FIN2010 Financial Management
Lecture 19: Project Analysis

Review—Cash Flow of a Project

- 3 Principles:
  - Cash flows, not earnings
  - Incremental: the difference between taking and rejecting the project
  - Ignore financing related costs

- Depreciation tax shield = depreciation * tax rate
  - We want to depreciate an asset as fast as possible (as long as we have positive EBIT)
  - Typically we use the double declining method

- The after-tax cash flow from the asset sale

  =sale price + tax savings = sale price + (tax rate*capital losses)

- Net working capital: only the change matters

Agenda

- Motivation
- What-If Analyses
  - Sensitivity analysis
  - Scenario analysis
- Break-Even Analysis
  - Accounting break-even
  - Cash break-even
  - Financial break-even
- Operating Leverage
- Managerial options

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Motivation

- NPV estimates are just that – estimates
- A positive NPV is a good start – now we need to take a closer look
  - Forecasting risk – how sensitive is our NPV to changes in the cash flow estimates; the more sensitive, the greater the forecasting risk
- Methods to assess the uncertainty and identify the drivers of value in a project.
  - Sensitivity analysis
  - Scenario analysis
  - Break-even analysis
  - Managerial options

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Sensitivity Analysis

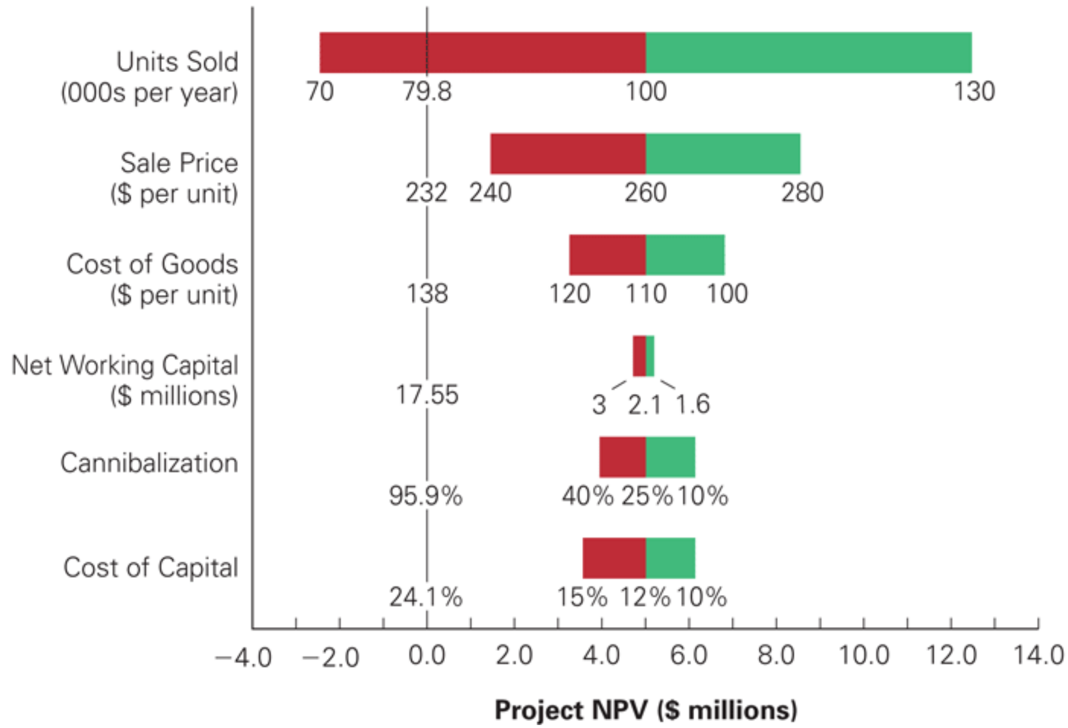
- What happens to NPV when we change one variable at a time
- Sensitivity analysis breaks the NPV calculation into its component assumptions and shows how the NPV varies as the underlying assumptions change.
  - It allows us to explore the effects of errors in our NPV estimates for the project.
- The greater the volatility in NPV in relation to a specific variable, the larger the forecasting risk associated with that variable, and the more attention we want to pay to its estimation

Sensitivity Analysis - Example

Best- and worst-case parameter assumptions for HomeNet

Paramater	Initial Assumption	Worst Case	Best Case
Units sold (thousands)	100	70	130
Sale price ($/unit)	260	240	280
Cost of goods ($/unit)	110	120	100
NWC ($thousands)	2100	3000	1600
Cost of capital	12%	15%	10%

HomeNet's NPV Under Different Assumptions



: NPV under the best-case assumption for each parameter.

:NPV under the worst-case assumption for each parameter.

- Top bar (NPV when changing assumption about units sold while keeping all other assumptions intact (P13 of Lecture 18)):
  - Best case: number of units sold = 130,000 per year, NPV = \$15.06 million.
  - Initial assumption: number of units sold = 100,000/year, NPV = \$6.86 million.
  - Worst case: number of units sold = 70,000 per year, NPV = - \$1.35 million.
- We repeat the calculation for each parameter.
- The results reveal that the most important parameter assumptions are the number of units sold and sale price. These variables are the drives of the project's value and deserve the most attention.

Scenario Analysis

- In sensitivity analysis, we have considered the consequences of varying only one parameter at a time. In reality, certain factors may affect more than one parameter.
- Scenario analysis considers the effect on the NPV of simultaneously changing multiple assumptions.

Scenario Analysis

- We can use scenario analysis to evaluate alternative pricing strategies for the HomeNet product.

Strategy	**Sale Price ($/unit)**	**Expected Units Sold (thousands)**	**NPV ($ thousands)**
Current strategy	260	100	6,855.00
Price reduction	245	110	6581
Price increase	275	90	4942

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Break-Even Analysis - Motivation

- When we are uncertain regarding the input to a capital budgeting decision, it is often useful to determine the break-even level of that input (cost of capital, sales, cost etc.).
- Break-even analysis asks: how bad things have to go to before a project turns into unacceptable?
- The break-even level of an input is one that causes the investment decision variable to equal zero.

Break-Even Analysis - Definitions

- Three common break-even measures
  - Accounting break-even: an input level at which net income (NI)= 0
  - Cash break-even: an input level at which operating cash flow (OCF) = 0
  - Financial break-even: an input level at which NPV = 0

- The input level is often sales. But one can also examine the break-even point for other input levels. For example, IRR is the level of cost of capital at which NPV=0. So it is the cost of capital that makes a project financially break even.

Fixed Costs and Variable Costs

- In break-even analysis, it is useful to break down a project's costs into two types:
  - Variable costs: costs that increases with the output level (Q) such as cost of goods sold.
  - Fixed costs: costs that do not change with the output level such as depreciation and fixed overhead expenses.
  - Total costs = fixed costs + variable costs = FC + vQ

Example:

- Your firm pays $3,000 per month in fixed costs. You also pay $15 per unit to produce your product.
- What is your total cost if you produce 1,000 units?
  - Variable costs = 15*1000=15,000
  - Fixed costs = 3000
  - Total costs = 3000 + 15,000 = 18,000
- What if you produce 5,000 units? Total costs = 3000 + 15*5000 = 78,000

Accounting Break Even

- The quantity (sales) that leads to a zero net income (NI)
- $NI = (QP - VC - FC - D)(1 - T) = 0$
- $QP - vQ - FC - D = 0$
- $Q(P - v) = FC + D$
- $Q_{BE} = (FC + D) / (P - v)$

- Where:
  - Q: number of units
  - P: price per unit
  - VC: variable costs
  - FC: fixed costs excluding depreciation
  - D: depreciation
  - T: tax rate
  - v: variable cost per unit

Accounting Break Even - Example

- A new product requires an initial investment of $5 million and will be depreciated to an expected salvage of zero over 5 years. The price of the new product is expected to be $25,000, and the variable cost per unit is $15,000. The fixed cost is $1 million. What is the accounting break-even point each year?
- Assumptions for year 1 to 5
  - Revenue and costs stay the same over years.
  - No salvage, no NWC and no additional investment.
  - No tax

- **Solution:**
  - Depreciation = 5,000,000 / 5 = 1,000,000
  - Q_{BE} = (1,000,000 + 1,000,000)/(25,000 – 15,000) = 200 units

Cash Flow Break Even

- The quantity (sales) that leads to a zero operating cash flow (OCF)
  - Assuming: $\Delta NWC = 0$ and tax rate= 0
  - $OCF = [(P\text{-}v)Q – FC – D] (1\text{-tax rate}) + D - \Delta NWC = (P\text{-}v)Q – FC$
  - $Q_{BE} = (FC) / (P – v)$

- In the previous example, what is the cash flow break-even quantity?

- **Solution:**
  - $Q_{BE} = 1{,}000{,}000 / (25{,}000 – 15{,}000) = 100$ units

Financial Break Even

- The quantity (sales) that leads to a zero NPV
- In the previous example, what is the financial break-even point if the cost of capital is 18%?

- **Solution:**
  - What OCF makes NPV = 0?

    N = 5; PV = 5,000,000; I/Y = 18; FV=0; CPT PMT = 1,598,889=OCF
  - Since OCF = [(P-v)Q – FC – D] (1-t)+ D = (P-v)Q – FC. Note: we assume t=0
  - Q_{BE} = (1,000,000 + 1,598,889) / (25,000 – 15,000) = 260 units

- Managers should think: can we sell at least 260 units per year?

Summary of Break Evens

- Accounting break-even
  - Often used as an early stage screening number
  - Gives managers an indication of how a project will impact accounting profit
  - If a project cannot break-even on an accounting basis, then it is not going to be a worthwhile project
- We are more interested in cash flows than we are in accounting numbers
  - If a firm just breaks even on an accounting basis, operating cash flow = depreciation
  - If a firm just breaks even on accounting basis, NPV will generally be < 0 because projects cash flows will be as follows

    -CAPEX, D_1,D_2,…D_t where D stands for depreciation

    Since –CAPEX= D_1+D_2+…+D_t, NPV= $-CAPEX + \frac{D_1}{(1+r)^1} + \frac{D_2}{(1+r)^2} + \ldots + \frac{D_t}{(1+r)^t} < 0$
- Cash BE < Accounting BE < Financial BE

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Operating Leverage - Motivation

- Consider the two firms A and B

	Firm A	Firm B
Sales	$10.0	$10.0
Operating Costs		
Fixed	7.0	2.0
Variable	2.0	7.0
Operating cash flow	$1.0	$1.0
FC/total costs	0.78	0.22
FC/sales	0.7	0.2

- Numbers on this table are just estimates.
- What if the actual sale is 50% higher or lower than the estimate? Which will happen to the operating cash flow?
- Note: OCF = [(P-v)Q – FC – D] (1-tax rate)+ D - ΔNWC= (P-v)Q – FC = sales – FC - VC, assuming ΔNWC = 0 and tax rate= 0

Operating Leverage - Motivation

- If actual sales are 50% higher than estimates:

	Firm A	Firm B
Sales	$15.0	$15.0
Operating Costs		
Fixed	7.0	2.0
Variable	3.0	10.5
Operating cash flow	$5.0	$2.5
% change in OCF	400%	150%

- If actual sales are 50% lower than estimates:

	Firm A	Firm B
Sales	$5.0	$5.0
Operating Costs		
Fixed	7.0	2.0
Variable	1.0	3.5
Operating cash flow	(3.0)	(0.5)
% change in OCF	-400%	-150%

- 50% change in sales leads to much larger changes in firms' operating cash flows.
- Firm A is the most sensitive to the changes in sales.
- Next, let's look into why.

Operating Leverage – Definition and Formula

- Operating leverage: relative proportion of fixed versus variable costs
- One consequence of operating leverage: 1% change in the volume of sales results in a more than 1% change in operating cash flows
- Degree of operating leverage (DOL) measures the sensitivity of a firm's operating cash flows (OCF) to sales.
- DOL $at\ Q\ units\ of\ sales$ $= \frac{\%\ change\ in\ operating\ cash\ flow}{\%\ change\ in\ sales}$

$$= \frac{\partial OCF}{\partial Q} \cdot \frac{1/OCF}{1/Q} = \frac{\partial[(P-v)Q-FC]}{\partial Q} * \frac{Q}{OCF}$$

$$=(P-v) * \frac{Q}{OCF}$$

$$= \frac{(P-v)Q}{(P-v)Q-FC} = \frac{(P-v)Q-FC+FC}{(P-v)Q-FC}$$

$$= 1 + \frac{FC}{OCF}$$

DOL depends on the sales level you are starting from

The Impact of Operating Leverage

- On break even level:
  - Holding everything else constant, the higher the fixed costs, the harder it is to break even.
  - Remember:
    - Accounting break even Q= (FC + D)/(P – v)
    - Cash break even Q = FC /(P – v)
    - Cash BE < Accounting BE < Financial BE

- On the variability of a project
  - The higher the proportion of fixed costs, the higher the DOL
  - The higher the DOL, the greater the variability in operating cash flow and NPV
  - As a result, fixed costs can amplify the risk of a business.

Making a Decision

- Having “what-if” analysis and break-even analysis is beneficial for making investment decisions. But beware of “Paralysis of Analysis”.
- At some point you have to make a decision
- If the majority of your scenarios have positive NPVs, then you can feel reasonably comfortable about accepting the project
- If you have a crucial variable that leads to a negative NPV with a small change in the estimates, then you may want to forego the project

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Managerial Options - Motivation

- In the previous analysis, we assume that once managers make a decision, the decision will be followed through and no revision will be made.
- In reality, managers have the option to revise decisions. This is called managerial options.
  - Once managers revise the decision, the value of the project will be different. We can include these revisions and factor in capital budgeting.

Managerial Options - Motivation

Managers’ have many options to revise a project:

- Expand (or contract)
  - To expand (contract) production if conditions become favorable (unfavorable).
- Abandon
  - To be terminated a project early if conditions become unfavorable.
  - Abandonment value: the value of a project if the project’s assets were sold externally; or alternatively, its opportunity value if the assets were employed somewhere in the firm.
- Postpone
  - To delay undertaking a project when the mangers do not have enough high quality information to make a good decision.

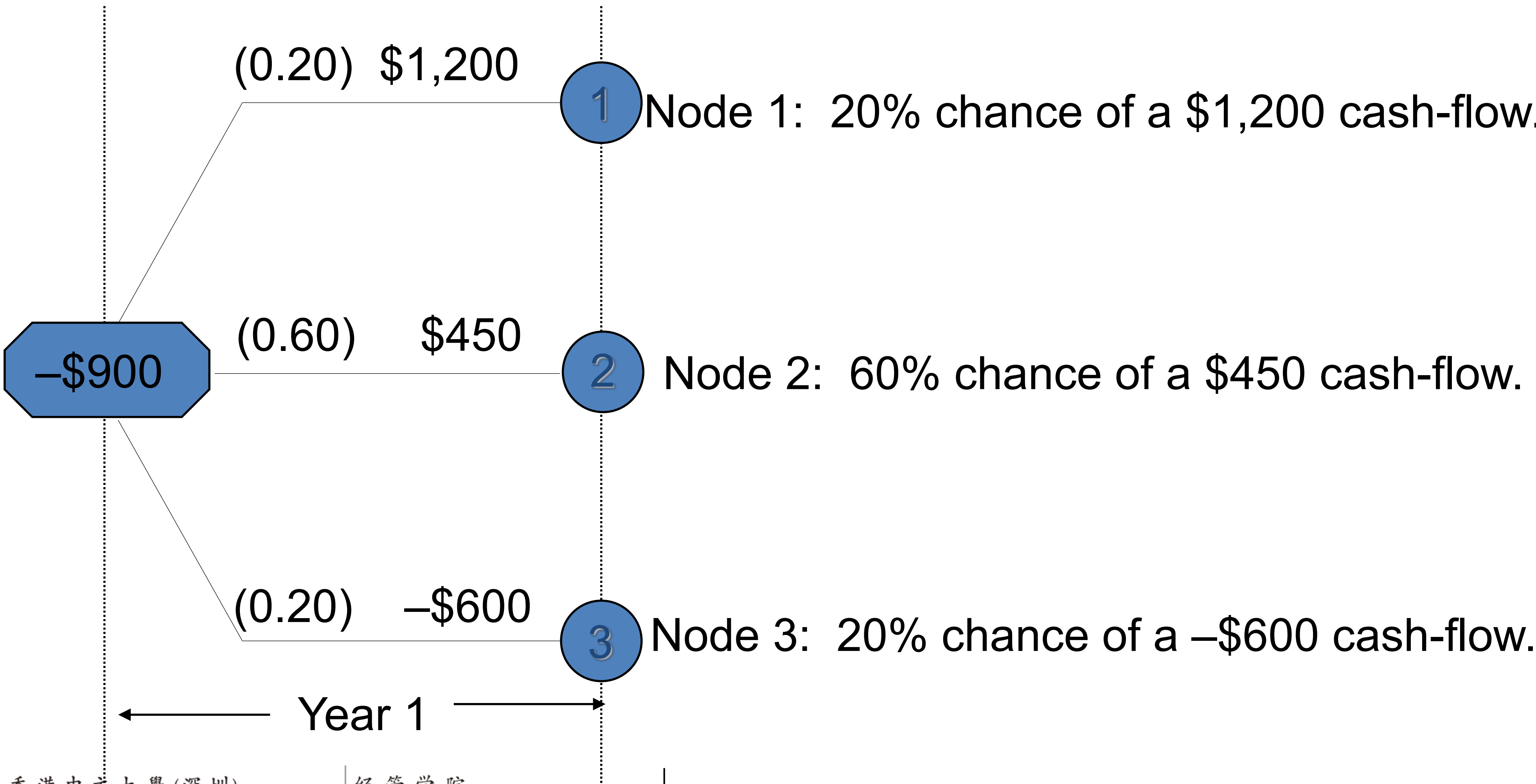
- Project Worth = NPV + Option(s) Value

Probability Tree

- A useful tool for analyzing managerial option is probability tree.
- Probability tree: a graphic or tabular approach for organizing the possible cash-flow streams generated by an investment.
  - The presentation resembles the branches of a tree.
  - Each complete branch represents one possible cash-flow sequence.

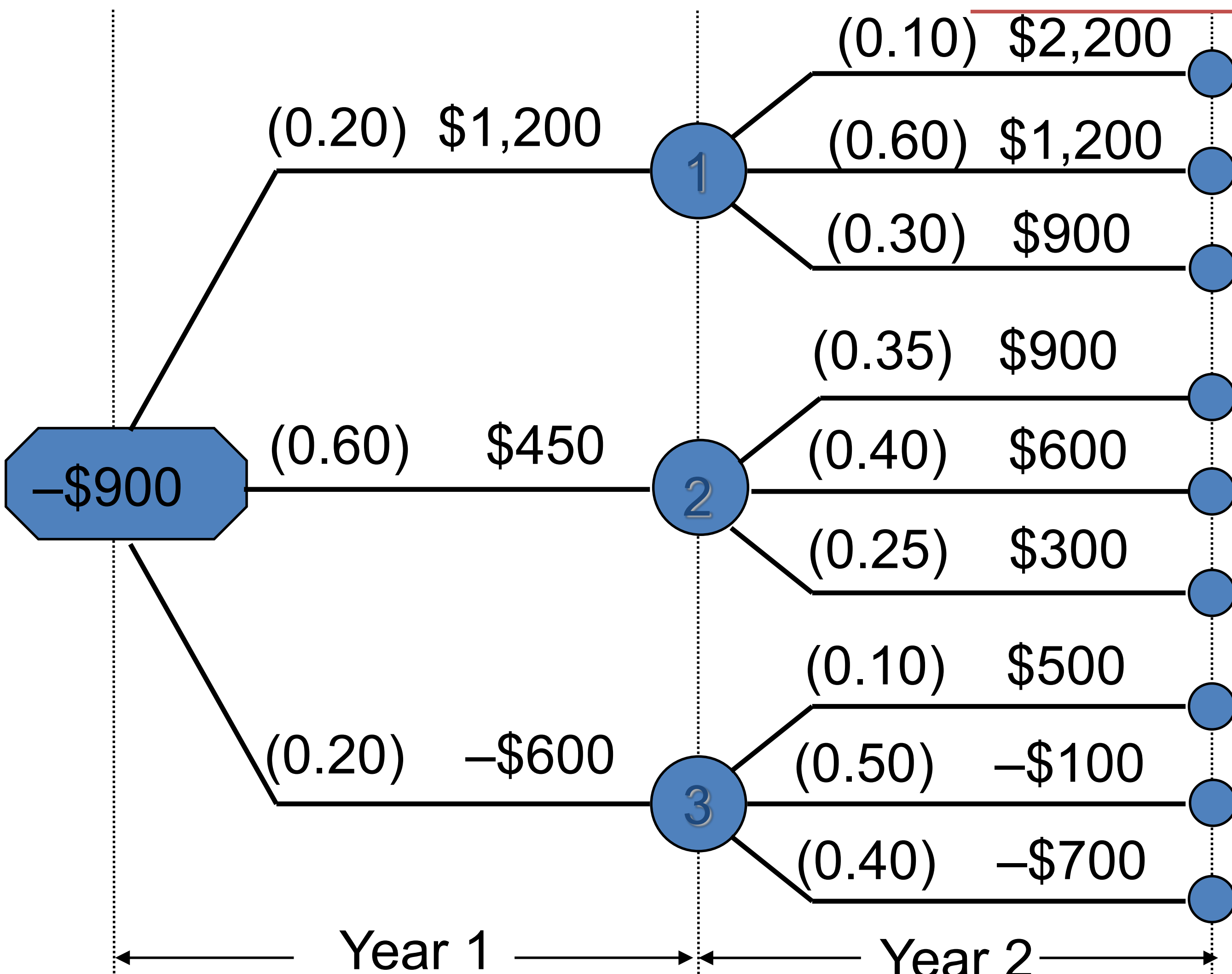
Probability Tree

Basket Wonders is examining a project that will have an initial cost today of $900. Uncertainty surrounding the first year cash flows creates three possible cash-flow scenarios in Year 1.



Probability Tree

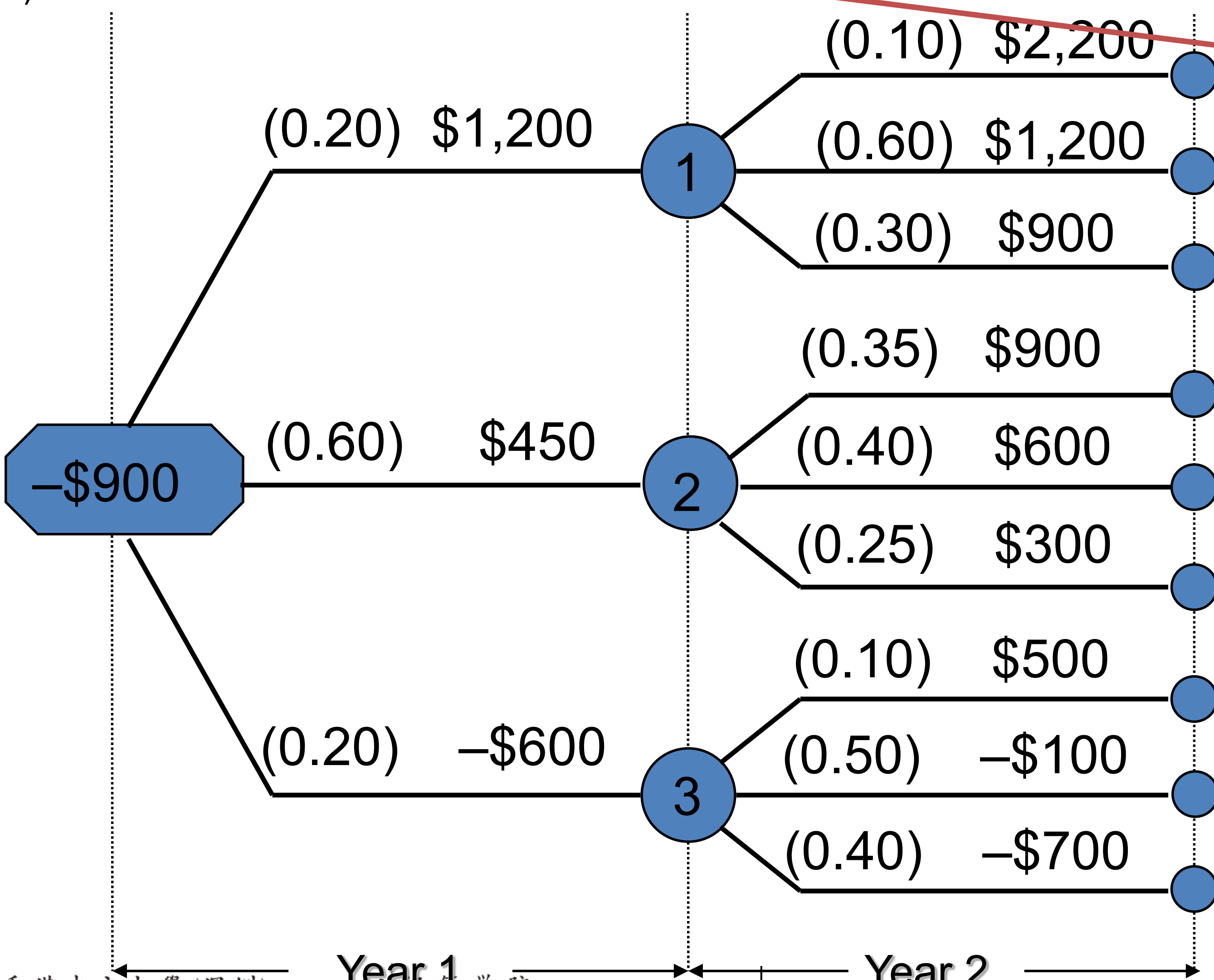
Each node in Year 2 represents a branch of our probability tree. The probabilities are said to be conditional probabilities.



Conditional on the first year cash flow being $1,200, there is a 10% chance that the second year cash flow will be $2,200

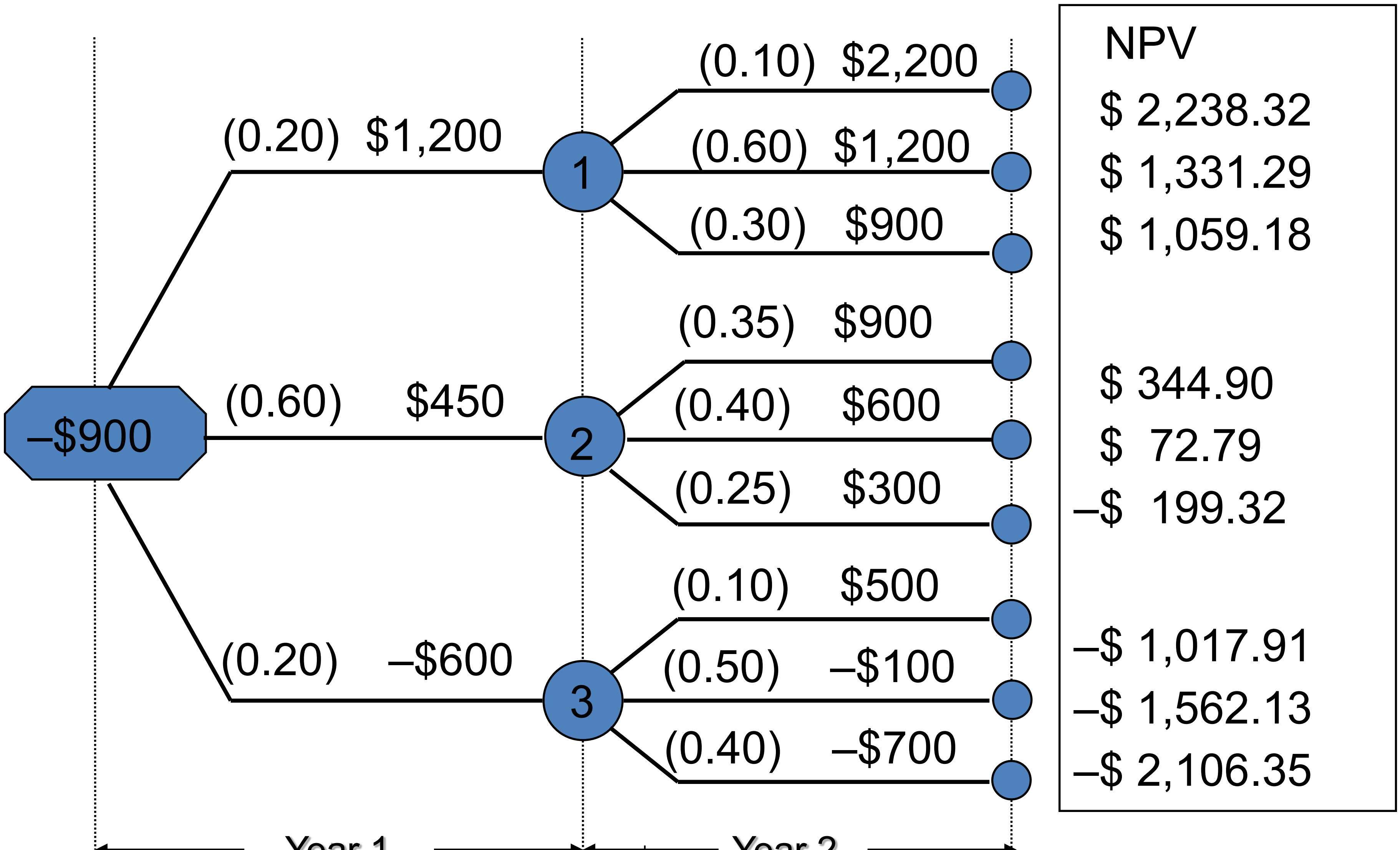
Probability Tree

There is a 2% chance that year 1 cash flow is $1,200 and year 2 cash flow is $2,200



Joint probability	
0.02	Branch 1
0.12	Branch 2
0.06	Branch 3
0.21	Branch 4
0.24	Branch 5
0.15	Branch 6
0.02	Branch 7
0.10	Branch 8
0.08	Branch 9

NPV for Each Cash-Flow Stream at 5% Discount Rate



Calculating the Expected Net Present Value (NPV)

$\overline{NPV} = \sum_{i=1}^{z} NPV_i * P_i$ where z is the possible branches

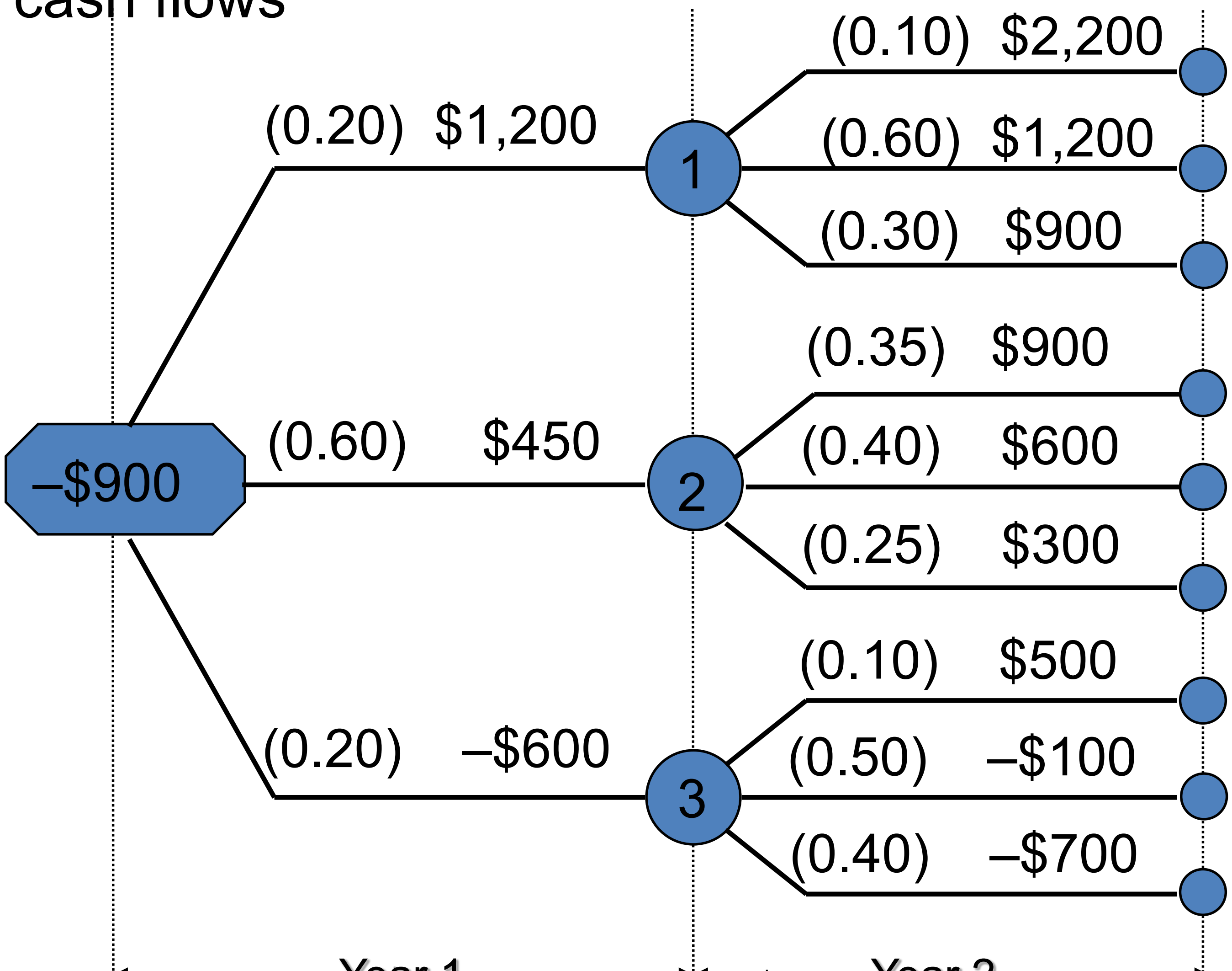
Branch	NPV_i	Joint probability	NPVi * joint probability
Branch 1	$2,238.32	0.02	$44.77
Branch 2	$1,331.29	0.12	$159.75
Branch 3	$1,059.18	0.06	$63.55
Branch 4	$344.90	0.21	$72.43
Branch 5	$72.79	0.24	$17.47
Branch 6	–$199.32	0.15	–$ 29.90
Branch 7	–$1,017.91	0.02	–$ 20.36
Branch 8	–$1,562.13	0.1	–$156.21
Branch 9	–$2,106.35	0.08	–$168.51
Expected Net Present Value = –$17.01			
Variance = $1,031,800.31			
The standard deviation = $1,015.78			

Managerial Option - Project Abandonment

Assume that this project can be abandoned at the end of the first year. We can salvage the equipment and get $200 FCF after tax. What is the project worth after considering this managerial option?

Managerial Option - Project Abandonment

- When will managers abandon a project? When its abandonment value exceeds the present value of the project’s subsequent future cash flows



At year 1, the value of future cash flows are as follows:

Node 1:

(2200/1.05)(0.1)+
(1200/1.05)(0.6)+
(900/1.05)(0.3)=$1,152

Node 2:

(900/1.05)(0.35)+
(600/1.05)(0.4)+
(300/1.05)(0.25)=$600

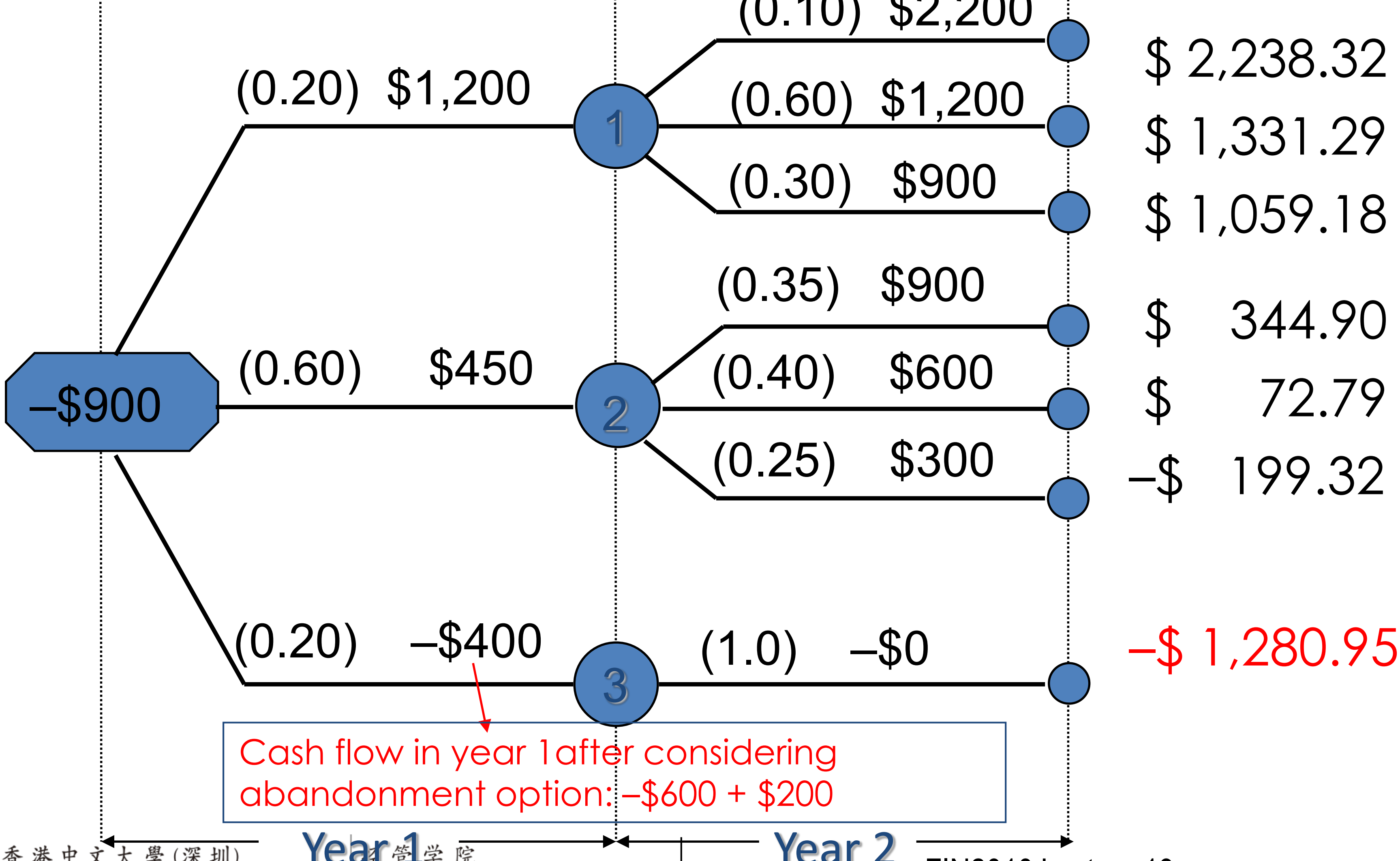
Node 3:

(500/1.05)(0.1)+ (–100/1.05)(0.5)+ (–700/1.05)(0.4)=-$266.67

Managerial Option - Project Abandonment

- In node 3, the optimal decision at the end of Year 1 is to abandon the project for $200.

NPV after managerial decisions



The Value of the Managerial Option

- How much value (in terms of project NPV) does this managerial option add?

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Branch 2	$1,331.29	0.12	$159.75
Branch 3	$1,059.18	0.06	$63.55
Branch 4	$344.90	0.21	$72.43
Branch 5	$72.79	0.24	$17.47
Branch 6	–$199.32	0.15	(29.90)
Branch 7	-1280.95	0.02	(25.62)
Branch 8	-1280.95	0.1	(128.10)
Branch 9	-1280.95	0.08	(102.48)
		Expected NPV	$71.88

- Value of Option = new NPV – NPV w/o considering option
- Value of Abandonment Option = $71.88 – (– $17.01)= $88.89

Summary

- What if analysis:
  - Sensitivity analysis: what happens if we change the assumption of one variable?
  - Scenario analysis: what happens under different scenarios
- Break even analysis:
  - Accounting break even: $Q_{BE} = (FC + D) / (P - v)$
  - Cash break even: $Q_{BE} = (FC) / (P - v)$
  - Financial break even: the level of Q when NPV=0
- Operating leverage:
  - $DOL = 1 + \frac{FC}{OCF}$
  - The higher the operating leverage, the more volatile the OCF.
- Managerial option: NPV= NPV w/o managerial option + option(s) value

Next Time—Cost of Capital

- What is cost of capital – motivation and intuition
- Cost of capital of equity
- Cost of capital of debt
- Cost of capital of preferred stock
- WACC
- Project cost of capital
- Flotation cost