

# Credit Risk

# Unlimited Liability

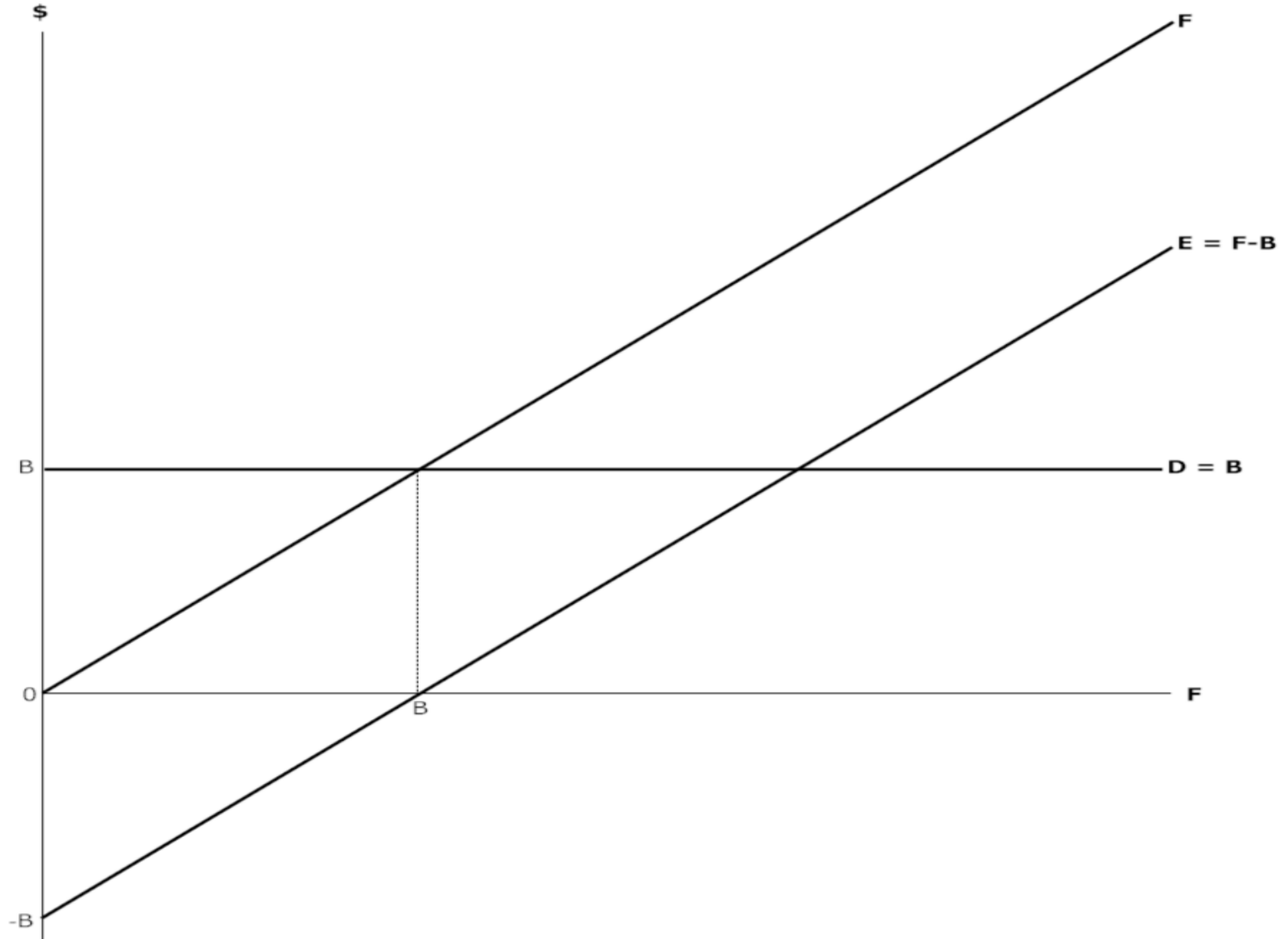
- Assume a single period – the firm is formed at  $t=0$ , and cash flows are realized at  $t=1$ .
- Let  $F$ ,  $D$ , and  $E$  represent the  $t=1$  payoffs on the firm's assets, its debt, and equity. Assume the firm has promised to repay creditors  $\$B$  at  $t=1$ . Under *unlimited liability*, these payoffs can be written:

$$F = D + E;$$

$$E = F - B; \text{ and}$$

$$D = B.$$

# Unlimited Liability





# Pricing Credit Risk using the BSM model

- Under *limited liability*, corporate payoffs are:  $F = D + E$ , where

$$E = \begin{cases} F - B & \text{if } F \geq B \\ 0 & \text{if } F < B \end{cases}$$

$$= \text{MAX}[F - B, 0] = F - B + \text{MAX}[B - F, 0]$$

$$D = \begin{cases} B & \text{if } F \geq B \\ F & \text{if } F < B \end{cases}$$

$$= F - \text{MAX}[F - B, 0] = B - \text{MAX}[B - F, 0]$$

# Pricing Credit Risk using the BSM model

- Two banks exist that are identical in all respects except for their financial leverage. Both banks have assets with a market value of \$1,000,000. The standard deviation of the return on these banks' assets is 40%.
  - Assume that both banks will be liquidated one year from today and that the rate of interest is 3%.
  - Assume that bank 1 has issued zero coupon deposits with a face value of \$500,000, whereas bank 2 has issued zero coupon deposits with a face value of \$800,000.

# Pricing Credit Risk using the BSM model

- What are the fair market values for the deposits held by banks 1 and 2? What are the values of the limited liability put options for these banks? What are the (risk neutral) probabilities of bankruptcy for these banks? What are the yields to maturity and credit risk premiums?
- Suppose the government institutes a deposit insurance scheme. What are the fair premiums for deposit insurance? What impact with the presence of the deposit insurance have upon the yields to maturity and credit risk premiums?
- Now suppose the government charges premiums based upon the average of the fair premiums that banks 1 and 2 should pay. Analyze the implications of such a pricing scheme. Specifically, who wins and who loses, and what incentives are conveyed by such a scheme?

# Pricing Credit Risk using the BSM model

<b>Bank 1</b>					
Time to expiration (T)	1	d1	2.0079	V(E)	\$518,617.63
Interest rate $r_f$	0.03	d2	1.6079	V(B)	\$485,222.77
standard deviation	0.4	N(d1)	0.9777	V(put)	\$3,840.40
		N(d2)	0.9461	V(D)	\$481,382.37
Asset Value (V(F))	\$1,000,000	1-N(d1)	0.0223	Yield to maturity	3.79%
Bond Face Value (B)	\$500,000	1-N(d2)	0.0539	Credit risk premium	0.79%
<b>Bank 2</b>					
Time to expiration (T)	1	d1	0.8329	V(E)	\$279,365.45
Interest rate $r_f$	0.03	d2	0.4329	V(B)	\$776,356.43
standard deviation	0.4	N(d1)	0.7975	V(put)	\$55,721.88
		N(d2)	0.6674	V(D)	\$720,634.55
Asset Value (V(F))	\$1,000,000	1-N(d1)	0.2025	Yield to maturity	10.45%
Bond Face Value (B)	\$800,000	1-N(d2)	0.3326	Credit risk premium	7.45%