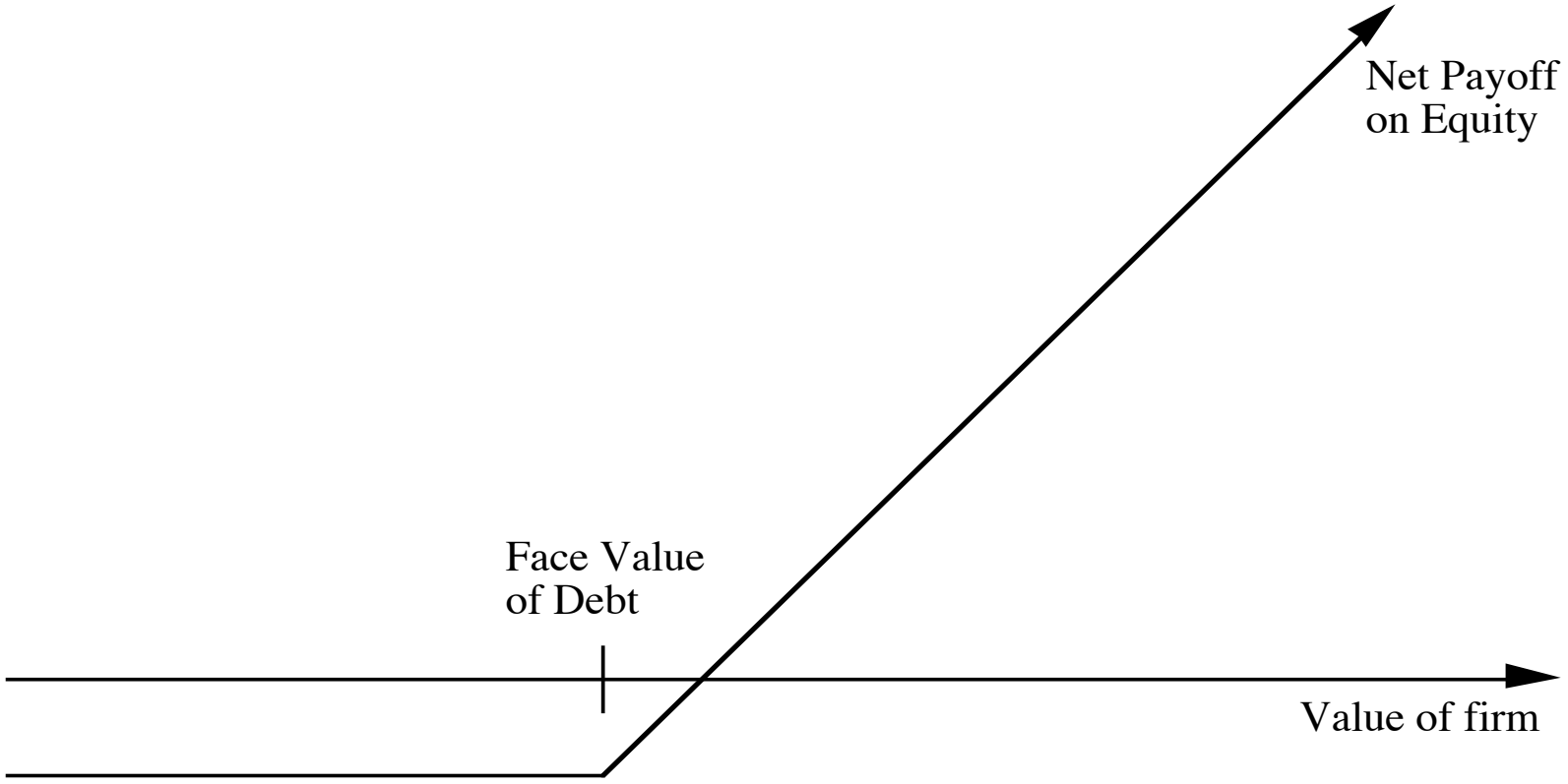
E. VALUING EQUITY AS AN OPTION

- 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



APPLICATION TO VALUATION: A SIMPLE EXAMPLE

- 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

- 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 = σ^2
  - Variance in firm value = 0.16
- Riskless rate = r
  - Treasury bond rate corresponding to option life = 10%

VALUING EQUITY AS A CALL OPTION

- 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

- 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

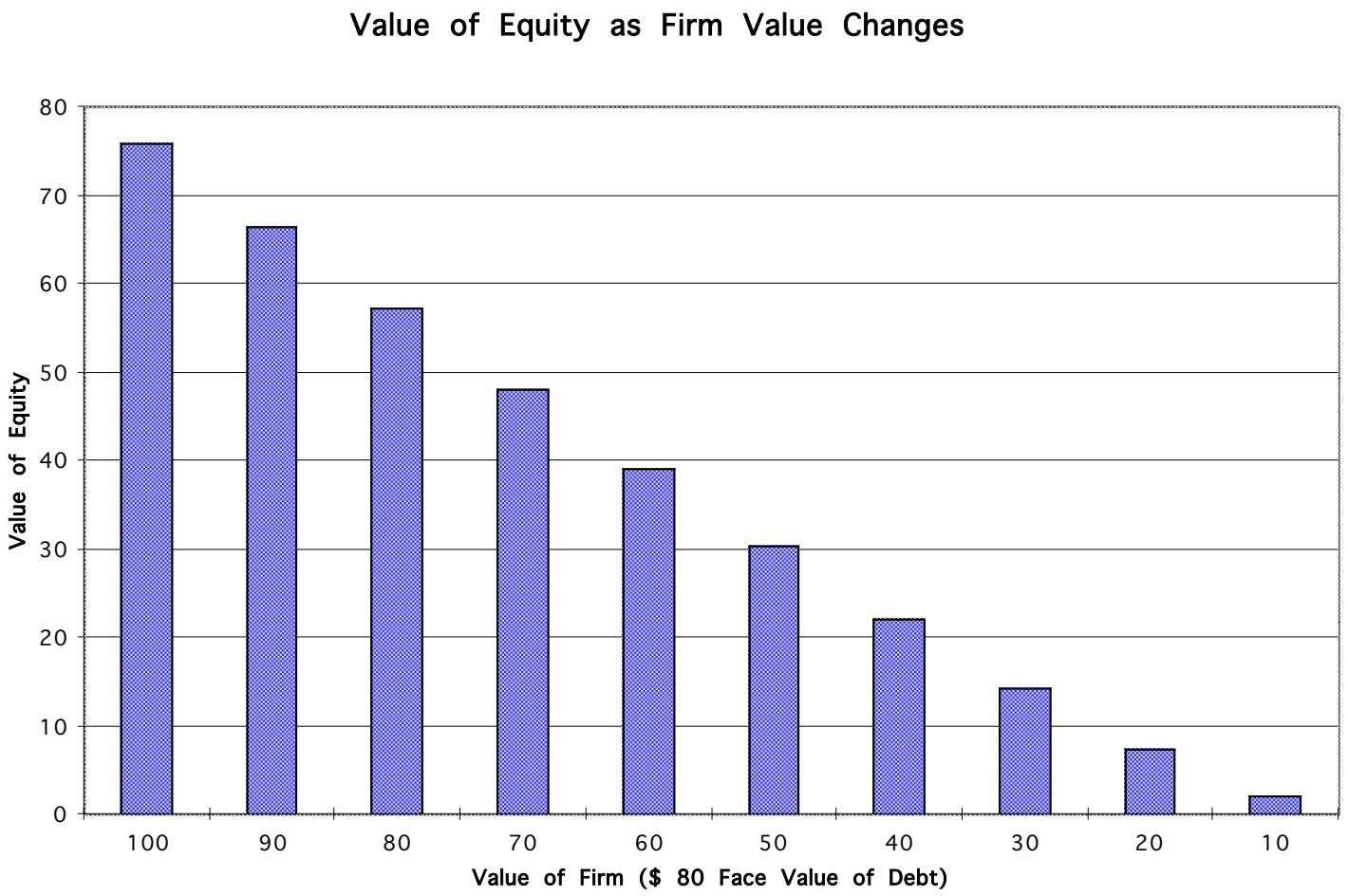
VALUING EQUITY IN THE TROUBLED FIRM

- 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 = σ^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

- 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 ..



II. THE CONFLICT BETWEEN STOCKHOLDERS AND BONDHOLDERS

- 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?
  - Yes
  - No

VALUING EQUITY AFTER THE PROJECT

- 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 = = σ^2
  - Variance in firm value = 0.25
- Riskless rate = r
  - Treasury bond rate corresponding to option life = 10%

OPTION VALUATION

- 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

- 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
  - Increase
  - Decrease
  - Remain Unchanged

EFFECTS ON EQUITY OF A CONGLOMERATE MERGER

- 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:
  - Variance in combined firm value

$= w1^2 \sigma1^2 + w2^2 \sigma2^2 + 2\, w1\, w2\, \rho^{12}\, \sigma1\sigma2$

$= (0.4)2\ (0.16) + (0.6)2\ (0.25) + 2\ (0.4)\ (0.6)\ (0.4)\ (0.4)\ (0.5)$

$= 0.154$

VALUING THE COMBINED FIRM

- 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

- 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	• Cumulate market values of equity and debt (or) • Value the assets in place using FCFF and WACC (or) • Use cumulated market value of assets, if traded.
Variance in Firm Value	• If stocks and bonds are traded, $\sigma^2_{firm} = w_e^2 \sigma_e^2 + w_d^2 \sigma_d^2 + 2 w_e w_d \rho_{ed} \sigma_e \sigma_d$ where σ_e^2 = variance in the stock price w_e = MV weight of Equity σ_d^2 = the variance in the bond price w_d = MV weight of debt • If not traded, use variances of similarly rated bonds. • Use average firm value variance from the industry in which company operates.
Value of the Debt	• If the debt is short term, you can use only the face or book value of the debt. • If the debt is long term and coupon bearing, add the cumulated nominal value of these coupons to the face value of the debt.
Maturity of the Debt	• Face value weighted duration of bonds outstanding (or) • If not available, use weighted maturity

VALUING EQUITY AS AN OPTION - EUROTUNNEL IN EARLY 1998

- Eurotunnel has been a financial disaster since its opening
  - In 1997, Eurotunnel had earnings before interest and taxes of -£56 million and net income of -£685 million
  - At the end of 1997, its book value of equity was -£117 million
- It had £8,865 million in face value of debt outstanding
  - The weighted average duration of this debt was 10.93 years
  -

Debt Type	Face Value	Duration
Short term	935	0.50
10 year	2435	6.7
20 year	3555	12.6
Longer	1940	18.2
Total	£8,865 mil	10.93 years

THE BASIC DCF VALUATION

- The value of the firm estimated using projected cashflows to the firm, discounted at the weighted average cost of capital was £2,312 million.
- This was based upon the following assumptions –
  - Revenues will grow 5% a year in perpetuity.
  - The COGS which is **currently 85% of revenues will drop to 65% of revenues in yr 5** and stay at that level.
  - Capital spending and depreciation **will grow 5% a year in perpetuity**.
  - There are no working capital requirements.
  - The debt ratio, which is **currently 95.35%, will drop to 70**% after year 5. The cost of debt is 10% in high growth period and 8% after that.
  - The beta for the stock **will be 1.10 for the next five years**, and drop to 0.8 after the next 5 years.
  - The long term bond rate is 6%.

OTHER INPUTS

- The stock has been traded on the London Exchange, and the **annualized std deviation based upon ln (prices) is 41%.**
- There are Eurotunnel bonds, that have been traded; the annualized std deviation in ln(price) for the bonds is 17%.
  - The correlation between stock price and bond price changes has been 0.5. The proportion of debt in the capital structure during the period (1992-1996) was 85%.
  - Annualized variance in firm value
  - $= (0.15)^2 (0.41)^2 + (0.85)^2 (0.17)^2 + 2 (0.15) (0.85)(0.5)(0.41)(0.17) = 0.0335$
- The 15-year bond rate is 6%. (I used a bond with a duration of roughly 11 years to match the life of my option)

VALUING EUROTUNNEL EQUITY AND DEBT

- Inputs to Model
  - Value of the underlying asset = S = Value of the firm = £2,312 million
  - Exercise price = K = Face Value of outstanding debt = £8,865 million
  - Life of the option = t = Weighted average duration of debt = 10.93 years
  - Variance in the value of the underlying asset = s2 = Variance in firm value = 0.0335
  - Riskless rate = r = Treasury bond rate corresponding to option life = 6%
- Based upon these inputs, the Black-Scholes model provides the following value for the call:
  - d1 = -0.8337 N(d1) = 0.2023
  - d2 = -1.4392 N(d2) = 0.0751
- Value of the call = 2312 (0.2023) - 8,865 $\exp^{(-0.06)(10.93)}$ (0.0751) = £122 million
- Appropriate interest rate on debt = (8865/2190)(1/10.93)-1= 13.65%

IN CLOSING...

- There are **real options everywhere.**
- **Most of them have no significant economic value** because there is no exclusivity associated with using them.
- When options have significant economic value, the inputs needed to value them in a binomial model can be used in more traditional approaches (decision trees) to yield equivalent value.
- The real value from real options lies in
  - Recognizing that b**uilding in flexibility and escape hatches** into large decisions has value
  - Insights we get on understanding how and why companies behave the way they do **in investment analysis and capital structure choices.**