Cornell University

Binomial Model in Real Options Analysis

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Operations Research

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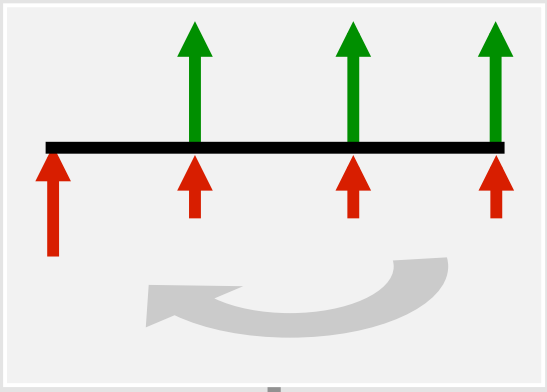
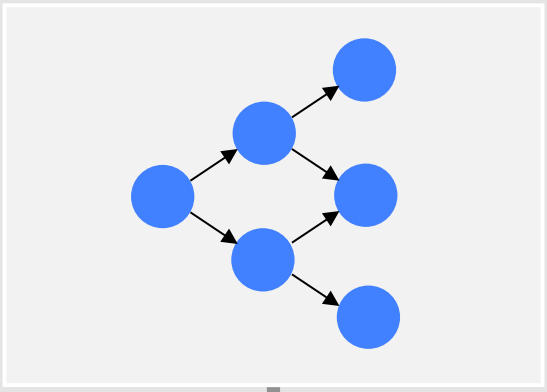
Problems with traditional capital budgeting methods motivate ROA

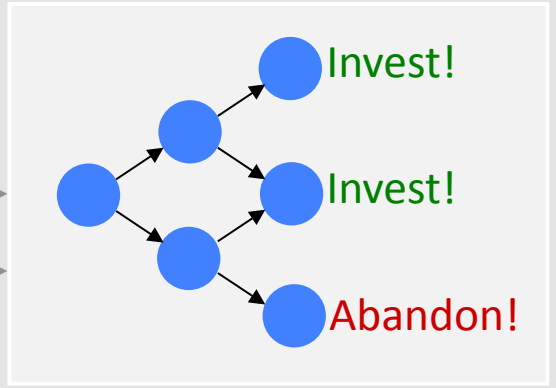
Net present value



The binomial model



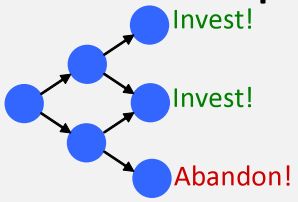
Real options analysis (ROA)



I investigate the application of the binomial model in valuing real options

Real Options

Binomial model in ROA example

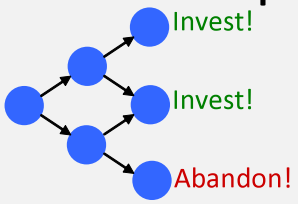


Assessment of ROA

I investigate the application of the binomial model in valuing real options

Real Options

Binomial model in ROA example



Assessment of ROA

A real option is the right (not obligation) to undertake some business decision

- Types of real options include
  - Option to invest
  - Option to wait
  - Option to expand
  - Option to contract

A real option is the right (not obligation) to undertake some business decision

GM's plant development project

GM wants to build a factory that produces fuel efficient cars. The project costs $60 million immediately for permits, which take a year. At the end of the year, GM could invest $400 million to complete the design phase. Once the design phase is over, GM has a two-year window during which it can invest the $800 million needed to build the plant.

Question

Which types of real options can you identify?

A real option is the right (not obligation) to undertake some business decision

GM's plant development project

GM wants to build a factory that produces fuel efficient cars. The project costs $60 million immediately for permits, which take a year. At the end of the year, GM **could** invest $400 million to complete the design phase. Once the design phase is over, GM has a two-year window during which it **can** invest the $800 million needed to build the plant.

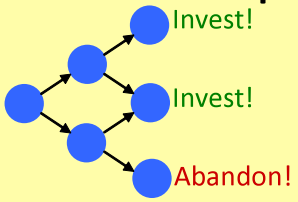
We can identify the following real options in this project

- GM has an option to invest $400 million in Year 1
- GM has the option to wait in Year 2.
- GM has the option to invest $800 million in Year 3

I investigate the application of the binomial model in valuing real options

Real Options

Binomial model in ROA example

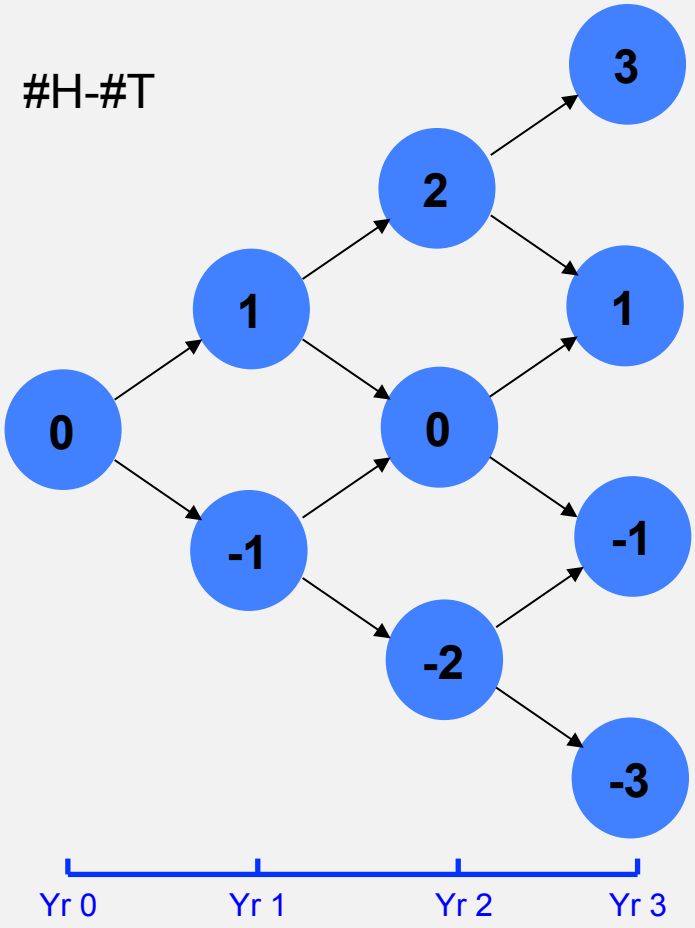


Assessment of ROA

Recall the three step process of the binomial model

Step 1

Construct a tree describing all possible states



Recall the three step process of the binomial model

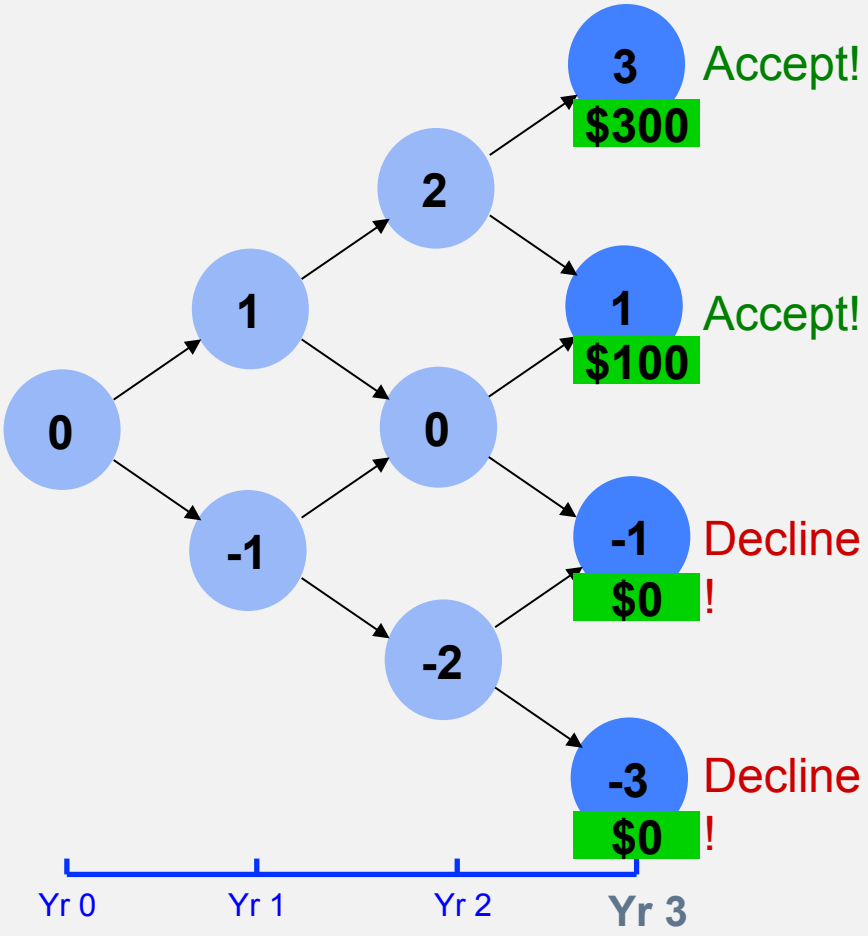
Step 2

Make decisions at the end nodes of the tree

Decision rule

$100(#H-#T) > 0 → Accept

Otherwise → Decline

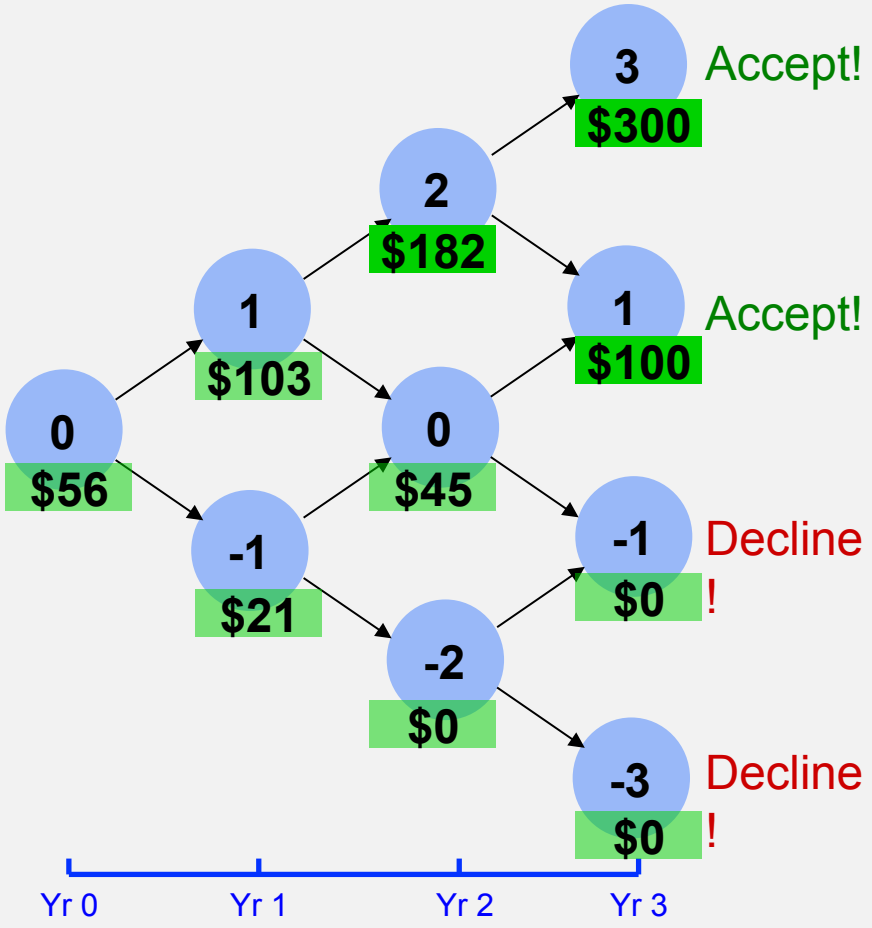


Recall the three step process of the binomial model

Step 3

Calculate value of game at each earlier node

$$\$182 = \frac{\text{expectation}}{1 + \text{interest rate}} = \frac{(0.5)(\$300) + (0.5)(\$100)}{1.10}$$



I will apply a similar three step process to evaluate GM's plant development project

GM's plant development project

GM wants to build a factory that produces fuel efficient cars. The project costs $60 million immediately for permits, which take a year. At the end of the year, the GM could invest $400 million to complete the design phase. Once the design phase is over, GM has a two-year window during which it can invest the $800 million needed to build the plant.

Question

What is a possible source of uncertainty?

I will apply a similar three step process to evaluate GM's plant development project

GM's plant development project

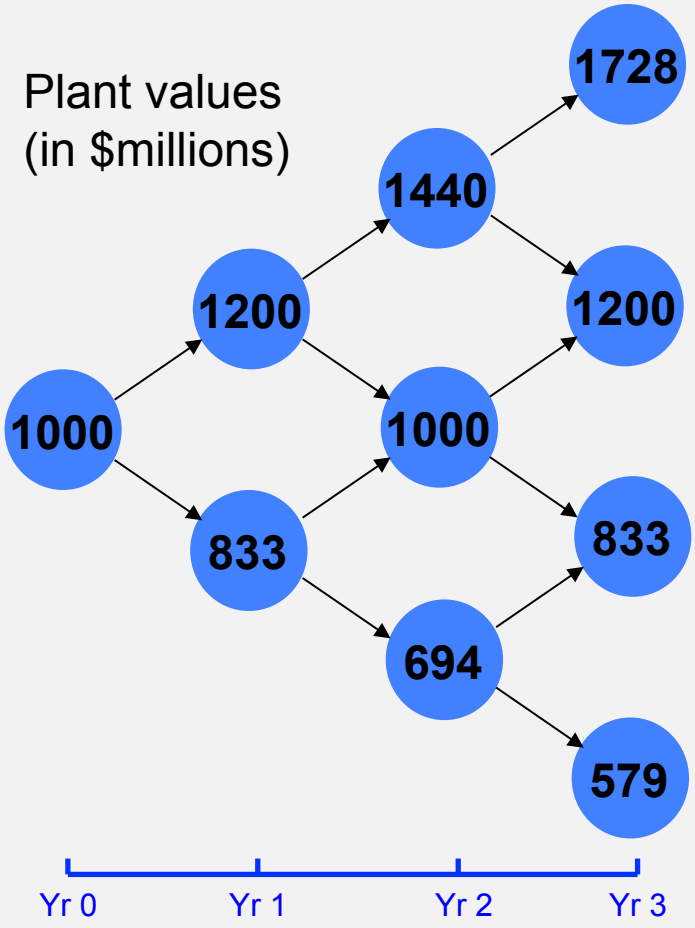
GM wants to build a factory that produces fuel efficient cars. The project costs $60 million immediately for permits, which take a year. At the end of the year, GM could invest $400 million to complete the design phase. Once the design phase is over, GM has a two-year window during which it can invest the $800 million needed to build the plant.

One source of uncertainty is the possible future values of the plant under plausible market scenarios.

Assume plant is worth $1 billion if it existed today and moves +20% or -16.7%

Step 1

Construct a tree describing all possible plant values



In year 3, GM has an option to invest $800 million to construct the plant

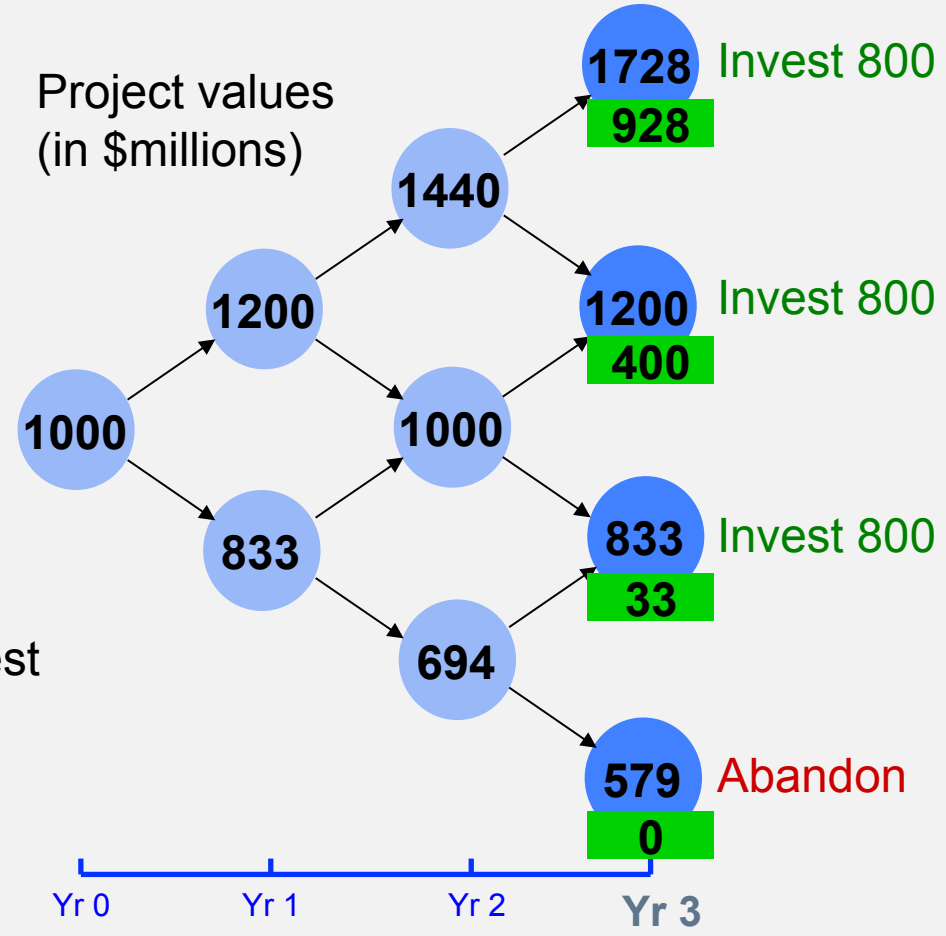
Step 2

Make decisions at the end nodes of the tree

Decision rule

If value of plant > 800 → invest

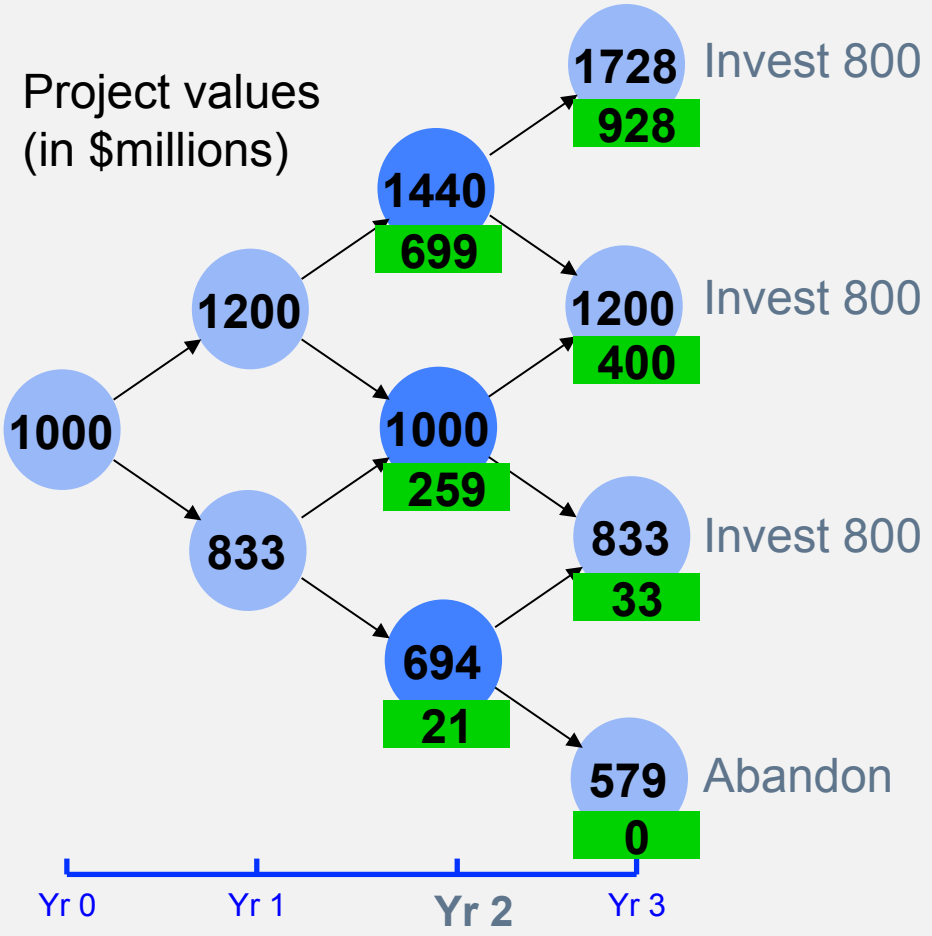
Otherwise → abandon



In year 2, GM has the option to wait (or invest $800 million)

Step 2.5

Calculate value of project at each earlier node and make decisions



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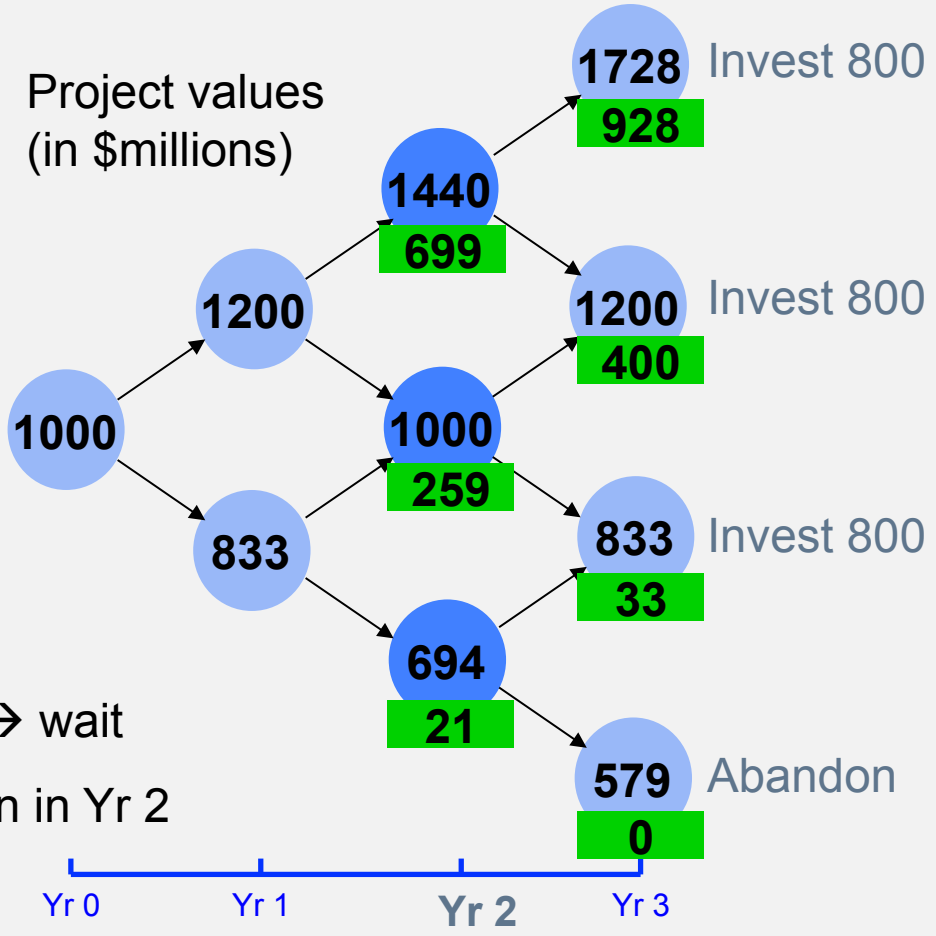


Decision rule

Value of project from waiting >

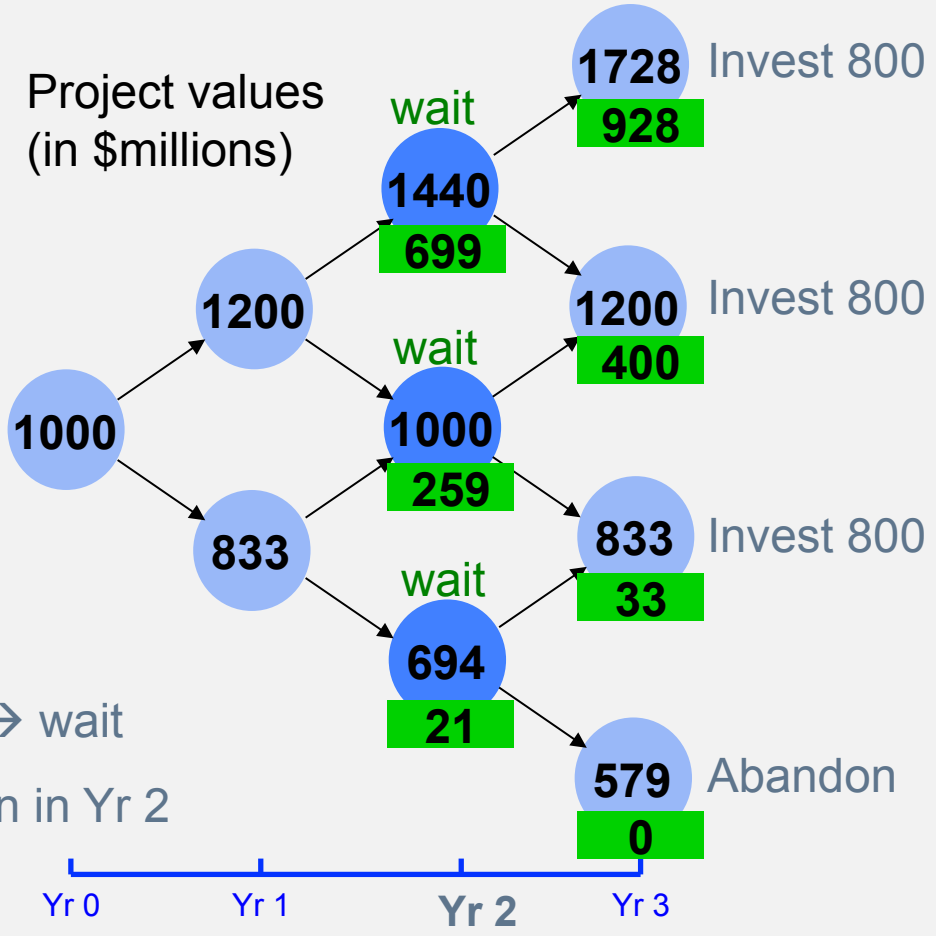
(value of plant – 800) → wait

Otherwise → invest $800 million in Yr 2

In year 2, GM has the option to wait (or invest $800 million)

Step 2.5

Calculate value of project at each earlier node and make decisions



Decision rule

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In year 1, GM has the option to invest $400 million to complete the design phase

Step 2.5

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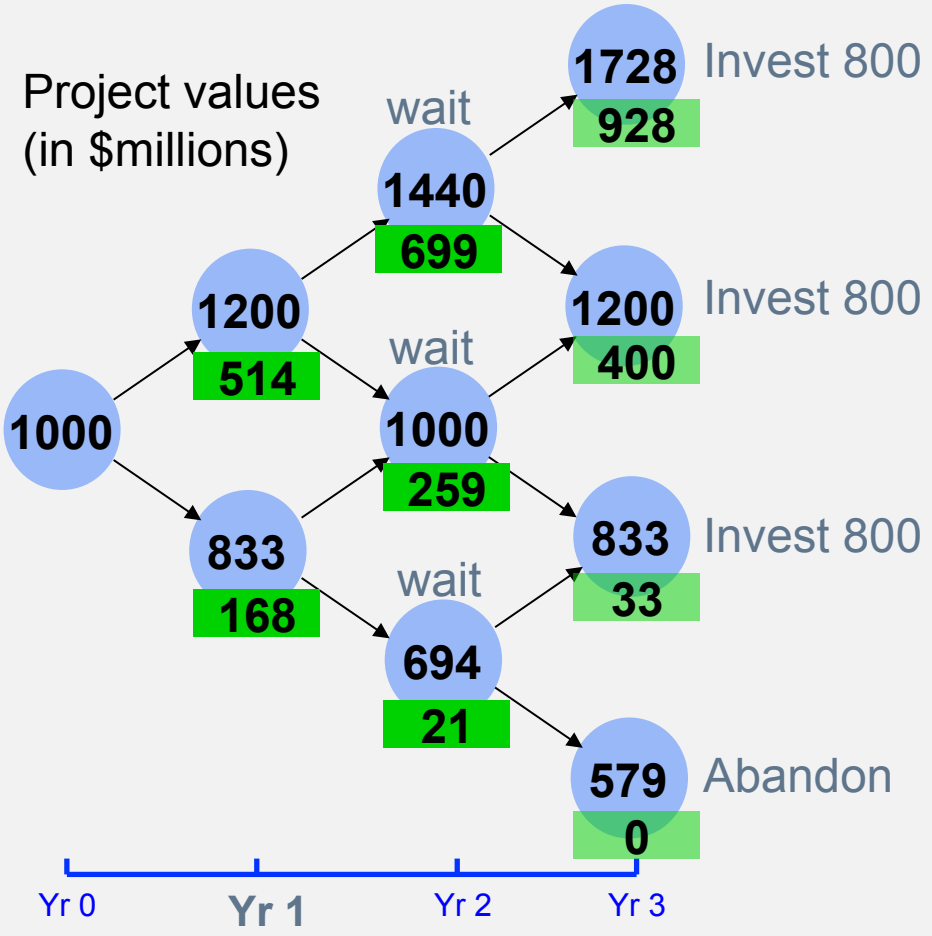


In year 1, GM has the option to invest $400 million to complete the design phase

Step 2.5

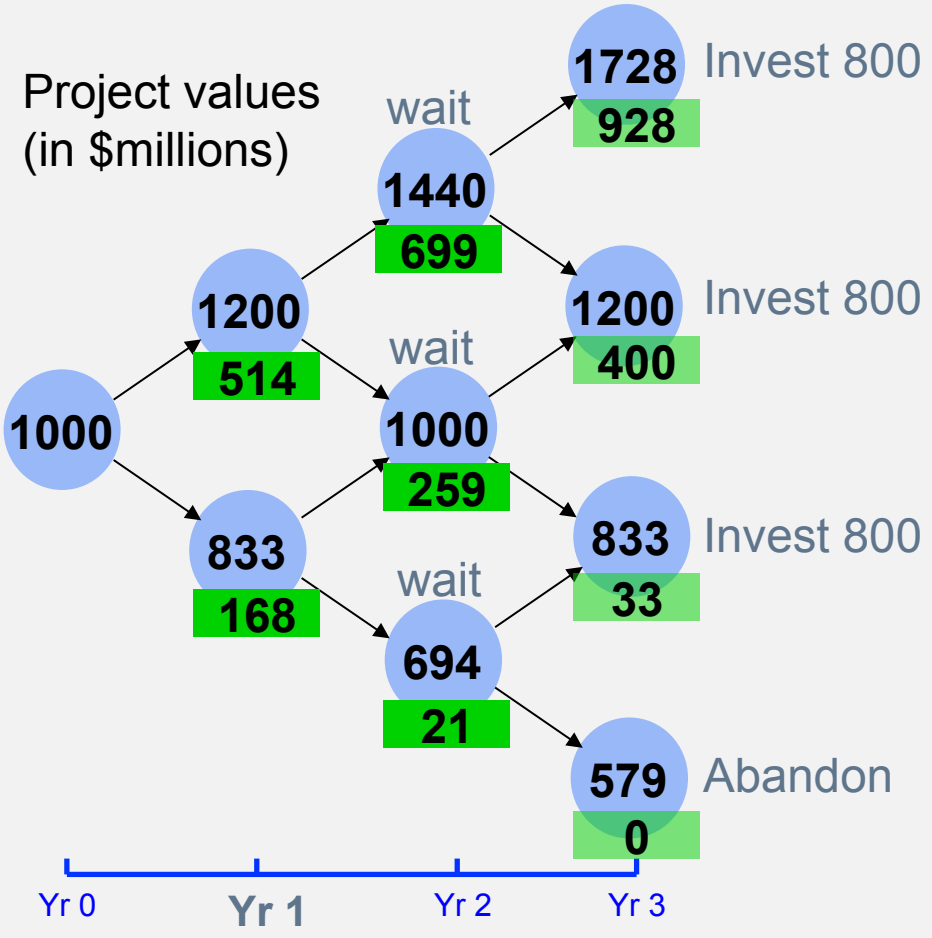
Calculate value of project at each earlier node and make decisions

Decision rule

Value of project > 400

→ invest 400

Otherwise → abandon



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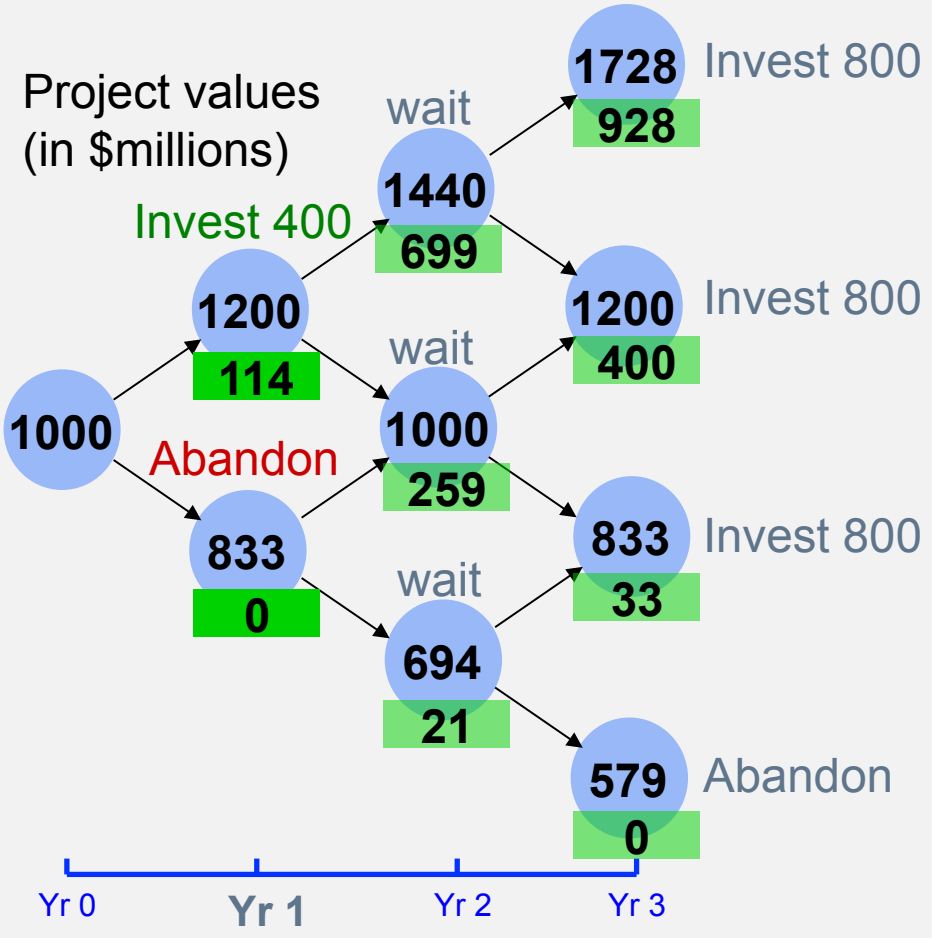
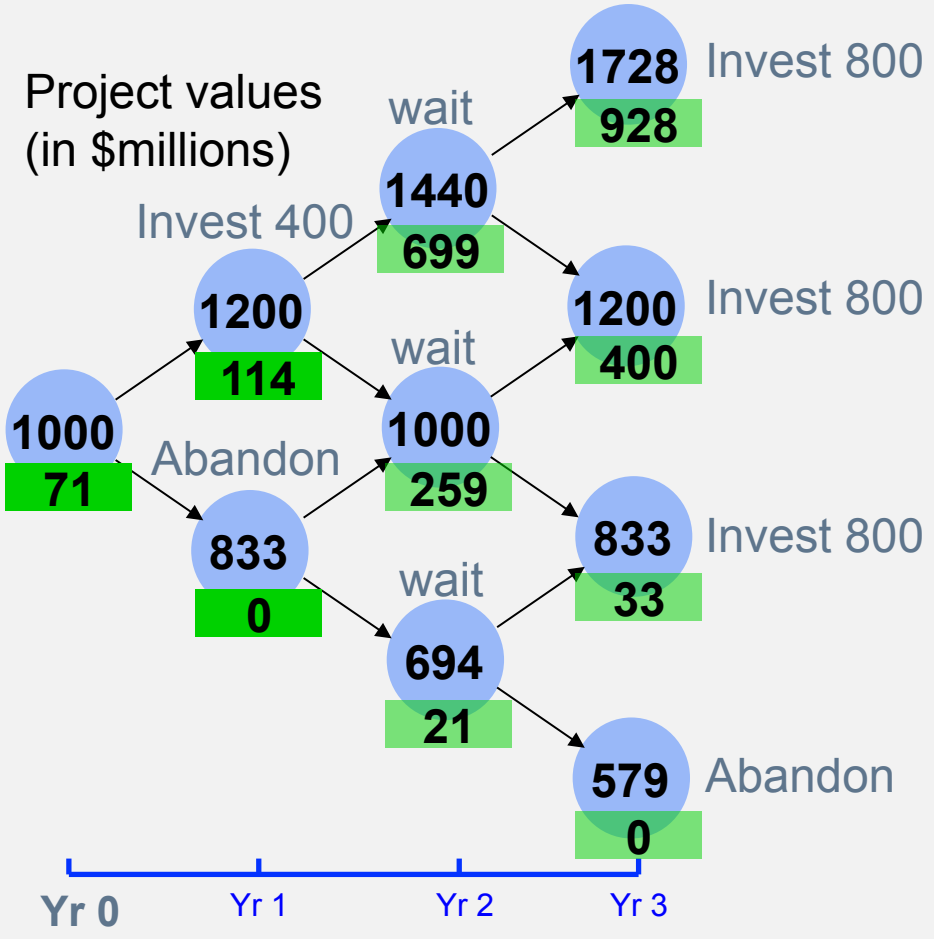


In year 0, GM has the option to invest $60 million for permits and preparation

Step 2.5

Calculate value of project at each earlier node and make decisions



In year 0, GM has the option to invest $60 million for permits and preparation

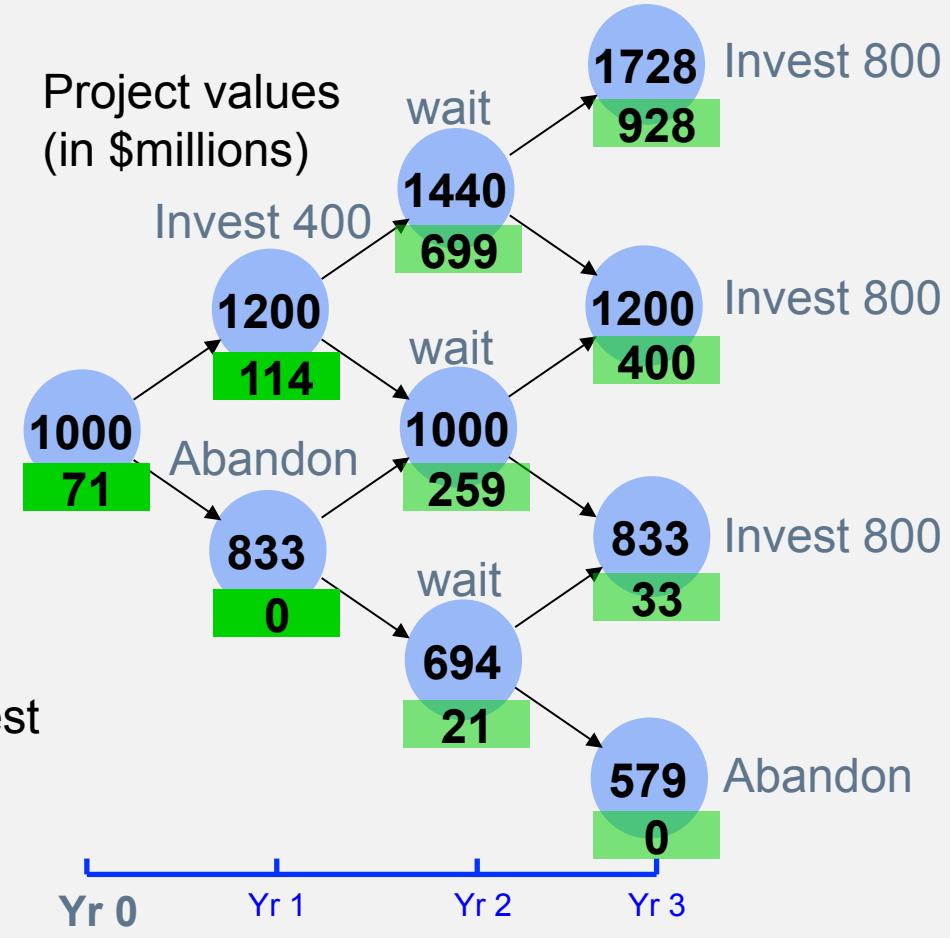
Step 2.5

Calculate value of project at each earlier node and make decisions

Decision rule

Value of project > 60 → invest

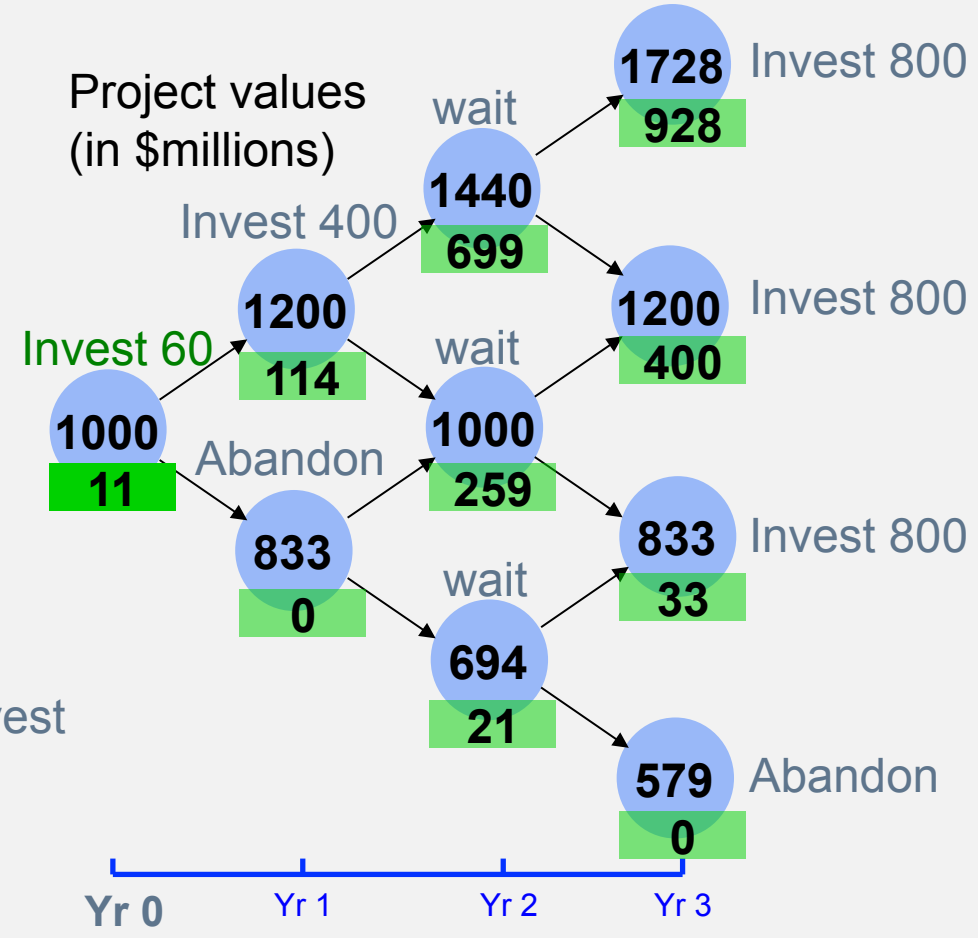
Otherwise → Abandon



In year 0, GM has the option to invest $60 million for permits and preparation

Step 2.5

Calculate value of project at each earlier node and make decisions



Decision rule

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Otherwise → Abandon

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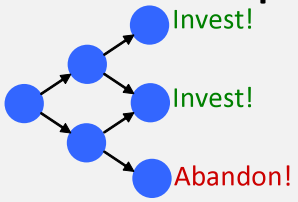
Binomial model in ROA example



Assessment of ROA

All models are simplified representations of reality, and all involve assumptions

ROA assumes that

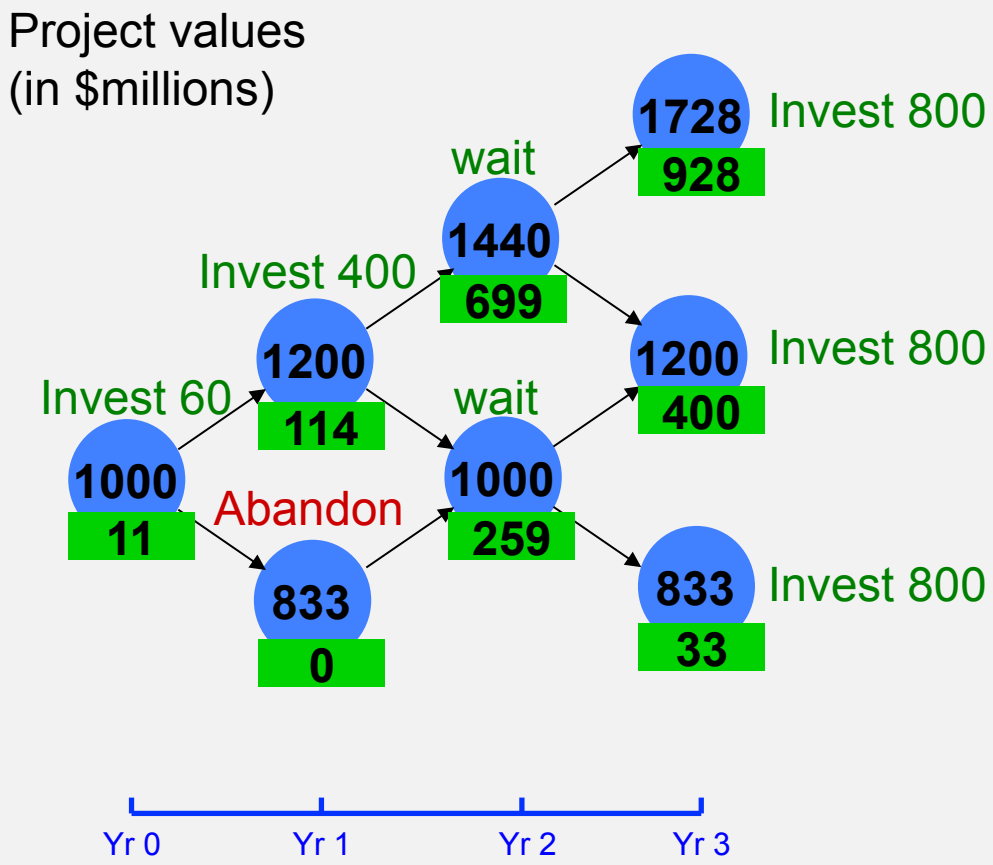
- the source of uncertainty can be modeled as a stochastic process
- managers exercise their option rights in a timely and rational manner

The binomial model is very flexible, which allows it to model complex projects

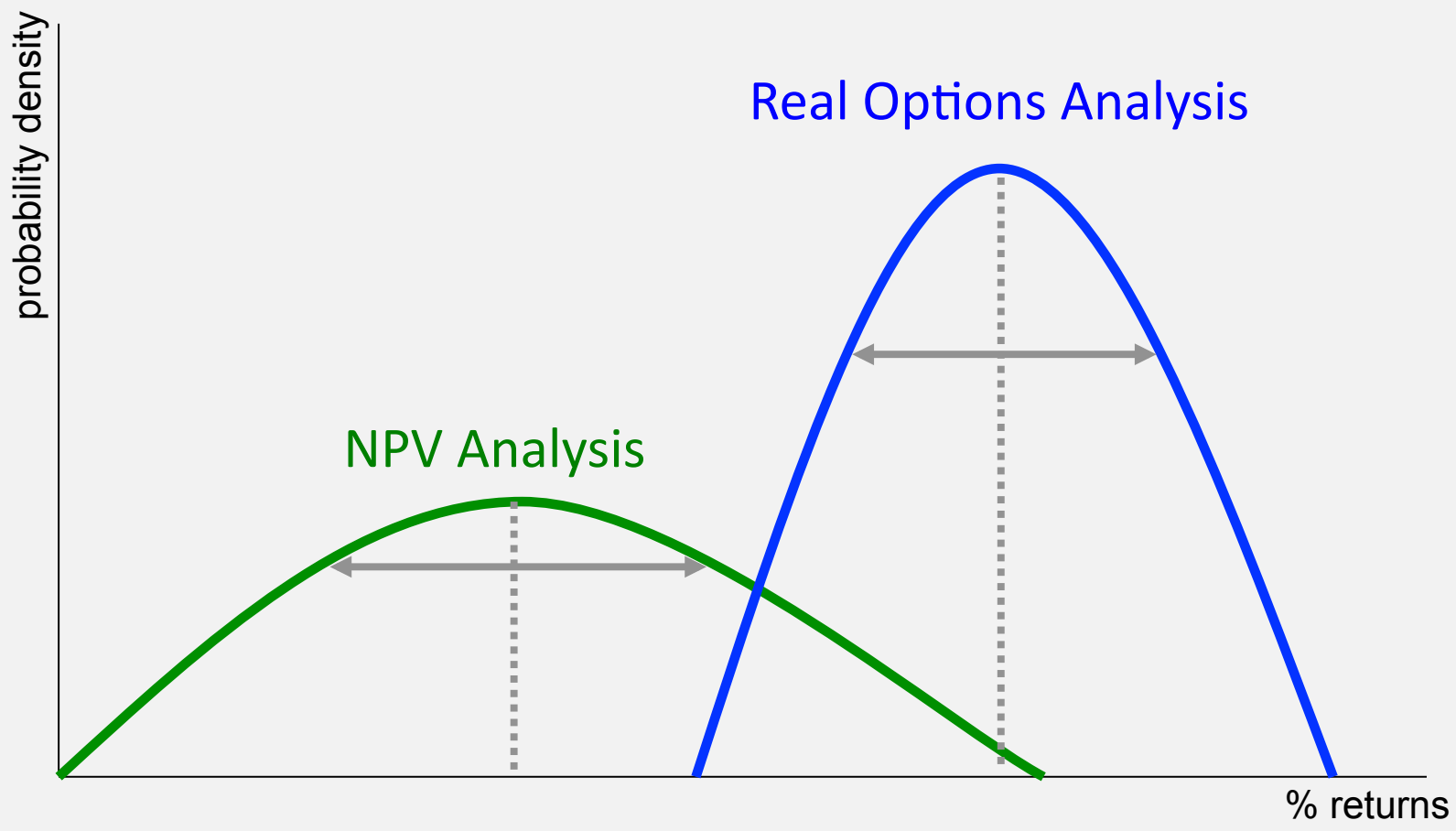
The binomial model can reflect

- Early decision points
- Multiple decisions
- Changing volatility

Real options analysis not only evaluates a project but also gives you a feasible plan



Real options analysis typically gives higher return and lower risk than does NPV



Questions?

Real Options

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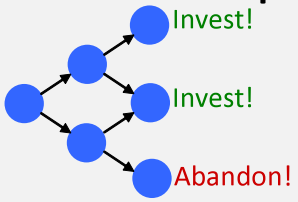

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Thank You!

References

Microsoft PowerPoint 2003 Clip Art web collections