

## CHEAP STOCK: EXTENDING THE OPTION PRICING MODEL

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## INTRODUCTION

- Summarize current best practices in cheap stock valuation and allocation
- Describe potential extensions to the option-pricing method for allocating equity value among different securities classes
- Provide examples that illustrate allocation in the presence of future, pre-exit financing rounds
- Outline framework for further extensions of the OPM
  - integrating valuation and allocation methods ("OPIUM")



## CURRENT BEST PRACTICES

To arrive at value of share-based compensation for option grants:

- Value aggregate equity, using standard approaches – income, market, cost ("Model #1")
- Allocate equity value among classes using Current, OPM, PWERM, or "hybrid" methodology ("Model #2")
- Value options grants using Black-Scholes model ("Model #3")

Is there a risk of "leakage" as values migrate from one model to the next?



## CURRENT BEST PRACTICES (cont.)

- Exposure draft of Cheap Stock Guide covers best practices for Models #1 and #2
  - Model #3 is beyond scope
- A key focus is on allocation methods (Model #2)
  - OPM is often the model of choice in practice
  - PWERM is considered a better method as an exit event approaches and exit visibility improves
  - Hybrid versions are employed when uncertainty is high



## OPTION PRICING METHOD

### Some Strengths

- Produces wide range of potential outcomes
- Assigns probabilities objectively, based on risk-neutral framework
- Can capture dilutive impact of current and anticipated future awards of stock and stock options
- Relative ease of application
- Relative ease of auditing results
- Pervasive



## OPTION PRICING METHOD

### Some Weaknesses

- Requires specification of single exit date
- Difficult to capture dilutive impact of future pre-exit financing rounds
- Does not capture "milestone" (non-normal) changes in value
  - Volatility adjustments are often employed as a remedy



## OPTION PRICING METHOD Resulting Limitations

Relevance may be directional to a "sweet spot"

- Problematic for early stage companies facing the need for multiple pre-exit financing rounds
  - Does not explicitly capture anticipated dilution
- Problematic for late stage companies where lognormal assumptions and risk-neutral probabilities no longer apply
  - Often requires shift to PWERM

## Modeling a Future Pre-exit Financing Round

## FUTURE FINANCING ROUND

### Hypothetical Assumptions

- Business opportunity has a value (***exclusive of financing needs***) of \$20 million
  - Volatility of opportunity: 50 percent
- Current (measurement date) capital structure consists of Series A preferred + common stock
- Expected liquidity event is 4 years away
  - 4-year risk-free rate is 4 percent
- May need to raise \$6 million or more (Series B) at the end of year 2 for initial product launch



## FUTURE FINANCING ROUND

### Hypothetical Assumptions (cont.)

- To expand/reach critical mass, may need to raise an additional \$12 million at end of year 4
- Ability to raise interim and final financing, and related prospective dilution of Series A and common, ***will depend on value of opportunity at each respective financing date***
  - Series B, A, and common stockholders will have ability to exit at end of year 4



## How would we allocate value to the existing investors using an OPM?

- Value the smaller, pre-expansion opportunity, and assume an exit event at the 2-year point?
  - This removes the need to address Series B pre-exit dilution
  - But no liquidity is actually anticipated at this point
- Value the opportunity, assume an exit event at the 4-year point, and capture the potential dilution via an increased marketability discount?
  - This utilizes the correct liquidity date
  - But the adjustment for dilution is hard to audit and support
  - And the method **assumes that the interim round will be successful**
- Are there other workarounds?



## Allocation by Explicitly Addressing Future Financing Needs

- Assume an exit event at the 4-year point
  - This properly reflects management expectations
- Capture dilutive impact at time of each financing
  - Requires use of binomial (or Monte Carlo) model
  - **Dilution will vary** based on value of opportunity at time of financing
  - **Risk of failure** (inability to obtain needed financing) is also explicitly modeled
    - How does one model "risk of failure"?



**Step 1:** Generate potential values of the underlying asset *exclusive of future financing needs* [Note: the binomial model used herein adjusts up and down movements so that there are equal (50 percent) probabilities of each]

Evolution of Expected Opportunity Value					
Period	0	1	2	3	4
Value of opportunity	20,000	30,287	45,866	69,459	105,186
		11,142	16,873	25,552	38,696
			6,207	9,400	14,235
				3,458	5,237
					1,927



**Step 2:** Solve for value of current capital structure by reducing the value for financing needs in years 2 and 4; note that *financing is contingent* on the opportunity's value at each date

Period	0	1	2	3	4
Expansion financing					12,000
Series B financing			6,000		
Value of current equity	7,091	14,189	28,343	57,591	93,186
		573	1,193	13,898	26,696
			0	1,074	2,235
				0	0
					0



**Step 3:** Isolate the exit value to the existing capital structure (Series A and common) using binomial probabilities

Period	0	1	2	3	4
Adjusted value, current equity	7,091	13,111	23,982	43,300	76,906
		1,651	3,309	6,622	13,229
			128	266	555
				0	0
					0

## How were binomial probabilities used to make these adjustments?

- The year 4 financing adjustment (Step 2) is easy; the highest value of \$105.2 million is allocated as follows:
  - \$12.0 million to new year 4 investors (Series C)
    - Assumes Series C investors provide value neutral financing
  - \$93.2 million to existing (at that time) Series B, A and common investors
- But our objective is to isolate the diluted value of **the current** capital structure – how do we adjust for the dilutive impact of the year 2/Series B round?

**Paths through a binomial model:** Up moves are across, down moves are diagonal. Period 1 has only two outcomes – one up path, one down. Period 2 has four outcomes; the second outcome can be reached along two different paths.

Period	0	1	2	3	4
Number of paths	1	1	1	1	1
		1	2	3	4
			1	3	6
				1	4
					1

## How were binomial probabilities used to make these adjustments? (cont.)

- The year 2 financing adjustment is based on binomial probabilities; the highest value at year 4 could only have been reached by going through the highest year 2 value:
  - **\$28.3 million** = \$34.3 million - \$6.0 million Series B
  - Thus, 17.5 percent of ownership (6.0/34.3) theoretically went to Series B **on this particular path** assuming a pure mathematical allocation
  - Of the \$93.2 million available to Series B, A and common investors at year 4, 17.5 percent (\$16.3 million) will go to Series B investors, leaving \$76.9 million for existing Series A and common
- Other Series B dilution adjustments, while more complicated, are solved in a similar way
  - The amount of Series B dilution at each exit value can be calculated by determining what year 2 paths contributed to year 4 values

## Summary of Hypothetical Example

- We expanded the OPM "sweet spot" by **explicitly addressing the dilutive impact** of a future, pre-exit financing round
- The dilution adjustments are rational, in that they vary depending on the value that must be given up to Series B investors **at the time of the investment**
- We accounted for the **probability of failure** to obtain Series B financing
- The adjusted solution is **no longer lognormal**, but rather shows what would be expected – a "waterfall" pattern in which the Series A and common benefit to a greater extent in the highest exit values, dropping off rapidly at lower exit values

## Other Extensions of the OPM

## OPTION PRICING METHOD

### Potential Extensions

- The OPM can serve as Model #1
  - valuation of aggregate equity via option methods (also referred to as "real option methods")
  - we already do this with the PWERM, which simultaneously serves as a valuation and allocation model
- The OPM can serve as Model #3
  - simultaneous valuation of option grants

***One integrated model*** that replaces all current models



## Direct Valuation of Option Grants?

- Advantages:
  - No "leakage" as values are all determined simultaneously, and not migrated from model to model
  - Same (aggregate equity) volatility can be used throughout
    - Not the case when we use separate models – we have to adjust from aggregate equity volatility (Model #2) to common stock volatility (Model #3)
- Disadvantages:
  - There are some issues regarding expected life of option grants



Questions?