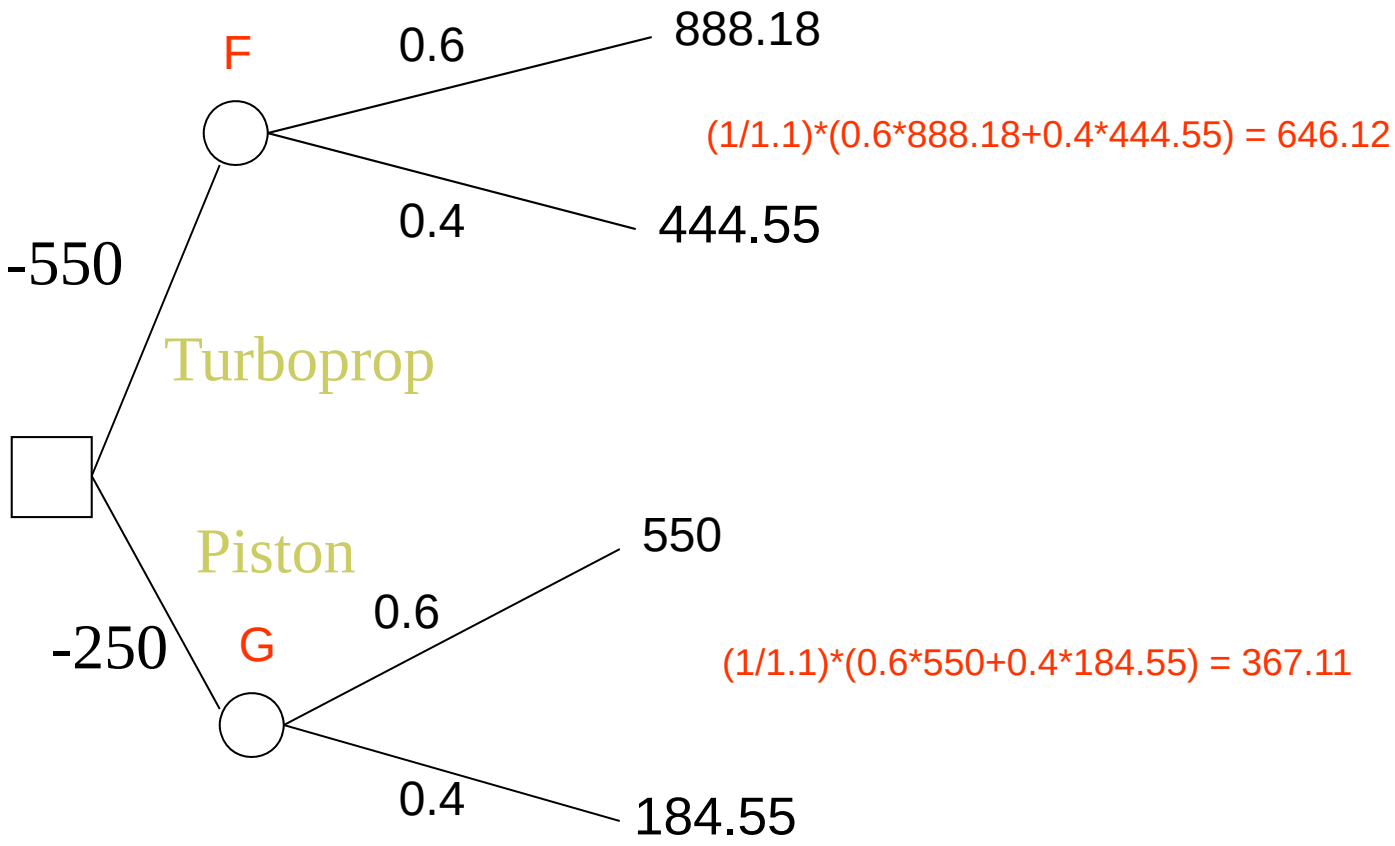

# Decision Trees