

Uncertainty, Default, and Risk

(Welch, Chapter 06-3)

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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.

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.

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.

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

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

Work Out Project Value

- ▶ What is the appropriate price for this project?

Work out Project Value

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

Conditional Project Value: Sun

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

Conditional Project Value: Rain

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

Unconditional Expected Value

What is the expected RoR on the project?

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**.

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.

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.

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?

Scheme 2: Prices

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

Graph: Payoff Diagram

| Prob | Payoffs | Scheme 1 | Scheme 2 | Scheme 2 |
|------|---------|-----------|----------|------------------|
| | ---+ | ---+ | ---+ | ---+ |
| | 100% Eq | \$50 Prms | G= | r(G): |
| | r(B): | E(Pay): | E(RoR): | P ₀ : |

payoff table

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?

Actual Histogram

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

Risk of Securities

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

Risk of Ownership

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

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.

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.”)

Graph: Payoff Table, Promised \$70

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

How Much To Promise

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

Graph: Payoff Table, Raise \$60

| Prob | Payoffs | Scheme 1 | Scheme 2 | Scheme 2 | |
|------|---------|----------|----------|------------------|-------|
| | 100% Eq | G = | r(G): | B = | r(B): |
| | E(Pay): | E(RoR): | | P ₀ : | |

Risk of Stock

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

Risk of Mortgage

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

Risk of Firm

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

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.

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.

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.

Graph: Normal Distribution

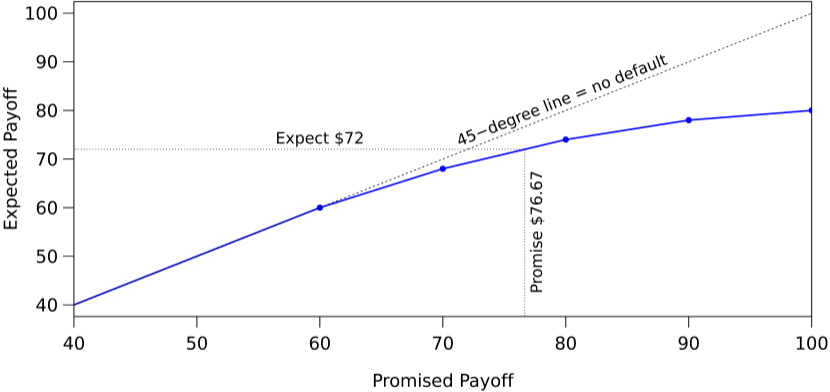


Figure 1: promised

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?