Real Option Valuation

Spotting Real (Strategic) Options

- Strategic options are a central in valuing new ventures
  - → Option to expand
  - → Option to delay
  - → Option to abandon
  - → Option to get into related businesses

- Different approaches to valuing real options
  - → Decision analytic approach
  - → Binomial method
  - → Black- Scholes model

Real Options in Traditional Valuation Methods

- Where are real options in DCF Method?
  → No where!

- Where are real options in Venture Capital Method?
  → Valuations might be completely based on real options value if the market priced these in
  → But we have no way to know whether the market has correctly accounted for real options

Example of "Real Options" Analysis in Horizon Communications

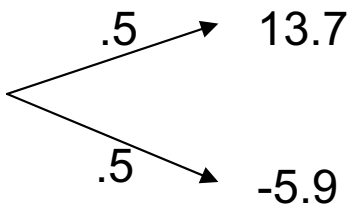
- Suppose the key source of uncertainty is the markup of price over carrier settlements. In the baseline (rosy?) scenario it was assumed that this was 25%.
- Suppose that instead there is really a 50% chance that it's 25% and a 50% chance that it's 15%.
- How would you model this uncertainty?

The Wrong Way to Model Markup Uncertainty

- Take the mean markup, 20%, and plug that number into the projections.
- Assuming 3% terminal growth, this gives an enterprise value of $4.1M per market. If Horizon is to enter 10 similar markets, this would give a valuation of $41M.
- Note the contrast to our previous (optimistic) valuation of $13.7M per market or $137M for 10 markets.

Why the Wrong Way is Wrong

- This approach fails to take into account that the value of entering the other markets is negative if the markup is only 15%. In fact, the value of each market is -$5.9M.



- If in the first year or two of the Chicago market, you learn that you can only get 15% markups, not 25% markups, then it is not optimal to enter the other markets.

  → Spotting the real option potential here means staging the entry into the local markets.

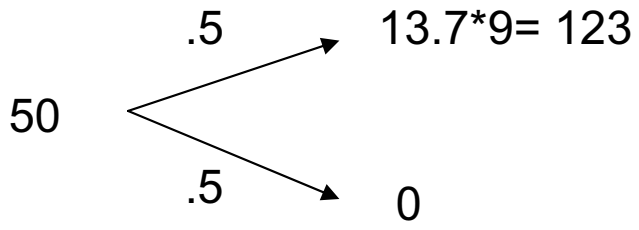
Horizon Single City Valuation								
Markup	25%							
	1	2	3	4	5	6	7	8
Revenue	0.8	9.4	21.8	35.0	49.0	63.8	65.7	67.7
Carrier Settlem	0.6	7.1	16.4	26.3	36.8	47.9	49.3	50.8
SalesExpense	1.5	4.4	4.6	4.7	4.9	5.0	2.6	2.7
G&A	1.8	2.0	2.1	2.1	2.2	2.3	2.3	2.4
EBITDA	-3.1	-4.1	-1.2	1.9	5.2	8.6	11.5	11.9
Depreciation	0.3	0.6	0.7	0.9	1.0	1.2	1.0	1.0
EBIT	-3.4	-4.7	-2.0	1.1	4.2	7.4	10.5	10.9
Taxes	0.0	0.0	0.0	0.0	0.0	1.0	4.8	3.9
EBIAT	-3.4	-4.7	-2.0	1.1	4.2	6.5	5.8	7.0
Depreciation	0.3	0.6	0.7	0.9	1.0	1.2	1.0	1.0
Ch. In NWC	0.0	-0.3	-0.5	-0.5	-0.6	-0.6	-0.1	-0.1
CAPX	4.9	2.4	2.4	2.4	2.4	2.4	1.0	1.0
FCF	-8.0	-6.2	-3.1	0.1	3.3	5.9	5.9	7.0
PVFCF	-5.2							
Growth	3%							
TV	55.7							
PVTV	17.0							
Int Expense	0.3	0.5	0.7	0.9	1.0	1.2	1.2	1.2
ITS	0.0	0.0	0.0	0.0	0.0	0.0	2.4	0.4
PVITS	1.0							
TVITS	1.0							
Ent./Equity Val.	3% gr.							
	13.7							

Horizon Single City Valuation									
Markup	15%								
	1	2	3	4	5	6	7	8	
Revenue	0.8	9.4	21.8	35.0	49.0	63.8	65.7	67.7	
Carrier Settlements	0.7	8.0	18.5	29.8	41.7	54.2	55.8	57.5	
SalesExpense	1.5	4.4	4.6	4.7	4.9	5.0	2.6	2.7	
G&A	1.8	2.0	2.1	2.1	2.2	2.3	2.3	2.4	
EBITDA	-3.2	-5.0	-3.4	-1.6	0.3	2.3	5.0	5.1	
Depreciation	0.3	0.6	0.7	0.9	1.0	1.2	1.0	1.0	
EBIT	-3.5	-5.6	-4.1	-2.4	-0.7	1.1	4.0	4.1	
Taxes	0.0	0.0	0.0	0.0	0.0	0.0	-4.1	1.5	
EBIAT	-3.5	-5.6	-4.1	-2.4	-0.7	1.1	8.1	2.6	
Depreciation	0.3	0.6	0.7	0.9	1.0	1.2	1.0	1.0	
Ch. In NWC	0.0	-0.3	-0.5	-0.5	-0.6	-0.6	-0.1	-0.1	
CAPX	4.9	2.4	2.4	2.4	2.4	2.4	1.0	1.0	
FCF	-8.1	-7.1	-5.3	-3.4	-1.6	0.5	8.1	2.7	
PVFCF	-14.4								
Growth	3%								
TV	21.4								
PVTV	6.5								
Int Expense	0.3	0.5	0.7	0.9	1.0	1.2	1.2	1.2	
ITS	0.0	0.0	0.0	0.0	0.0	0.0	2.4	0.4	
PVITS	1.0								
TVITS	1.0								
Ent./Equity Val.	3% gr.								
	-5.9								

Decision Analytic Approach

- Investors are **not passive**:

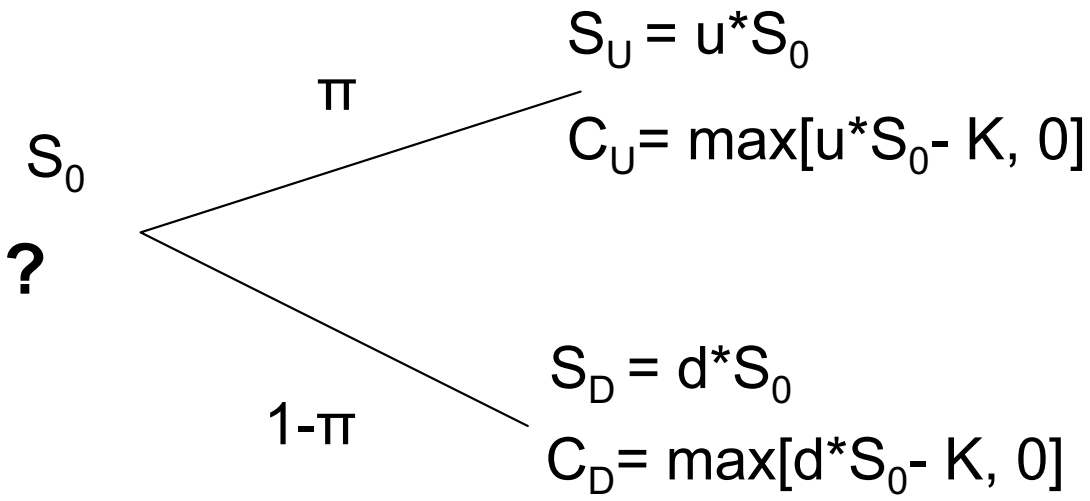
  → If markups turns out to be only 15%, then don't enter the other 9 markets and your payoff at this point is zero. Payoffs in two years accounting for inflation are:



$$(-5.9*0.5 + 13.7*0.5) + 0.5*(9*13.7)/1.16^2 = 50$$

- Considerably higher than in the case without the real option, value was only 41

Valuing Financial Options



- Stock price: S_i
- Strike price: K
- 1+Interest rate: R_f

Valuing Options with Tracking Portfolios: The Binomial Method

- Replicate cash flows of call option with common stock and debt

  → Up-node: $a * (u * S_0) + b * R_f = C_U$

  → Down-node: $a * (d * S_0) + b * R_f = C_D$

- Tracking portfolio:

  → $a = (C_U - C_D) / [(u-d)*S_0]$ (hedge ratio, delta)

  → $b = (u*C_D - d*C_U) / [(u-d)*R_f]$ (amount borrowed)

- Current value of the option is therefore:

  → $C_0 = (a * S_0 + b)$

  $= \{[(R_f - d)/(u-d)]*Cu + [(u - R_f)/(u-d)]*Cd\}$

Risk Neutral Valuation Method

- Option values from the binomial method are equivalent to assuming that investors are risk neutral and earn the risk free rate of return on all investments.
- Under this assumption, the return on the stock must satisfy:

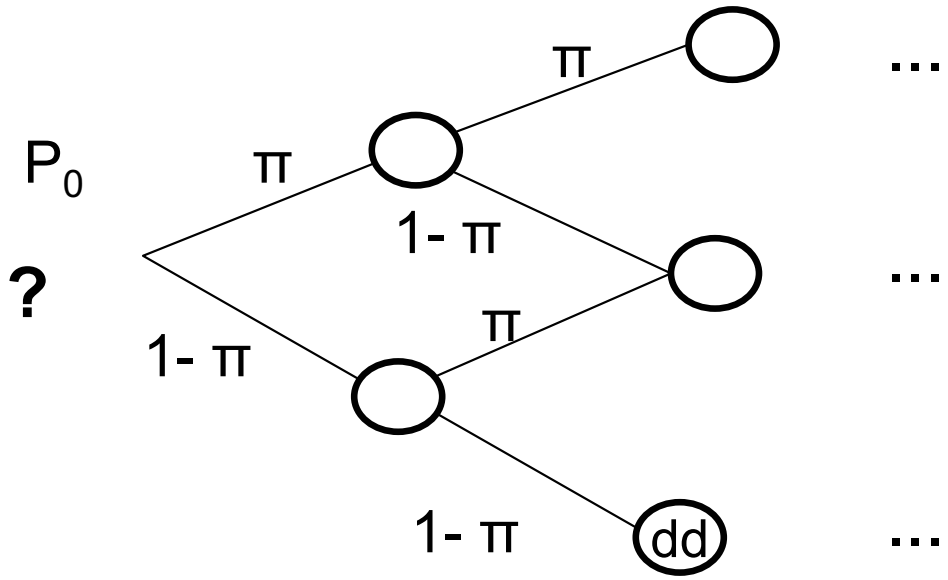
  $\rightarrow S_0 * R_f = \pi * (u * S_0) + (1 - \pi) * (d * S_0)$

  $\rightarrow \pi = (R_f - d) / (u-d)$,

  where we can think of π as the "risk-neutral probability" of an up-movement in the stock.
- Calculate current value of option

  $\rightarrow C_0 = (\pi * C_U + (1 - \pi) * C_D)/R_f$

N-Period Value of Option



- Binomial formula

$$\rightarrow c_0 = 1/(1+ r_f)^N * \sum N!/j!(N-j)! * \pi^j *(1- \pi)^{N-j}*\max[0, u^j*d^{N-j}*P_0 - K]$$

Black-Scholes Formula

$$c_0 = P_0 * N(d_1) - PV(K) * N(d_1 - \sigma*\sqrt{T})$$

$\rightarrow$ (stock price * delta) - ($ borrowed at r_f)

$\rightarrow d_1 = (\ln(P_0 / PV(K)) / \sigma\sqrt{T}) + \sigma\sqrt{T}/2$

N(z): probability that a normal (0,1) variable is less than z

σ: standard deviation of the natural log of stock returns

Where are Probabilities/Expected Returns in Financial Option Pricing Formulas?

- Expected stock returns (future stock price) do not explicitly enter into the option pricing formulas.
- The stock price today incorporates all the necessary information about expected stock returns. It reflects the average investor's valuation of the probability distribution of future stock prices

Using Option Pricing Methodologies to Value Real Options?

- How do we translate key variables into real options?

- r_f = Time value of money
- t = Length of time till option has to be realized
- K = Expenditure required to acquire project assets
- σ = Riskiness of project
- S_0 = Present value of project

How to Get Variables for Option Pricing

- Use DCF valuation analysis to get present value
- Use scenario analysis to get volatility of present value
  - → Need to make assumptions about probabilities of various outcomes
  - → Need to make assumptions about the cash flows under different scenarios
  - → If you have volatility of comparable company you might be able to use these. But rarely available

Difficulties in Applying Option Pricing Methodologies to New Ventures

- Present value of project? Riskiness?
  - → Underlying **project** is not traded and therefore its market value is not immediately known
  - → Returns might not be normally distributed
  - → Real options lead to real decisions! These affect the future value of the project itself

Option Pricing in the Case of Horizon

- Find risk neutral probabilities
  - → Market value of project is 29.0. This is the discounted value of the expected payoffs in the low and and high markup states assuming a probability of 0.5 for each state and a 16% discount rate.
  - → The risk-neutral probabilities are given by:

    $\pi * (137.0) + (1 - \pi) * (-59.0) = 29.0 * (1.07)^2$

  - → So, $\pi = 0.47$

- Present value of the Horizon option:
  - → $PV = (0.47 * 137.0 + 0.53*0) / (1.07)^2 = 56.2$

Decision Analysis vs. Option Pricing

- The Option Pricing Method gives a higher valuation than the Decision Analysis Method (56 vs. 50).
- Note that you need the same information to price the options using both methods.
- Both methods have their drawbacks
  - → The Option Pricing Method assumes that there is arbitrage when there clearly isn't
  - → The Decision Analysis Method discounts payoffs using CAPM-based discount rates which assume that payoffs are linear.

What to Do

- It is not so important to get the pricing details right (Decision Analysis vs. Option Pricing)

- Much more important to spot the option and to get some rough sense of its value.

- Understand what is the critical part of the existing project that generates the real option

  → Real options have to be embedded in the first step, otherwise you do not need the first part. Then it is not a real option anymore but an opportunity!

What not to do

- Don't use them opportunistically: Sometimes people use real options as ex post justification of bad investment decisions!

- "This business may look bad, but it gives us options to get into better businesses."

  $\rightarrow$ A bad project is still a bad project. Avoid it if you can!