

# The option to expand: Valuing a young, start-up company

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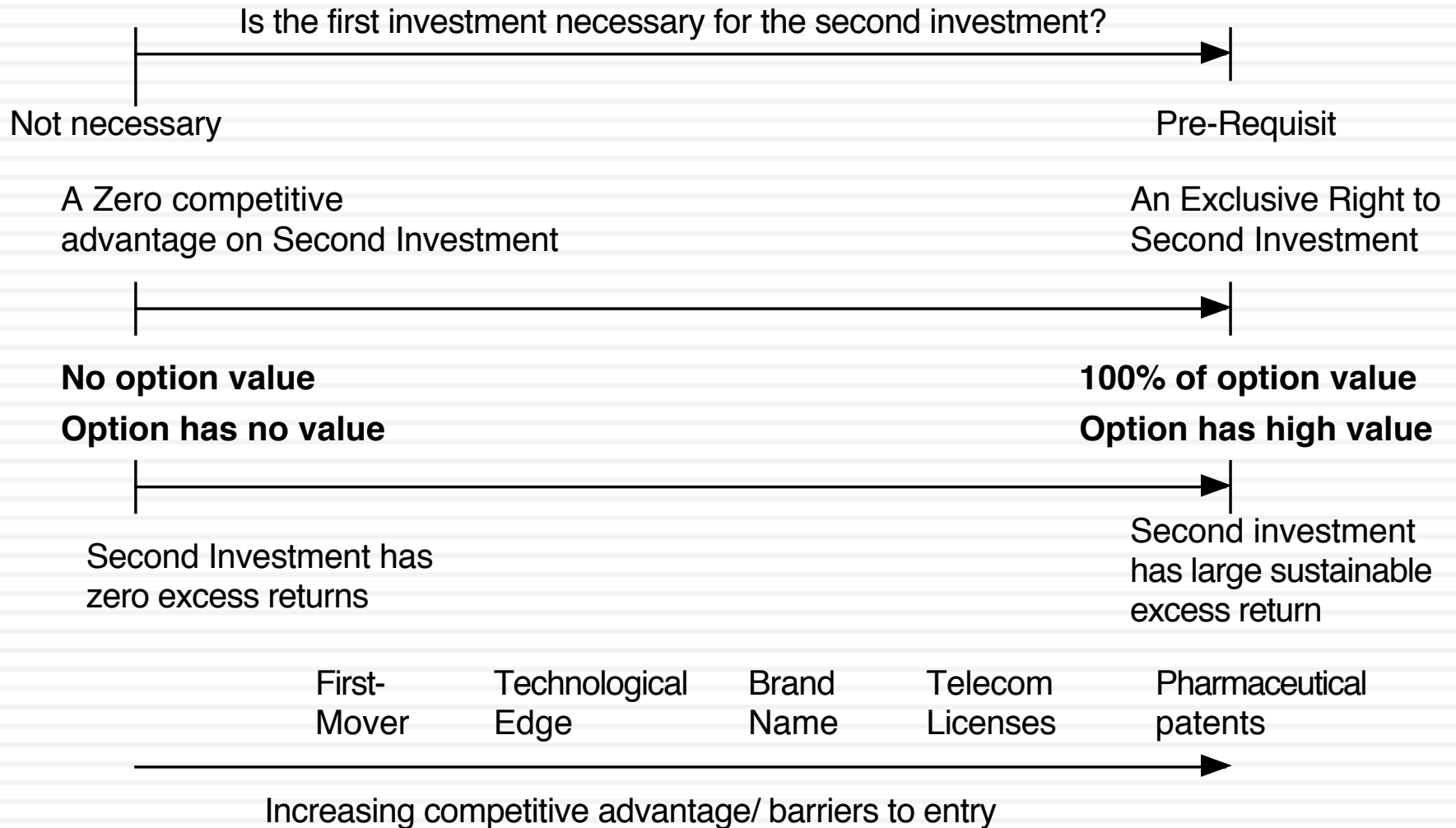
- You have completed a DCF valuation of a small anti-virus software company, Secure Mail, and estimated a value of \$115 million.
- Assume that there is the possibility that the company could use the customer base that it develops for the anti-virus software and the technology on which the software is based to create a database software program sometime in the next 5 years.
  - It will cost Secure Mail about \$500 million to develop a new database program, if they decided to do it today.
  - Based upon the information you have now on the potential for a database program, the company can expect to generate about \$40 million a year in after-tax cashflows for ten years. The cost of capital for private companies that provide database software is 12%.
  - The annualized standard deviation in firm value at publicly traded database companies is 50%.
  - The five-year treasury bond rate is 3%.

# Valuing the Expansion Option

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- S = Value of entering the database software market  
= PV of \$40 million for 10 years @12% = \$226 million
- K = Exercise price  
= Cost of entering the database software market = \$ 500 million
- t = Period over which you have the right to enter the market  
= 5 years
- $\sigma$  = Standard deviation of stock prices of database firms = 50%
- r = Riskless rate = 3%
- Call Value= \$ 56 Million
- DCF valuation of the firm = \$ 115 million
- Value of Option to Expand to Database market = \$ 56 million
- Value of the company with option to expand = \$ 171 million

# A note of caution: Opportunities are not options...



# The Real Options Test for Expansion Options

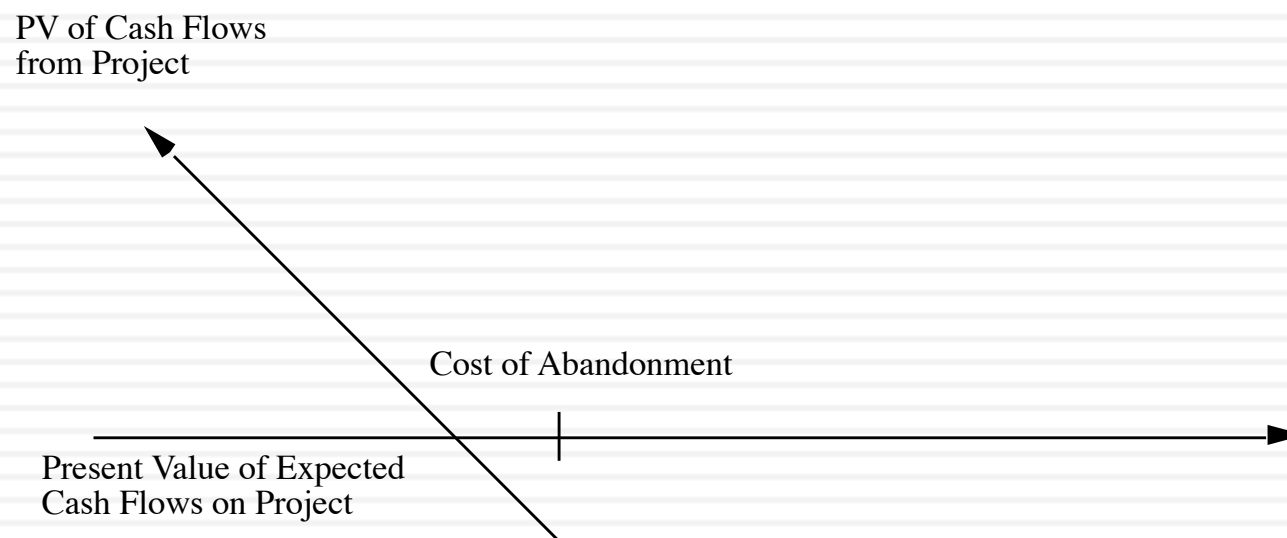
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- The Options Test
  - ▣ Underlying Asset: Expansion Project
  - ▣ Contingency
  - ▣ If PV of CF from expansion  $>$  Expansion Cost: PV - Expansion Cost
  - ▣ If PV of CF from expansion  $<$  Expansion Cost: 0
- The Exclusivity Test
  - ▣ Barriers may range from strong (exclusive licenses granted by the government) to weaker (brand name, knowledge of the market) to weakest (first mover).
- The Pricing Test
  - ▣ Underlying Asset: As with patents, there is no trading in the underlying asset and you have to estimate value and volatility.
  - ▣ Option: Licenses are sometimes bought and sold, but more diffuse expansion options are not.
  - ▣ Cost of Exercising the Option: Not known with any precision and may itself evolve over time as the market evolves.
- Using option pricing models to value expansion options will not only yield extremely noisy estimates, but may attach inappropriate premiums to discounted cashflow estimates.

## C. The Option to Abandon

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- A firm may sometimes have the option to abandon a project, if the cash flows do not measure up to expectations.
- If abandoning the project allows the firm to save itself from further losses, this option can make a project more valuable.



# Valuing the Option to Abandon

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- Airbus is considering a joint venture with Lear Aircraft to produce a small commercial airplane (capable of carrying 40-50 passengers on short haul flights)
  - Airbus will have to invest \$ 500 million for a 50% share of the venture
  - Its share of the present value of expected cash flows is 480 million.
- Lear Aircraft, which is eager to enter into the deal, offers to buy Airbus's 50% share of the investment anytime over the next five years for \$ 400 million, if Airbus decides to get out of the venture.
- A simulation of the cash flows on this time share investment yields a variance in the present value of the cash flows from being in the partnership is 0.16.
- The project has a life of 30 years.

# Project with Option to Abandon

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- Value of the Underlying Asset ( $S$ ) = PV of Cash Flows from Project = \$ 480 million
- Strike Price ( $K$ ) = Salvage Value from Abandonment = \$ 400 million
- Variance in Underlying Asset's Value = 0.16
- Time to expiration = Life of the Project = 5 years
- Dividend Yield =  $1/\text{Life of the Project} = 1/30 = 0.033$  (We are assuming that the project's present value will drop by roughly  $1/n$  each year into the project)
- Assume that the five-year riskless rate is 6%. The value of the put option can be estimated.

# Should Airbus enter into the joint venture?

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$$\begin{aligned}\text{Value of Put} &= Ke^{-rt} (1-N(d2)) - Se^{-yt} (1-N(d1)) \\ &= 400 \exp^{(-0.06)(5)} (1-0.4624) - 480 \exp^{(-0.033)(5)} (1-0.7882) \\ &= \$ 73.23 \text{ million}\end{aligned}$$

- The value of this abandonment option has to be added on to the net present value of the project of - \$ 20 million, yielding a total net present value with the abandonment option of \$ 53.23 million.



# Implications for Investment Analysis/ Valuation

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- Having a option to abandon a project can make otherwise unacceptable projects acceptable.
- Other things remaining equal, you would attach more value to companies with
  - ▣ More cost flexibility, that is, making more of the costs of the projects into variable costs as opposed to fixed costs.
  - ▣ Fewer long-term contracts/obligations with employees and customers, since these add to the cost of abandoning a project.
- These actions will undoubtedly cost the firm some value, but this has to be weighed off against the increase in the value of the abandonment option.

# D. Options in Capital Structure

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- The most direct applications of option pricing in capital structure decisions is in the design of securities. In fact, most complex financial instruments can be broken down into some combination of a simple bond/common stock and a variety of options.
  - If these securities are to be issued to the public, and traded, the options have to be priced.
  - If these are non-traded instruments (bank loans, for instance), they still have to be priced into the interest rate on the instrument.
- The other application of option pricing is in valuing flexibility. Often, firms preserve debt capacity or hold back on issuing debt because they want to maintain flexibility.

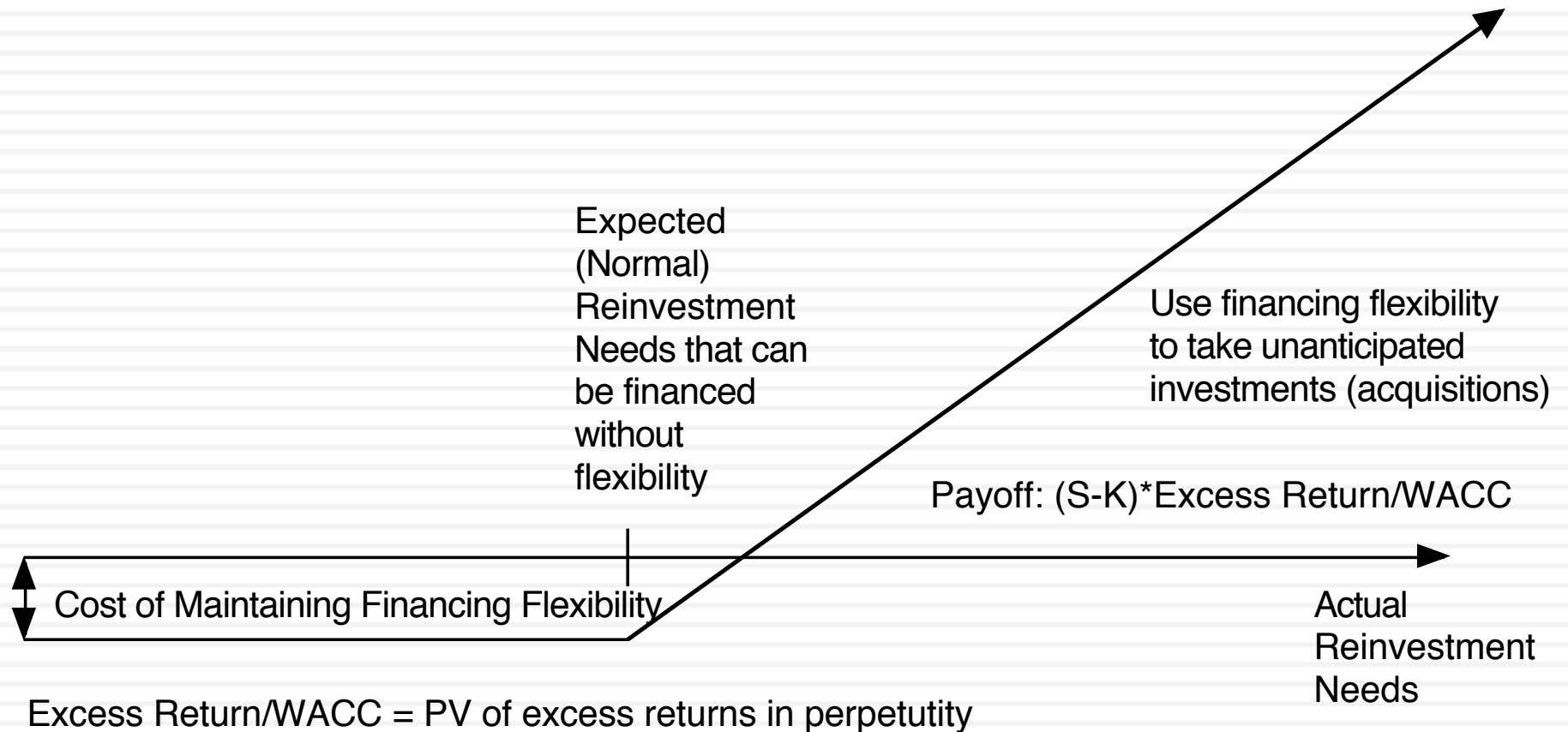
# The Value of Flexibility

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- Firms maintain excess debt capacity or larger cash balances than are warranted by current needs, to meet unexpected future requirements.
- While maintaining this financing flexibility has value to firms, it also has a cost; the excess debt capacity implies that the firm is giving up some value and has a higher cost of capital.
- The value of flexibility can be analyzed using the option pricing framework; a firm maintains large cash balances and excess debt capacity in order to have the option to take projects that might arise in the future.

# The Value of Flexibility

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# Disney's Optimal Debt Ratio

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Debt Ratio	Cost of Equity	Cost of Debt	Cost of Capital
0.00%	13.00%	4.61%	13.00%
10.00%	13.43%	4.61%	12.55%
Current:18%	13.85%	4.80%	12.22%
20.00%	13.96%	4.99%	12.17%
30.00%	14.65%	5.28%	11.84%
40.00%	15.56%	5.76%	11.64%
50.00%	16.85%	6.56%	11.70%
60.00%	18.77%	7.68%	12.11%
70.00%	21.97%	7.68%	11.97%
80.00%	28.95%	7.97%	12.17%
90.00%	52.14%	9.42%	13.69%

# Inputs to Option Valuation Model- Disney

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Model input	Estimated as	In general...	For Disney
S	Expected annual reinvestment needs (as % of firm value)	Measures magnitude of reinvestment needs	Average of Reinvestment/ Value over last 5 years = 5.3%
$\sigma^2$	Variance in annual reinvestment needs	Measures how much volatility there is in investment needs.	Variance over last 5 years in $\ln(\text{Reinvestment}/\text{Value}) = 0.375$
K	(Internal + Normal access to external funds)/ Value	Measures the capital constraint	Average over last 5 years = 4.8%
T	1 year	Measures an annual value for flexibility	T = 1

# Valuing Flexibility at Disney

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- The value of an option with these characteristics is 1.6092%. You can consider this the value of the option to take a project, but the overall value of flexibility will still depend upon the quality of the projects taken. In other words, the value of the option to take a project is zero if the project has zero net present value.
- Disney earns 18.69% on its projects has a cost of capital of 12.22%. The excess return (annually) is 6.47%. Assuming that they can continue to generate these excess returns in perpetuity:  
Value of Flexibility (annual) =  $1.6092\% \times (.0647 / .1222) = 0.85\%$  of value
- Disney's cost of capital at its optimal debt ratio is 11.64%. The cost it incurs to maintain flexibility is therefore 0.58% annually (12.22% - 11.64%). It therefore pays to maintain flexibility.

# Determinants of the Value of Flexibility

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- Capital Constraints (External and Internal): The greater the capacity to raise funds, either internally or externally, the less the value of flexibility.
  - 1.1: Firms with significant internal operating cash flows should value flexibility less than firms with small or negative operating cash flows.
  - 1.2: Firms with easy access to financial markets should have a lower value for flexibility than firms without that access.
- Unpredictability of reinvestment needs: The more unpredictable the reinvestment needs of a firm, the greater the value of flexibility.
- Capacity to earn excess returns: The greater the capacity to earn excess returns, the greater the value of flexibility.
  - 1.3: Firms that do not have the capacity to earn or sustain excess returns get no value from flexibility.



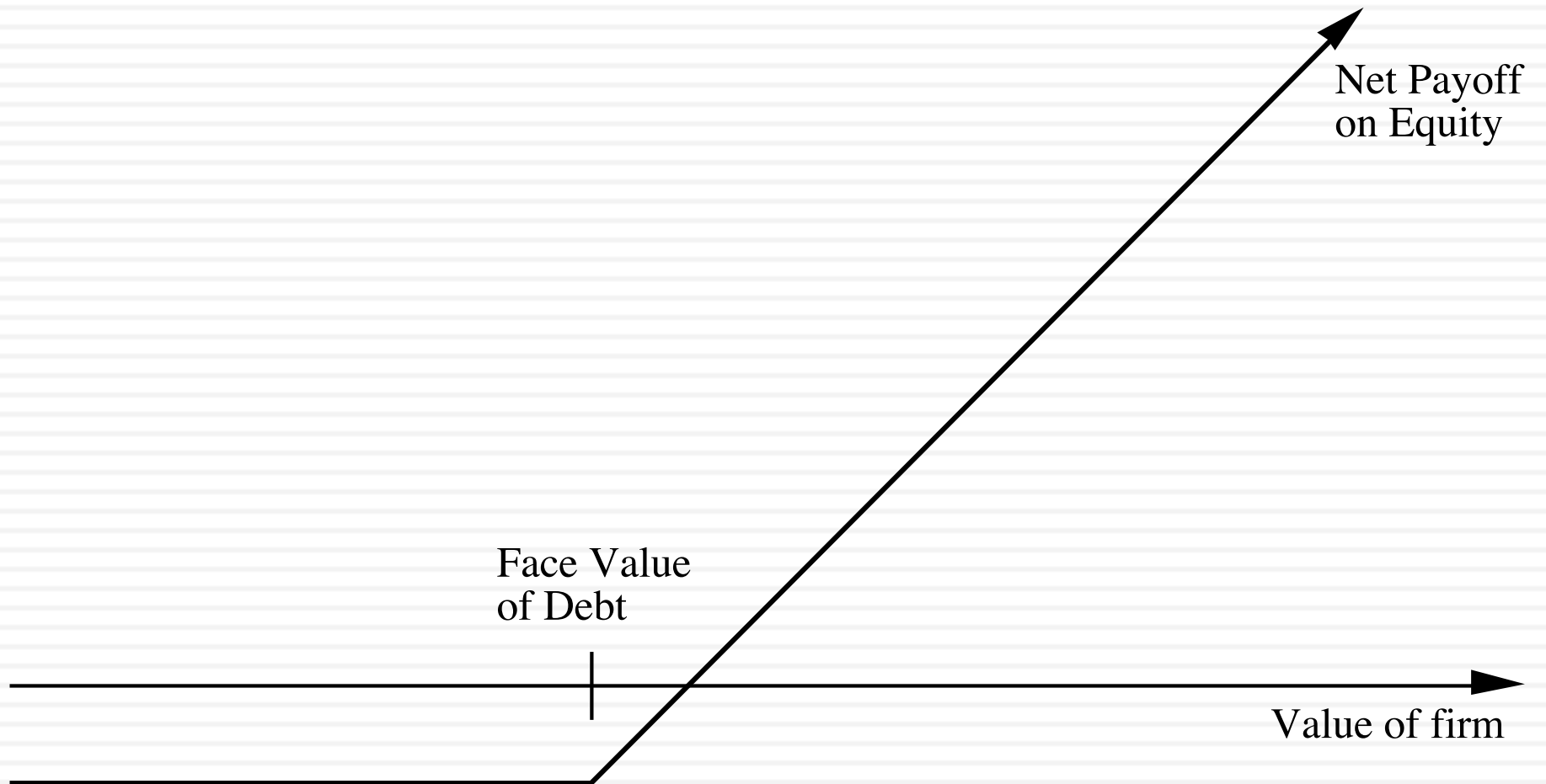
## E. Valuing Equity as an option

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- The equity in a firm is a residual claim, i.e., equity holders lay claim to all cashflows left over after other financial claim-holders (debt, preferred stock etc.) have been satisfied.
- If a firm is liquidated, the same principle applies, with equity investors receiving whatever is left over in the firm after all outstanding debts and other financial claims are paid off.
- The principle of limited liability, however, protects equity investors in publicly traded firms if the value of the firm is less than the value of the outstanding debt, and they cannot lose more than their investment in the firm.

# Payoff Diagram for Liquidation Option

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# Application to valuation: A simple example

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- Assume that you have a firm whose assets are currently valued at \$100 million and that the standard deviation in this asset value is 40%.
- Further, assume that the face value of debt is \$80 million (It is zero coupon debt with 10 years left to maturity).
- If the ten-year treasury bond rate is 10%,
  - ▣ how much is the equity worth?
  - ▣ What should the interest rate on debt be?

# Model Parameters

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- Value of the underlying asset =  $S$ 
  - ▣ Value of the firm = \$ 100 million
- Exercise price =  $K$ 
  - ▣ Face Value of outstanding debt = \$ 80 million
- Life of the option =  $t$ 
  - ▣ Life of zero-coupon debt = 10 years
- Variance in the value of the underlying asset =  $\sigma^2$ 
  - ▣ Variance in firm value = 0.16
- Riskless rate =  $r$ 
  - ▣ Treasury bond rate corresponding to option life = 10%

# Valuing Equity as a Call Option

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- Based upon these inputs, the Black-Scholes model provides the following value for the call:  
d1 = 1.5994                      N(d1) = 0.9451  
d2 = 0.3345                      N(d2) = 0.6310
- Value of the call =  $100 (0.9451) - 80 \exp^{(-0.10)(10)} (0.6310) = \$75.94$  million
- Value of the outstanding debt =  $\$100 - \$75.94 = \$24.06$  million
- Interest rate on debt =  $(\$ 80 / \$24.06)^{1/10} - 1 = 12.77\%$

# I. The Effect of Catastrophic Drops in Value

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- Assume now that a catastrophe wipes out half the value of this firm (the value drops to \$ 50 million), while the face value of the debt remains at \$ 80 million. What will happen to the equity value of this firm?
  - a. It will drop in value to \$ 25.94 million [ \$ 50 million - market value of debt from previous page]
  - b. It will be worth nothing since debt outstanding > Firm Value
  - c. It will be worth more than \$ 25.94 million

# Valuing Equity in the Troubled Firm

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- Value of the underlying asset =  $S$ 
  - ▣ Value of the firm = \$ 50 million
- Exercise price =  $K$ 
  - ▣ Face Value of outstanding debt = \$ 80 million
- Life of the option =  $t$ 
  - ▣ Life of zero-coupon debt = 10 years
- Variance in the value of the underlying asset =  $\sigma^2$ 
  - ▣ Variance in firm value = 0.16
- Riskless rate =  $r$ 
  - ▣ Treasury bond rate corresponding to option life = 10%

# The Value of Equity as an Option

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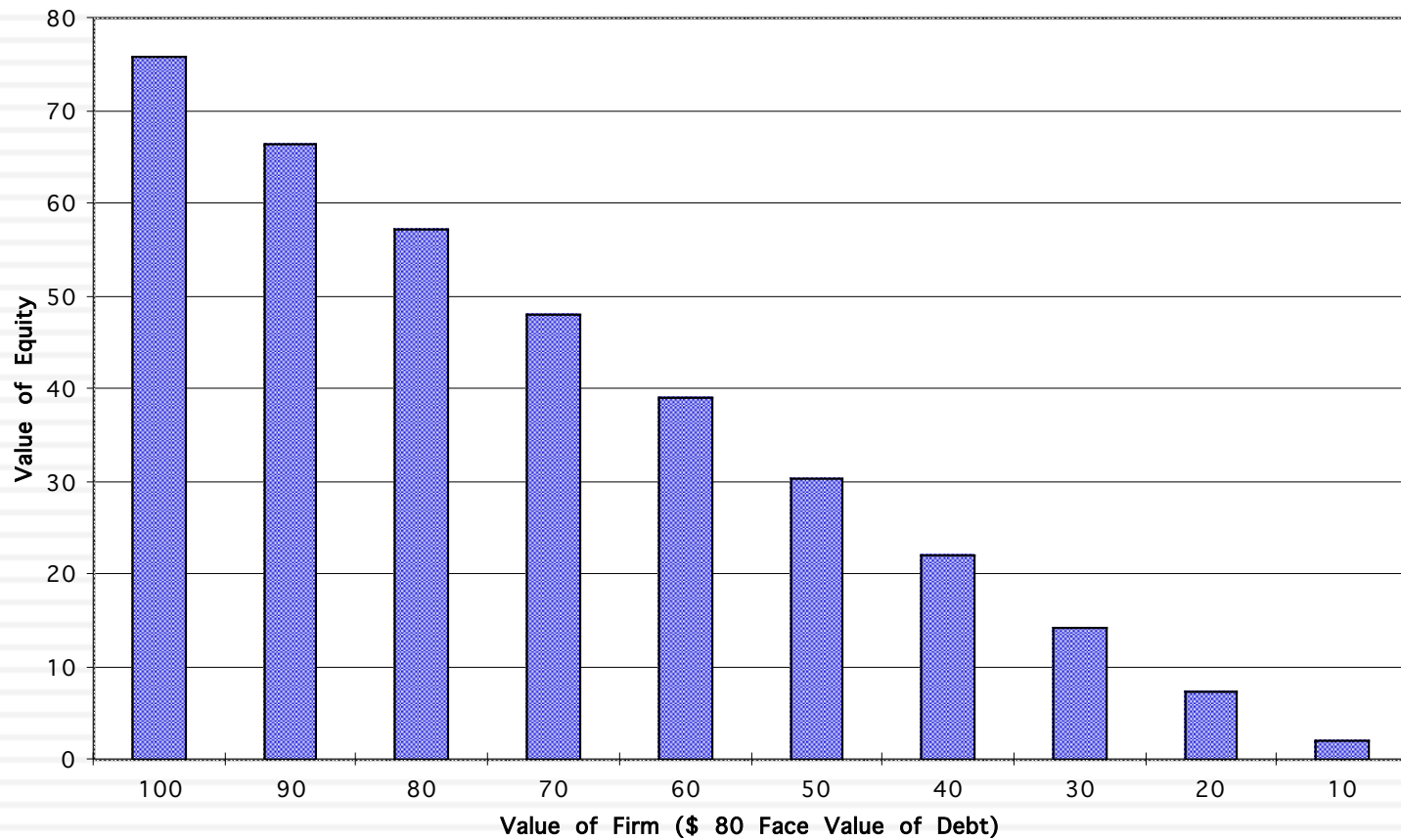
- Based upon these inputs, the Black-Scholes model provides the following value for the call:  
d1 = 1.0515                      N(d1) = 0.8534  
d2 = -0.2135                      N(d2) = 0.4155
- Value of the call =  $50 (0.8534) - 80 \exp^{(-0.10)(10)} (0.4155) = \$30.44$  million
- Value of the bond =  $\$50 - \$30.44 = \$19.56$  million
- The equity in this firm drops by \$45.50 million, less than the overall drop in value of \$50 million, because of the option characteristics of equity.
- This might explain why stock in firms, which are in Chapter 11 and essentially bankrupt, still has value.



# Equity value persists ..

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Value of Equity as Firm Value Changes



## II. The conflict between stockholders and bondholders

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- Consider again the firm described in the earlier example , with a value of assets of \$100 million, a face value of zero-coupon ten-year debt of \$80 million, a standard deviation in the value of the firm of 40%. The equity and debt in this firm were valued as follows:
  - ▣ Value of Equity = \$75.94 million
  - ▣ Value of Debt = \$24.06 million
  - ▣ Value of Firm == \$100 million
- Now assume that the stockholders have the opportunity to take a project with a negative net present value of -\$2 million, but assume that this project is a very risky project that will push up the standard deviation in firm value to 50%. Would you invest in this project?
  - a. Yes
  - b. No

# Valuing Equity after the Project

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- Value of the underlying asset =  $S$ 
  - ▣ Value of the firm = \$ 100 million - \$2 million = \$ 98 million (The value of the firm is lowered because of the negative net present value project)
- Exercise price =  $K$ 
  - ▣ Face Value of outstanding debt = \$ 80 million
- Life of the option =  $t$
- Life of zero-coupon debt = 10 years
- Variance in the value of the underlying asset =  $\sigma^2$ 
  - ▣ Variance in firm value = 0.25
- Riskless rate =  $r$ 
  - ▣ Treasury bond rate corresponding to option life = 10%

# Option Valuation

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- Option Pricing Results for Equity and Debt Value
  - ▣ Value of Equity = \$77.71
  - ▣ Value of Debt = \$20.29
  - ▣ Value of Firm = \$98.00
- The value of equity rises from \$75.94 million to \$77.71 million , even though the firm value declines by \$2 million. The increase in equity value comes at the expense of bondholders, who find their wealth decline from \$24.06 million to \$20.19 million.

# Effects of an Acquisition

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- Assume that you are the manager of a firm and that you buy another firm, with a fair market value of \$ 150 million, for exactly \$ 150 million. In an efficient market, the stock price of your firm will
  - a. Increase
  - b. Decrease
  - c. Remain Unchanged

# Effects on equity of a conglomerate merger

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- You are provided information on two firms, which operate in unrelated businesses and hope to merge.

	Firm A	Firm B
Value of the firm	\$100 million	\$ 150 million
Face Value of Debt (10 yr zeros)	\$ 80 million	\$ 50 million
Maturity of debt	10 years	10 years
Std. Dev. in value	40 %	50 %
Correlation between cashflows	0.4	

- The ten-year bond rate is 10%.

- The variance in the value of the firm after the acquisition can be calculated as follows:

$$\begin{aligned}\text{Variance in combined firm value} &= w_1^2 \sigma_1^2 + w_2^2 \sigma_2^2 + 2 w_1 w_2 \rho_{12} \sigma_1 \sigma_2 \\ &= (0.4)^2 (0.16) + (0.6)^2 (0.25) + 2 (0.4) (0.6) (0.4) (0.4) (0.5) \\ &= 0.154\end{aligned}$$

# Valuing the Combined Firm

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- The values of equity and debt in the individual firms and the combined firm can then be estimated using the option pricing model:

	Firm A	Firm B	Combined firm
Value of equity in the firm		\$75.94	\$134.47 \$ 207.43
Value of debt in the firm		\$24.06	\$ 15.53 \$ 42.57
Value of the firm		\$100.00	\$150.00 \$ 250.00

- The combined value of the equity prior to the merger is \$ 210.41 million and it declines to \$207.43 million after.
- The wealth of the bondholders increases by an equal amount.
- There is a transfer of wealth from stockholders to bondholders, as a consequence of the merger. Thus, conglomerate mergers that are not followed by increases in leverage are likely to see this redistribution of wealth occur across claim holders in the firm.

# Obtaining option pricing inputs - Some real world problems

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- The examples that have been used to illustrate the use of option pricing theory to value equity have made some simplifying assumptions. Among them are the following:
  - (1) There were only two claim holders in the firm - debt and equity.
  - (2) There is only one issue of debt outstanding and it can be retired at face value.
  - (3) The debt has a zero coupon and no special features (convertibility, put clauses etc.)
  - (4) The value of the firm and the variance in that value can be estimated.



# Real World Approaches to Valuing Equity in Troubled Firms: Getting Inputs

Input	Estimation Process
Value of the Firm	<ul style="list-style-type: none"> <li>• Cumulate market values of equity and debt (or)</li> <li>• Value the <u>assets in place</u> using FCFF and WACC (or)</li> <li>• Use cumulated market value of assets, if traded.</li> </ul>
Variance in Firm Value	<ul style="list-style-type: none"> <li>• If stocks and bonds are traded,  <math display="block">\sigma^2_{\text{firm}} = w_e^2 \sigma_e^2 + w_d^2 \sigma_d^2 + 2 w_e w_d \rho_{ed} \sigma_e \sigma_d</math>                     where <math>\sigma_e^2</math> = variance in the stock price  <math>w_e</math> = MV weight of Equity  <math>\sigma_d^2</math> = the variance in the bond price      <math>w_d</math> = MV weight of debt                 </li> <li>• If not traded, use variances of similarly rated bonds.</li> <li>• Use average firm value variance from the industry in which company operates.</li> </ul>
Value of the Debt	<ul style="list-style-type: none"> <li>• If the debt is short term, you can use only the face or book value of the debt.</li> <li>• If the debt is long term and coupon bearing, add the cumulated nominal value of these coupons to the face value of the debt.</li> </ul>
Maturity of the Debt	<ul style="list-style-type: none"> <li>• Face value weighted duration of bonds outstanding (or)</li> <li>• If not available, use weighted maturity</li> </ul>