

Uncertainty, Default, and Risk

(Welch, Chapter 06-3)

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1: Payoff Tables in CBR

- ▶ We have just covered RoRs and NPV under uncertain future cash flows.
- ▶ Now comes another important conceptual leap:
 - ▶ Payoff Tables and Contingent Claims Valuation.
 - ▶ Bonds vs Levered Equity.
 - ▶ Bond Risk vs Equity Risk.

2: Splitting CFs into Debt and Equity

- ▶ Essential concept of finance. For illustration:
- ▶ You can see yourself either as
 - ▶ Lender: provides capital in exchange for the promise of a fixed amount of money. (Also called leverage)
 - ▶ Levered (home-) owner: owns the house only with the bundled obligation to repay the loan.

3: Specific Example

- ▶ Reminder: every PCM investment is fairly priced.
- ▶ The world is risk-neutral.
- ▶ The $E(r)$ on 1-year Treasuries is 5%.
 - ▶ Same for all other 1-year assets.

- ▶ This is the project example for all the following pages.

4: A Financed Project (House, Firm, Student ...)

Next Year's Payoffs	Prob	Meaning
\$100	90%	Sunshine
\$50	10%	Hurricane

5: Work Out Project Value

- ▶ What is the appropriate price for this project?

6: Work out Project Value

1. Figure out the expected payoff is \$95.
2. Discount it at 5%: \$90.48.

7: Conditional Project Value: Sun

- ▶ What is the RoR on the project in the good state?
 - ▶ This is the **promised rate of return**.

8: Conditional Project Value: Rain

What is the RoR on the project in the bad state?

9: Unconditional Expected Value

What is the expected RoR on the project?

10: What is Stock?

- ▶ **Levered Equity** or **Levered Stock** or just **Stock** are all the same.
 - ▶ i.e., it is what will be left after debt has been paid off.
 - ▶ A stock levered with \$10 is not the same as a stock levered with \$20. They are like apples and oranges.
- ▶ **Stock market** sounds better than **levered equity market**.

11: Stock + Bond

- ▶ You can finance the project in one of two ways:
 1. Buy it outright (with \$0 mortgage) with financing from your life's savings account.
 2. Buy it with a mortgage and a smaller sum (from your savings):
 - ▶ You then own just the residual levered equity
 - ▶ It is what you get to keep after you will have repaid the debt.

12: Example (Promise \$50)

- ▶ Let's work with a specific example.
- ▶ Let's finance your purchase with a loan (=bond) promising \$50.
 - ▶ We assume that financial markets are still perfect, as before.

13: Scheme 2: Stock and Bond (\$50)

- ▶ In the good state, how much do bond and levered equity receive?
- ▶ In the bad state, how much do bond and levered equity receive?

14: Scheme 2: Prices

- ▶ What is the appropriate price for the bond?
- ▶ What is the appropriate price for the levered equity?

15: Graph: Payoff Diagram

Prob	Payoffs	Scheme 1	Scheme 2	Scheme 2	
100%	Eq	\$50 Prms	G=	r(G):	B=
r(B):	E(Pay):	E(RoR):	P_0 :		

payoff table{width="90%"}

16: Histogram Preparation

- ▶ In the good state, what is the *RoR* that the bond and the levered equity receive?
- ▶ In the bad state, what is the *RoR* that the bond and the levered equity receive?

17: Actual Histogram

Draw a histogram of the return distributions for all three forms of ownership considered so far.

18: Risk of Securities

Is full project ownership (=zero leverage) or levered project ownership riskier?

19: Risk of Ownership

Is full project ownership (=zero leverage) or bond ownership riskier?

20: Limited Liability

- ▶ **Limited Liability:** you are on the hook only for what you invested, and no more.
 - ▶ A central innovation in finance in the Renaissance (not known in Medieval or Roman times),
 - ▶ came into wide use in the 18th and 19th century.
 - ▶ made it possible for owners to hand control to specialists and not worry for their entire holdings.
 - ▶ The President of Columbia University wrote in 1911 that its discovery was more important than that of steam and electricity.

21: Bond Promising \$70 Next Year

- ▶ Common equity has **limited liability**.
- ▶ Now price a bond with a promise of \$70.
- ▶ Enter everything you know.
- ▶ Work down the project without financing.
- ▶ Work down the pricing of the bond.
- ▶ Work back up the pricing of the equity.

(PS: Unlimited liability owners are sometimes called “partners” or “names.”)

22: Graph: Payoff Table, Promised \$70

Prob	Payoffs	Scheme 1	Scheme 2	Scheme 2
—+—+—+—+—+—				
			Firm	Bond Lev Eq
	100% Eq \$70 Prms	G=	r(G):	B=
	r(B):	E(Pay):	E(RoR):	P ₀ :

23: How Much To Promise

- ▶ What if you wanted to raise \$ x (choose number)?
- ▶ How much (yield) would you have to promise?

24: Graph: Payoff Table, Raise \$60

Prob	Payoffs	Scheme 1	Scheme 2	Scheme 2				
100%	Eq	G=	r(G):	B=	r(B):	Firm	Bond	Lev Eq
E(Pay):	E(RoR):	P_0 :						

25: Risk of Stock

What happens to the riskiness of the *stock* when more mortgage (say, \$70 rather than \$1) is taken on?

26: Risk of Mortgage

What happens to the riskiness of the *mortgage* when more mortgage (say, \$70 rather than \$1) is taken on?

27: Risk of Firm

What happens to the riskiness of the “firm” (the house overall) when more mortgage is taken on?

28: A Broader View of Leverage

- ▶ Leverage = Small movement in lever can create much bigger or smaller movement elsewhere (in the equity).
- ▶ The safer part is “outsourced” to specialists.
- ▶ Small movement in underlying project can make levered ownership much riskier — more upside and more downside.

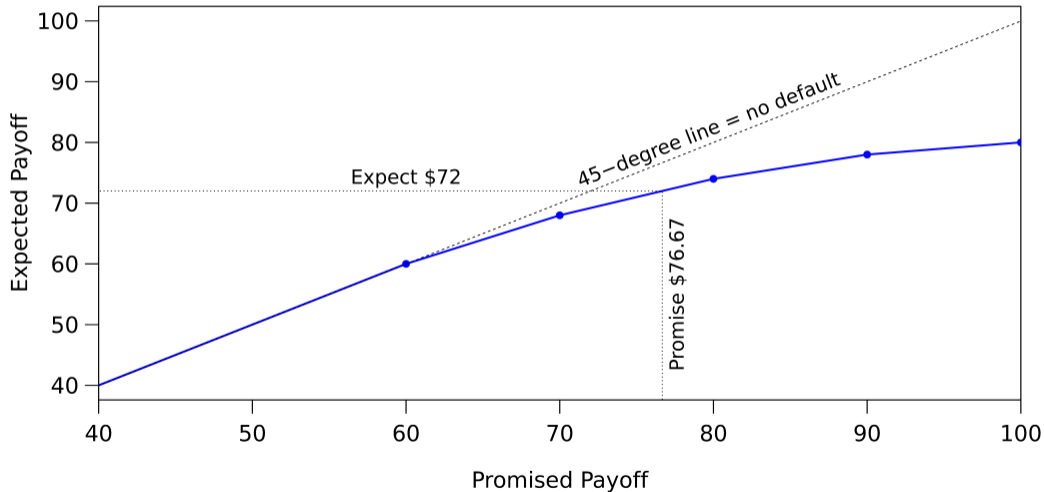
29: Financial vs Operating Leverage

- ▶ Can be done in various ways:
- ▶ With *Financial Leverage*, as in the example above.
- ▶ With *Operational Leverage*.
 - ▶ Example: Instead of owning safe building and risky technology (together = project medium risky), just lease the safer building.
 - ▶ All your money is now in risky technology.

30: More than Two Outcomes

- ▶ Everything you learned generalizes.
- ▶ In fact, everything can be done with normally distributed returns, too.
- ▶ In this case, the curve would be smooth.

31: Graph: Normal Distribution



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32: Discounting

- ▶ Recall that you can discount nominal payouts with nominal expected rates of return and come to the same result as with real payouts with real expected rates of return.
- ▶ Can you discount promised payouts with promised RoRs and come to the same result as when you discount expected payouts with expected RoRs?