15.482 Healthcare Finance
Spring 2017

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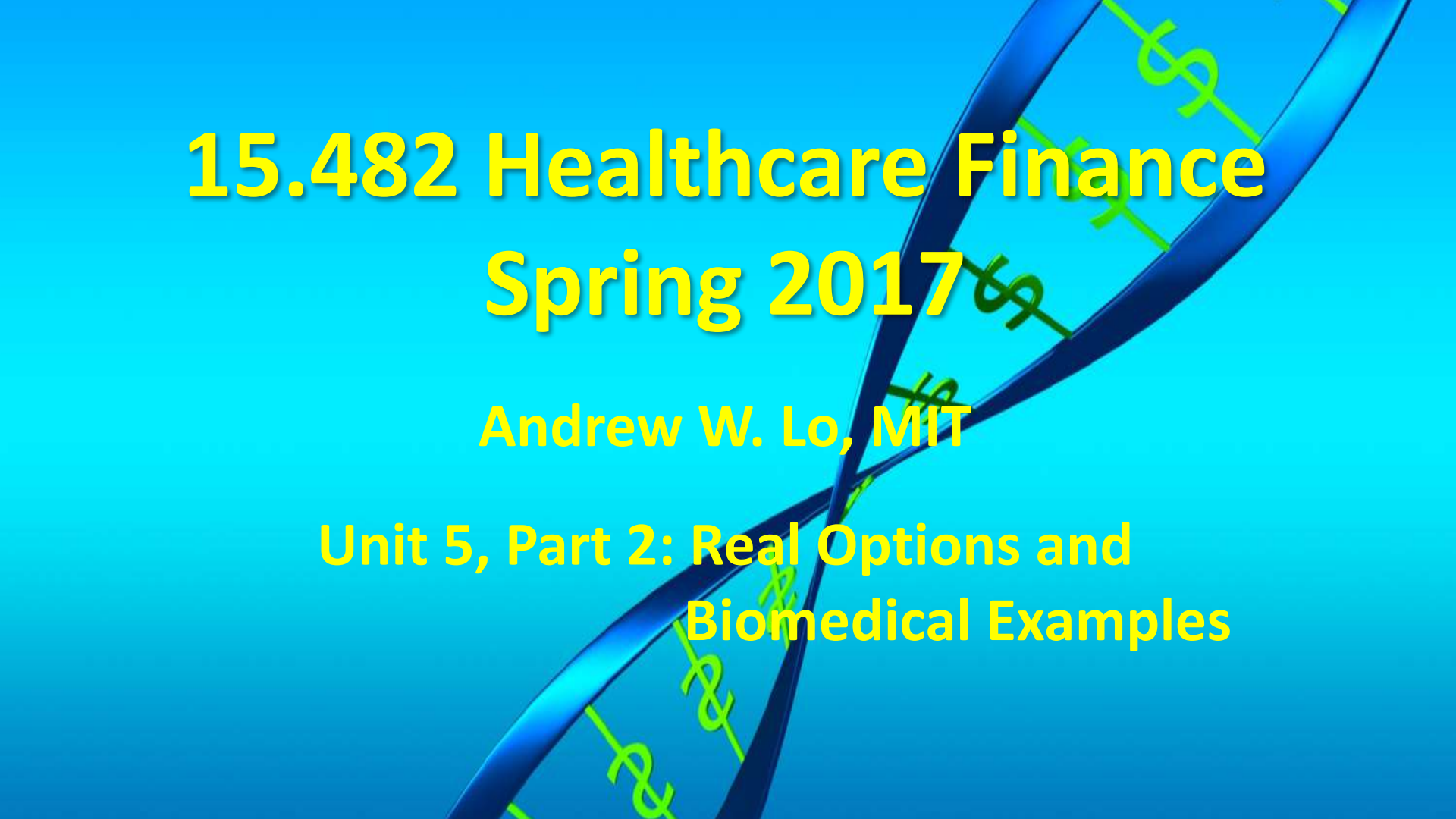
Unit 5, Part 2: Real Options and Biomedical Examples



Unit Outline

- Options
- Option Pricing Models
- Real Options
- Monte Carlo Simulation

Real Options

Motivation

- Building a factory gives the company the right, but not the obligation, to produce certain goods
- Patent gives owner the right, but not the obligation, to, use certain intellectual property

NATURE | BREAKING NEWS

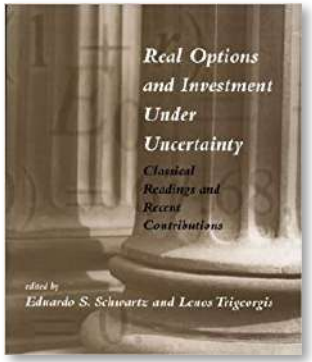
Feb 15, 2017

Broad Institute wins bitter battle over CRISPR patents

The US Patent and Trademark Office issues a verdict in legal tussle over rights to genome-editing technology.

Motivation

- These are “real” vs. financial options (Myers, 1977)
- See also Schwartz and Trigeorgis (2001)
- Underlying asset is typically not traded, therefore, arbitrage arguments do not apply, but much of the intuition does carry over
  - Option’s value increases with time to maturity and volatility
  - American options are more valuable than European (flexibility has positive NPV)
  - Decision trees can be used to value real options



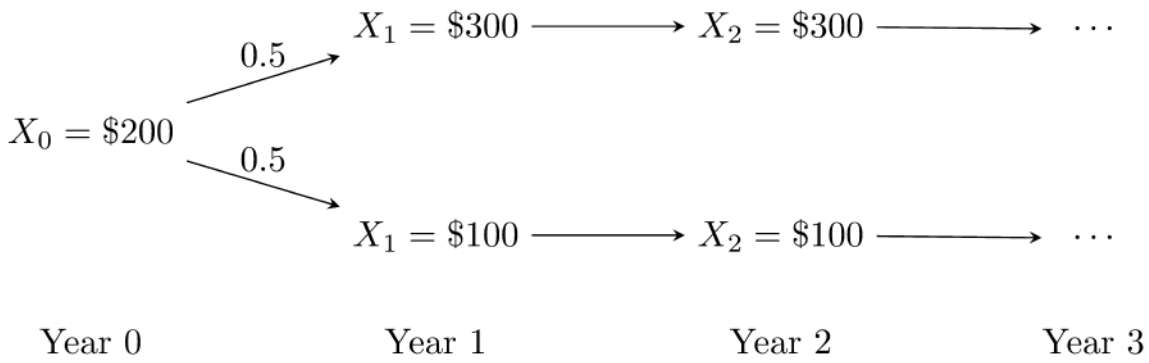
Real Options

Investment Decisions Can Be Viewed As Real Options

- Company has the **option** to invest
- Can wait for more information before making decision
- The value of this flexibility can be very large
- Any decision involving irreversible investments can be viewed this way:
  - Opening or closing a mine; building or retiring an oil tanker; signing a long-term fuel contract; undertaking an R&D program; developing a drug

Simple Real Option Example

Suppose we wish to purchase manufacturing facilities to produce a drug for which we just received FDA approval. The net profit per year X_t is \$200MM today, but next year, pricing legislation will either yield \$300MM or \$100MM, depending on the outcome, and it will remain the same thereafter.



- The cost of the facilities is \$1.5B today or \$1.65B next year. Should we purchase it today or wait a year? Assume a discount rate of 10% per year.

Simple Real Option Example

- If we invest now:

$$\text{rNPV} = -1{,}500 + 200 + \sum_{k=1}^{\infty} \frac{0.5 \times 100 + 0.5 \times 300}{1.10^k} = 700$$

- Suppose we wait one year, and invest only if the price goes up:

$$\text{rNPV} = 0.5 \times \left[\frac{-1,650}{1.10} + \sum_{k=1}^{\infty} \frac{300}{1.10^k} \right] + 0.5 \times 0 = 750$$

- Waiting is better than investing now as we avoid the down state
- The option to wait is worth \$750 – \$700 = \$50 million

Simple Real Option Example

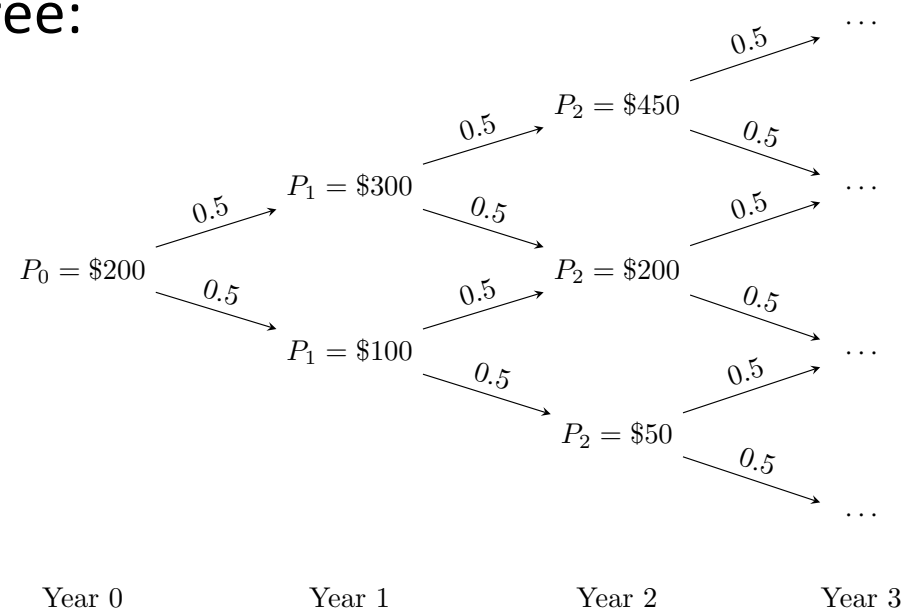
- How can you tell there is an embedded option? Look for the "max"

$$\text{rNPV} \;=\; \text{E}\left(\text{Max}\left[\frac{-1,650}{1.10}+\sum_{k=1}^{\infty}\frac{X_k}{1.10^k}\;,\;0\right]\right)$$

- The "Max" function is what creates positive value by "cutting off part of the left tail"
- What if owner of manufacturing plant is not willing to wait one year?

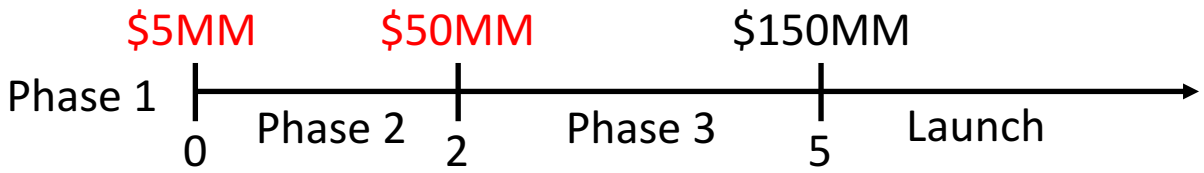
Simple Real Option Example

- We assumed no uncertainty in the price after the first year, but we can model fluctuations in the price more generally using a binomial tree:



Decision Trees: An Example

- New drug just passed phase 1 clinical trial; now requires $5 million for phase 2 which will take 2 years and has a 40% probability of success (PoS)
- If phase 2 achieves its endpoint, $50 million is needed for phase 3 which will take 3 years and has 70% PoS or probability of approval
- If approved, and at product launch 3 years after the start of phase 3 trials, the forecasted NPV, which includes all drug sale revenues, production and marketing costs, is $150 million.
- Assuming a constant discount rate of 20% per year, what is the risk-adjusted NPV of this project?



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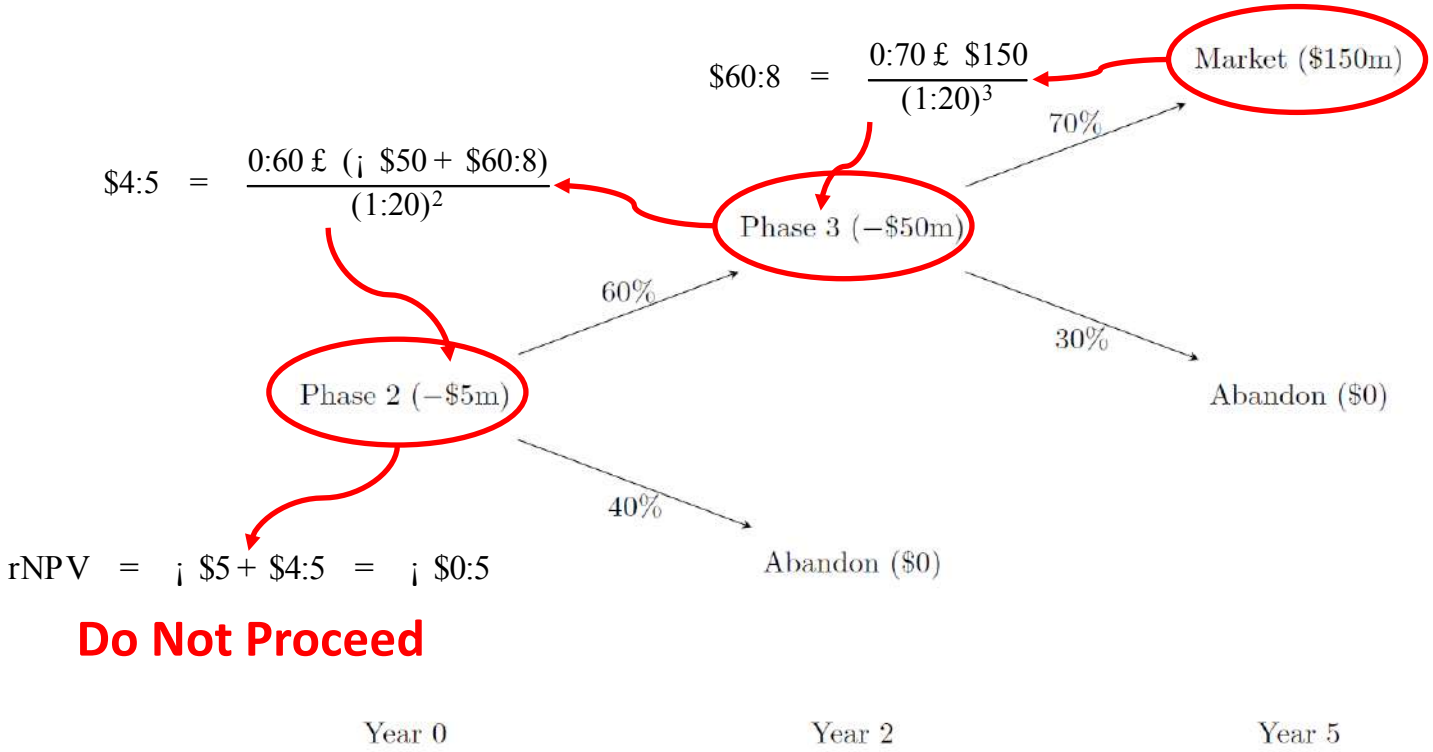
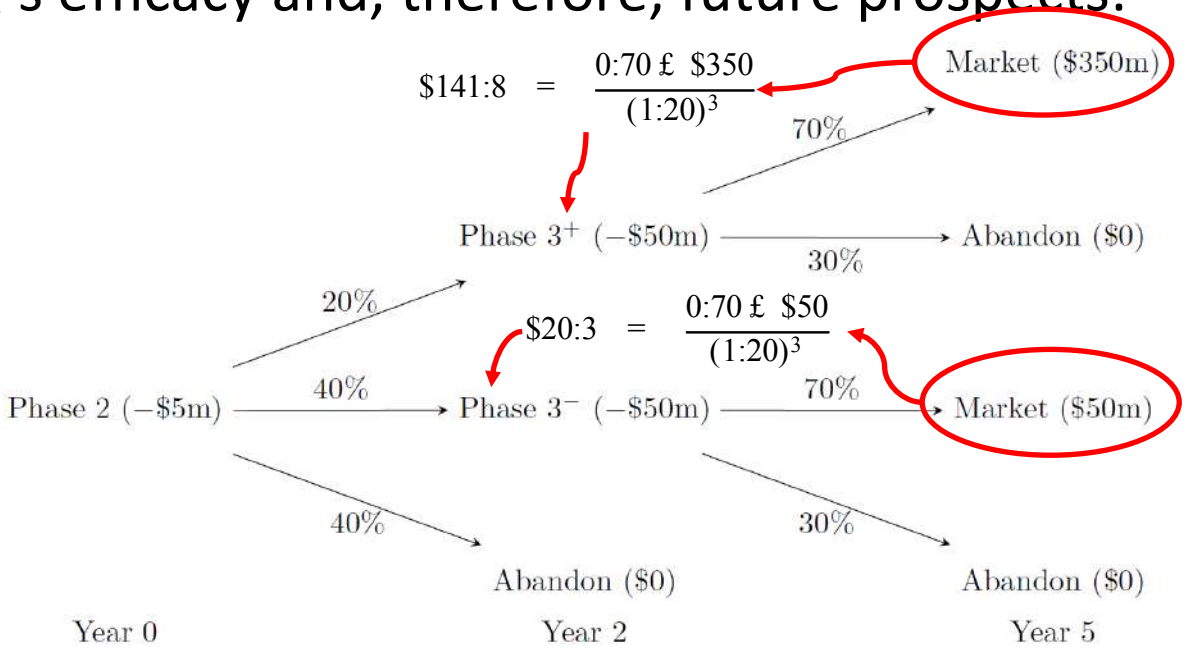


Decision Trees: An Example

- Now suppose phase 2 offers more refined information about the drug's efficacy and, therefore, future prospects:



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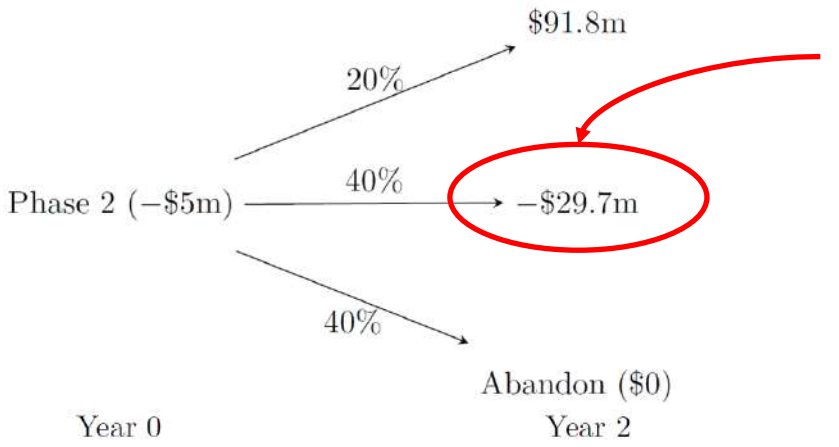

But **we don't have to proceed** with phase 3 if phase 2 shows low efficacy

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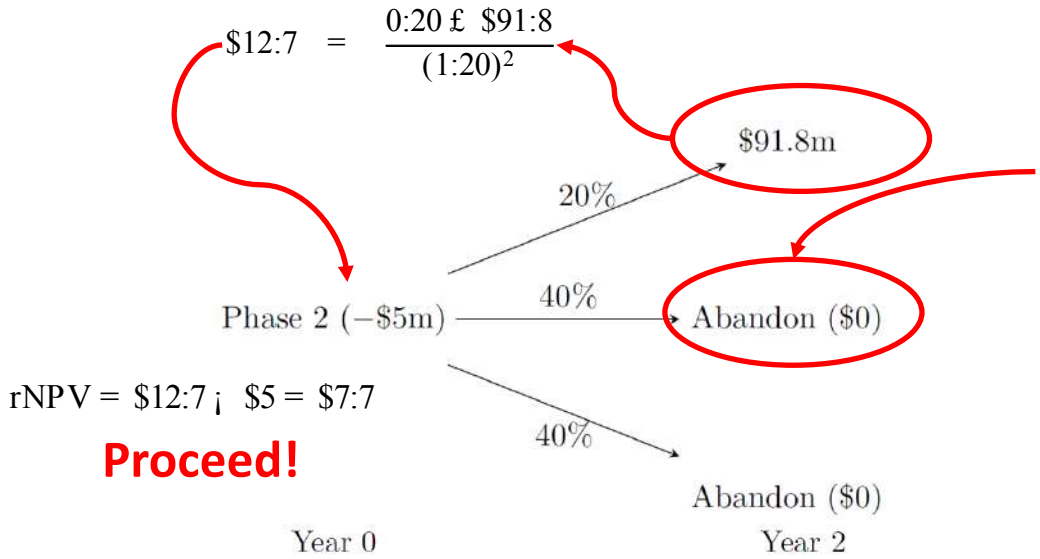

But **we don't have to proceed** with phase 3 if phase 2 shows low efficacy

This real option has value:
= Max[Phase 3±,0]