Real options

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Key points

- Recognize the analogy between financial options and the investment decisions of financial managers
- Recognize the problems of NPV analysis when information is valuable.

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Structure of the lecture

- Review of NPV
- Real options
- An application

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Example

Type of Market	Probability of Market Type (Idiosynchratic)	Demand	Probability of Demand (Systematic)	Annual Cash flow
Berkeley, CA	0.8	High	0.25	$32K
	0.8	Med	0.50	22
	0.8	Low	0.25	12
Cleveland, OH	0.2	High	0.25	22
	0.2	Med	0.50	12
	0.2	Low	0.25	2

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Example

- It costs 100K to make the initial investment
- Assume:
  - r_f=2.1%
  - β=1
  - $E(r_m-r_f)$=8.4%
  - r_{coffee}=?

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Value of the project

- NPV Valuation:

- Can you do better?
- Hire a marketing research firm and value the project with the new information. What is the most you are willing to pay for the information?
- Early exercise

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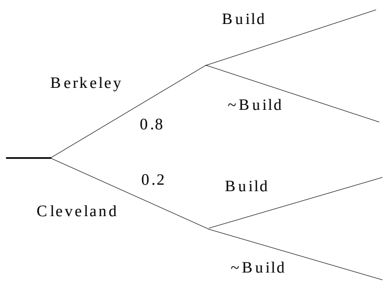
To build or not to build



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Early exercise

- Remember that early exercise is not optimal for an American call option on a non dividend paying stock
- What if we have only ten years lease on the land for the coffee shop?
- Should we wait?

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Early exercise

- As our lease runs for 10 yrs, we give up one year of cashflows by waiting.
- Re-calculate the PV of the project

- The $8.1K drop in value is like a dividend. We miss out on the dividend by not exercising early.

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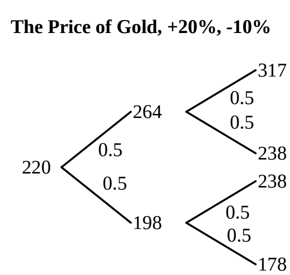
Gold mine example

- We have the rights to operate a gold mine for three years. The mine produces 50K ounces. Costs of extraction: $230/ounce. Gold is currently selling for $220/ounces. The price of gold has a beta of 0. The risk free rate is 5%. First CF occurs immediately.



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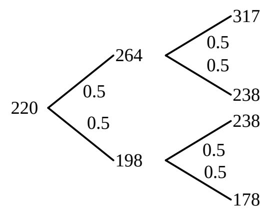
Gold mine example

- Traditional NPV calculation:

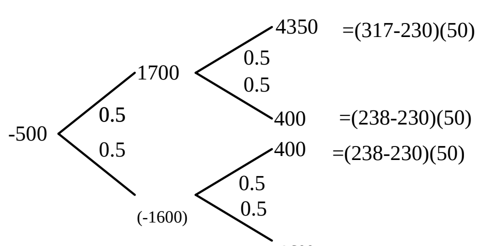
The Price of Gold, +20%, -10%



Opening and shutting down Options

- What is wrong with our calculation?
- Open and close decisions.

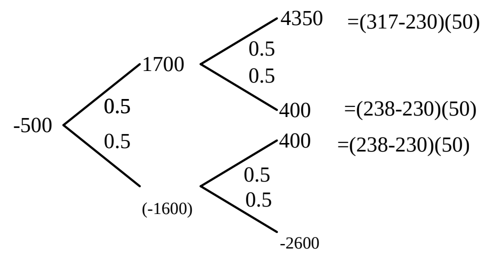
Cashflows



Opening and shutting down Options

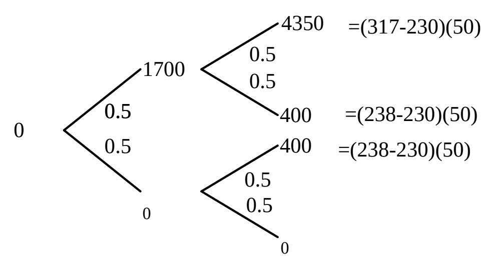
- At the nodes with negative CF would you operate the mine?

Cashflows



Opening and shutting down Options

Cashflows



- Replace zeros when the CF is negative and take NPV.
- NPV=

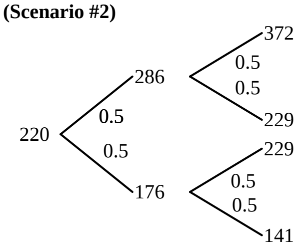
Opening and shutting down options - Recognizing the option

- What is the cash flow in each period when you take into account opening and shutting down options?

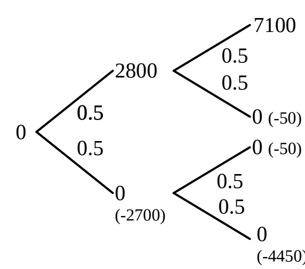
Cashflow= Max [50(price of gold-230),0)

Gold mine - Variance matters, +30%, -20%

The Price of Gold (Scenario #2)



Cashflows for Scenario #2



$$NPV_{GoldMine} = 0 + .25[\frac{2800}{(1+.05)} + \frac{7100}{(1+.05)^2}] + .25[\frac{2800}{(1+.05)}] = 2943$$

Costs to shutting down

- With opening and closing costs, the example become more realistic.
- It costs \$500K to open or shut down the mine.
- Now the cashflows depend not only on the price of gold, but also on whether the mine was open or closed last year

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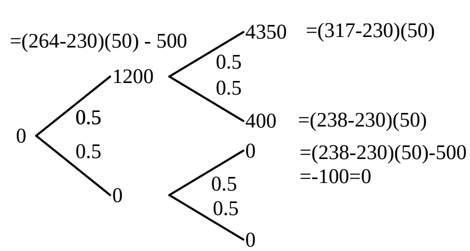
Opening and shutting costs

Opening and Closing Costs



$$NPV_{GoldMine} = 0 + .5\left[\frac{1200}{(1+.05)}\right] + .25\left[\frac{4350}{(1+.05)^2}\right] + .25\left[\frac{400}{(1+.05)^2}\right] + 0 = 1649$$

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Opening and shutting costs

If the mine was open:

Cashflow = Max[50(P_{Gold} - 230), -500]=
=50*Max (P_{Gold} - 220,0)-500

If the mine was closed:

Cashflow= Max[50(P_{Gold} - 230) - 500, 0]=
50*Max [50(P_{Gold} - 240), 0]

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Conclusion on opening and shutting costs

- Now the cashflows depend not only on the price of gold, but also on whether the mine was open or closed last year
- History matters. New entrant acts differently from an entrenched.

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Takeaway

- **Traditional NPV analysis may understate the value** of an investment when the investment project contains imbedded options.

- **Options are valuable when information is valuable.** Information is valuable when it affects real investment decisions.

- **Real options are a way to value flexibility.**

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