Uncertainty, Default, and Risk

(Welch, Chapter 06-2)

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Previous Slides

In Perfect Markets Under Uncertainty:

- Random Variables
- Means and Standard Deviaions
- Risk Preferences

Default ("Credit") Risk

Most loans have credit risk

The borrower can default (not pay).

Loosely, credit risk = promised return that is lost on average when borrowers go belly-up.

Default

Can the U.S. government default?

Do Treasury securities have default (credit) risk?

Working Example: Fair Default

Henceforth, assume Treasury bond costs \$200 and promises to pay \$210.
$\Rightarrow \; E(r) = r = 5\%$.

In this chapter, we mostly assume you are risk-neutral.

Me and You

I want to borrow \$200 from you.

I promise to repay \$210.

However, I may go bankrupt in 1 out of 100 cases, in which case I can repay only \$50.

- It does not matter whether it is my fault or not.
- No ethics involved here.

What If I Promise?

What is your promised RoR on my personal bond?

Good Promise?

Do I promise to give you the same RoR as the Treasury?

Your Expected Dollar Return

What amount would you expect my bond to return?

Your Expected RoR

What RoR would you expect my bond to give you?

Would You Extend Credit?

Would you prefer to make this loan or to put your money into the 5% government bond?

Reduce Loan Amount

How much money would you give me in exchange for my promise to pay you $210?

On Documents

If Bloomberg (or WSJ) were to print my bond's interest rate, what interest rate would they print?

Which one would be more interesting?

Quoted = Expected Rates?

Are quoted interest rates on risky bonds expected rates?

Default (Credit) [vs Risk] Premium

Default Premium: compensation to make you break even on average.

- It is required to get you to participate even if you are completely risk-neutral.
- If you repeat the investment infinitely many times, the average default payment is 0.
- You get more if everything goes well, less otherwise.

Risk-Neutral Interest Rate

In the real world, would this interest rate really be high enough?

[Default vs] Risk Premium

Risk Premium: extra compensation to give you *more* than the **time premium** on average.

- If you are risk-averse, you require a risk premium to participate.
- If you repeat the investment infinitely many times, the risk premium will allow you to earn more than an investor holding Treasuries will earn.

Risk Compensation?

Never confuse the credit premium and the risk premium.

In our world, with a Treasury rate of 5.00% and a quoted bond of 5.81%, the risk premium was still zero.

The Default/Credit Risk Premium is not For Risk Aversion

Warning: You must be clear about the distinction between default premia and risk premia.

Make sure you know what they are about, and know the difference between these concepts!

Premium Decomposition I

In a risk-neutral world:

Quoted (=Promised) Interest Rate ≥ Expected Interest Rate.

Quoted Interest Rate = Time Premium + Default Premium

Expected Interest Rate = Time Premium

In the real world, there are also risk premia, liquidity premia, tax premia, etc.

Premium Decomposition II

In our example,

- the promised interest rate was 5.81%,
- the time premium 5.00%,
- the default premium 0.81%, and
- the risk premium 0.00%.

Typical Premium Magnitudes

Risk premia for “fairly safe” bonds from “large, safe” companies can be as low as a few bp.

The default premium is usually bigger than the risk premium.

There can be no risk premium without a default premium!

Promised IRR?

IRR computed from promised cash flows is a promised IRR.

- It is what everyone quotes.

The promised IRR must never be used in the IRR Capital Budgeting Rule.

- For capital budgeting purposes, you must use an IRR computed from expected cash flows, not from promised cash flows.

Default (Credit) in NPV

In PV applications, you have to use

$$PV = \frac{E(\text{Cash Flow})}{1 + E(\text{Discount Rate})} \, .$$

You must use **expected** values in both the numerator and the denominator.

- In the real world, users often mess up PV because they do not understand the difference between promised and expected quantities.

Default (Credit) in NPV

The expected payoff is in the numerator, and it takes care of the default risk of our project.

The correct PV of our loan promising \$210 is

$$PV = \frac{E(\text{Cash Flow})}{1 + E(\text{Disc Rate})} = \frac{\$208.40}{(1 + 5\%)} \approx \$198.47 \ .$$

It is *not* the promised amount of \$210 divided by the cost of capital of 5%.

Using *Promised* in NPV?

The expected discount rate—*not the promised RoR*—is in the denominator.

- It is the opportunity cost of capital on other projects, quoted in terms of their expected RoRs, not in terms of their promised RoRs.
- You can't use the **promised** RoR of opportunities (elsewhere) as your cost of capital.
- They are just promised, too.

Implication of Risk-Neutrality

In our risk-neutral PCM, every project has the same cost of capital (here 5%)

...regardless of how likely the project or bond is to pay what it promises.

Credit Ratings

Large corporations have credit ratings, too, ranging from AAA (best) to F.

- Typical AAA firm has a $\sim 0\%$ probability of default over 10 years.
- Typical B firm has a 20% probability of one non-payment over 5 years.
- Typical C firm has a 50% probability of one non-payment over 6–8 years.

Graph: U.S. Bond Mortality

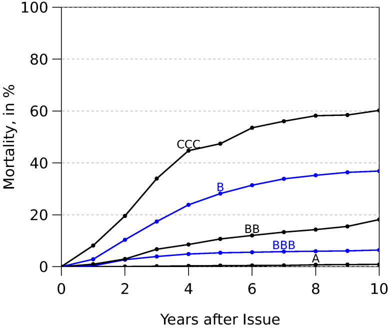

Figure 1: altman bond mortality

Graph: U.S. Bond Death

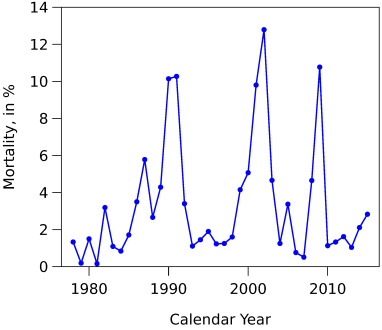

Figure 2: altman bond deaths

More Default or Risk Premium?

Most yield spread of corporate bonds is due to the chance of default (i.e., the credit spread).

Example: if a Boston Celtics $= 9.4\%$, whereas a similar Treasury $= 5.6\%$, then I would guesstimate that Celtics bond pays off $\approx 6.0\%$.

- 3.4% would be the default risk, and
- 0.4% would be the risk (and other) premium.

Crucial Uncertainty Lesson

Never ever confuse expected rates with (higher) promised rates.

The 9.4% from the Boston Celtics is not expected! Newspapers and websites virtually never report expected rates.

Critical Mistake

If you use a promised or quoted cash flow where you have to use an expected cash flow (i.e., you mix up these two), do not mention **under any circumstances** that you took this finance course with me as your instructor.

Just say you went to HBS instead.

Credit (Default) Swaps (CDS)

You can buy insurance against default, called credit (default) swaps.

- The financial crisis of 2008 has made them famous, because they played a central role.

This market is over-the-counter (OTC).

- Sellers: hedge funds who want to speculate on default.
- Buyers: mutual funds or pension funds who want to reduce their risk exposure.

CDS Contract Basics

In the event of default, the seller of CDS may either:

- pay the CDS buyer a fixed amount, or
- allow the CDS buyer to sell the bond for a pre-agreed price to the CDS seller upfront.

The terms are negotiated up-front.

CDS Market Size

In 2016, there was more than $17 trillion of single-name credit swaps outstanding.

- Hard to assess—offsets may or may not be counted as 0.

CDS Market Background I

This is a rather opaque market—it's possible that the risk of credit is no longer with the holders of the corporate debt.

- Risk is somewhat similar to the housing derivative risk—an obscure bank in Germany may blow up over housing trouble in Kansas.
- A fund can buy the bonds, insure itself many times over against default with a CDS, and then vote to try to drive the firm itself into bankruptcy.

CDS Market Background II

However, as a buyer of a CDS, you will also have to worry about whether the issuer of the CDS will go bankrupt itself.

And whether the board deciding what is a default is conflicted.

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

- Every investment in our PCM is fairly priced.
- The $E(r)$ on 1-year Treasuries (and all other 1-year assets) is 5%.
- The world is risk-neutral.

This is the project example for all the following pages.

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

NEXT Year's Payoffs	Probability	
\$100	90%	(Sunshine)
\$50	10%	(Hurricane)

Work Out Project Value

What is the appropriate price for this project?

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 (=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., levered equity 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

Project Payoffs	Scheme 1 Firm, FM (=100% Equity)	Scheme 2 Bond, DT (Promise=$50)	Levered Equity, EQ
prob(G)=	r=	r=	r=
prob(B)=	r=	r=	r=
E(Payoff) (= E(C))			
E(Rate of Return) (= E(r))			
Discounted Price P_0			
% Financing			

Figure 3: 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 sofar.

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

Project Payoffs	Scheme 1: Firm, FM (=100% Equity)	Scheme 2: Bond, DT (Promise=\$70)	Scheme 2: Levered Equity, EQ
prob(G)=	r=____	r=____	r=____
prob(B)=	r=____	r=____	r=____
E(Payoff) (= E(C))			
E(Rate of Return) (= E(r))			
Discounted Price P_0			
% Financing			

Figure 4: payoff table

Graph: Payoff Table, Needed Promise

Project Payoffs	Scheme 1 Firm, FM (=100% Equity)	Scheme 2 Bond, DT (Promise=??)	Levered Equity, EQ
prob(G)=	r=	r=	r=
prob(B)=	r=	r=	r=
E(Payoff) (= E(C))			
E(Rate of Return) (= E(r))			
Discounted Price P_0			
% Financing			

Figure 5: payoff table

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.

Fin vs Op 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

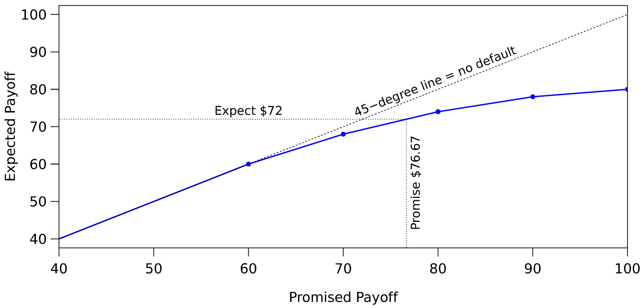

Figure 6: promised

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?