Default Risk and Yield Curve

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Outline of talk

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Default Risk and Bond Pricing

- Although bonds generally promise a fixed flow of income, that income stream is not riskless unless the investor can be sure the issuer will not default on the obligation;
- While German, U.S. (and many other) government bond may be treated as free of default risk, this is not true of corporate bonds;
- If the company goes bankrupt, the bondholders will not receive all the payments they have been promised;
- Therefore, the actual payments on these bonds are uncertain, because they depend to some degree on the ultimate financial status of the firm;
- Bond default risk is measured by *Moody' Investor Services*, *Standard & Poor' Corporation*, and *Fitch Investors Service*, all of which provide financial information on firms as well as the credit risk of large corporate and municipal bond issues;

Default Risk and Bond Pricing

- International sovereign bonds, which also entail default risk, especially in emerging markets, also are commonly rated for default risk;
- Each rating firm assigns letter grades to reflect its assessment of bond safety. The top rating is **AAA** or **Aaa**. Moody' modifies each rating class with a 1, 2, or 3 suffix (e.g., **Aaa1**, **Aaa2**, **Aaa3**) to provide a finer gradation of ratings. The other agencies use a + or - modification;
- Bonds rated **BBB** or above (S&P, Fitch) or **Baa** and above (Moody') are considered **investment grade bonds**, while lower-rated bonds are classified as **speculative grade** or **junk bonds**.

FIGURE 1: Definition of each bond rating class

	Moody's Investors Service	Fitch Ratings	S&P Global Ratings	Rating Grade Description
Investment Grade	Aaa	AAA	AAA	Highest credit quality, lowest level of credit risk
	Aa1 Aa2 Aa3	AA+ AA AA-	AA+ AA AA-	Very high credit quality with very low credit risk
	A1 A2 A3	A+ A A-	A+ A A-	High credit quality with low credit risk
	Baa1 Baa2 Baa3	BBB+ BBB BBB-	BBB+ BBB BBB-	Good credit quality with moderate credit risk
Speculative Grade	Ba1 Ba2 Ba3	BB+ BB BB-	BB+ BB BB-	Speculative with substantial credit risk
	B1 B2 B3	B+ B B-	B+ B B-	Highly speculative with high credit risk
	Caa1 Caa2 Caa3	CCC+ CCC CCC-	CCC+ CCC CCC-	Substantial credit risk with default as a real possibility
	Ca	CC	CC	Very high levels of credit risk with default either occurring or about to occur
	C	C	C	Default or default-like process has begun
		SD	RD	Selective Default (SD): Issuers have defaulted on one or more specific issues but are expected to meet their other payment obligations. Restricted Default (RD): Issuers have missed one or more payments but are not under supervision for reorganization or liquidation.
		D	D	Default: Issuers are unlikely to pay their obligations and have likely entered into bankruptcy filings, administration, receivership, liquidation or other formal winding-up procedures.

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Yield to Maturity and Default Risk

- Because corporate bonds are subject to default risk, we must distinguish between the **bond' promised yield to maturity** and its **expected yield**;
- The promised or stated yield will be realized only if the firm meets the obligations of the bond issue. The stated yield is the maximum possible yield to maturity of the bond;
- The expected yield to maturity must consider the possibility of a default;

Yield to Maturity and Default Risk

- At the height of the financial crisis in October 2008, as Ford Motor Company struggled, its 6.625% coupon bonds due in 2028 were rated CCC and were selling at about 33% of par value, resulting in a yield to maturity of about 20%. Investors did not really believe the expected rate of return on these bonds was 20%. They recognized the distinct possibility that bondholders would not receive all the payments promised in the bond contract and that the yield based on expected cash flows was far less than the yield based on promised cash flows. As it turned out, Ford weathered the storm and investors who purchased its bonds made a very nice profit. Today, the bonds sell for about 95% of par value.

Yield to Maturity and Default Risk

- **Example:** Suppose a firm issued a 9% coupon bond 20 years ago. The bond now has 10 years left until its maturity date, but the firm is having financial difficulties. Investors believe that the firm will be able to make good on the remaining interest payments but that at the maturity date, the firm will be forced into bankruptcy and bondholders will receive only 70% of par value. The bond is selling at €750. The Yield To Maturity Would (YTM) then be calculated using the following inputs:

Table 1: Expected versus Promised Yield.

Description	Expected YTM	Stated YTM
Coupon payment	€45	€45
Number of semiannual periods	20 periods	20 periods
Final payment	€700	€1,000
Price	€750	€750

- The YTM based on promised payments is 13.7%. Based on the expected payment of €700 at maturity, however, the yield would be only 11.6%. The stated YTM is greater than the YTM investors actually expect to receive;
- The example in Table 1 suggests that when a bond becomes more subject to default risk, its price will fall, thus its promised YTM will rise;
- The **default premium**, i.e. the spread between the stated yield to maturity and that on otherwise comparable Treasury bond, **will rise**;
- However, its expected YTM, which ultimately is tied to the systematic risk of the bond, will be far less affected.

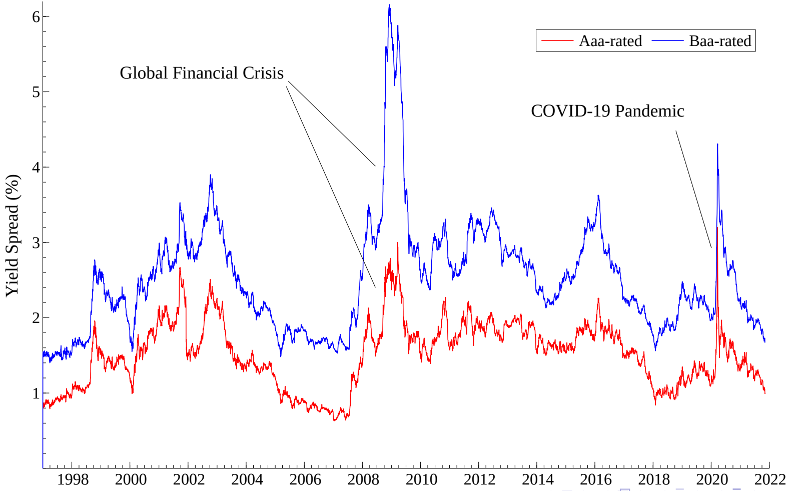
- Now, suppose that the condition of the firm in Table 1 deteriorates further, and investors now believe that the bond will pay off only 55% of face value at maturity. Investors now demand an expected YTM of 12% (i.e., 6% semiannually), which is 0.4% higher than 11.6% (see previous example). However, the price of the bond will fall from €750 to €688. At this price, the stated YTM based on promised cash flows is 15.2%. While the expected YTM has increased by 0.4%. The drop in price has caused the promised YTM, and the default premium, to rise by 1.5%.

- To compensate fo the possibility of default, corporate bonds must offer a default premium which is the difference between the promised yield on a corporate bond and the yield of an otherwise identical government bond that is riskless in terms of default;
- If the firm remains solvent and actually pays the investor all of the promised cash flows, the investor will realize a higher yield to maturity than would be realized from the government bond;
- If, however, the firm goes bankrupt, the corporate bond is likely to provide a lower return than the government bond. The corporate bond has the potential for both better and worse performance than the default-free Treasury bond. In other words, it is riskier;

Yield to Maturity and Default Risk

- The pattern of default premiums offered on risky bonds is sometimes called the risk structure of interest rates. The greater the default risk, the higher the default premium. Figure 2 shows spreads between yields to maturity of bonds of different risk classes since 1997. You can see here clear evidence of default-risk premiums on promised yields. It is worth noticing the incredible run-up of credit spreads during the Global Financial Crisis of 2008-2009 and the COVID-19 pandemic.

Figure 2: Yield spreads between different risk classes.



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- A **Credit Default Swap** (CDS) is an insurance policy on the default risk of a corporate (also a sovereign) bond or loan;
- As an example, the annual premium in July 2011 on a five-year Citigroup CDS was about 1.3%, meaning that the CDS buyer would pay the seller an annual premium of $1.30 for each $100 of a bond principal;
- The seller collects these annual payments for the term of the contract, but must compensate the buyer for loss of bond value in the event of a default;

Credit Default Swaps

- As originally envisioned, CDSs were designed to allow lenders to buy protection against losses on sizable loans;
- The natural buyers of CDSs would then be large bondholders or banks that had made large loans and wished to enhance the creditworthiness of those loans;
- Even if the borrowing firm had shaky credit standing, the "insured" debt would be as safe as the issuer of the CDS. An investor holding a bond with a BB rating could, in principle, raise the effective quality of the debt to AAA by buying a CDS on the issuer;
- This insight suggests how CDS contracts should be priced. If a BB-rated bond bundled with insurance via a CDS is effectively equivalent to a AAA-rated bond, then the fair price of the swap ought to approximate the yield spread between AAA-rated and BB-rated bonds.

Figure 3: CDS Spread - Some Italian Banks (y-axis is quarterly basis point).

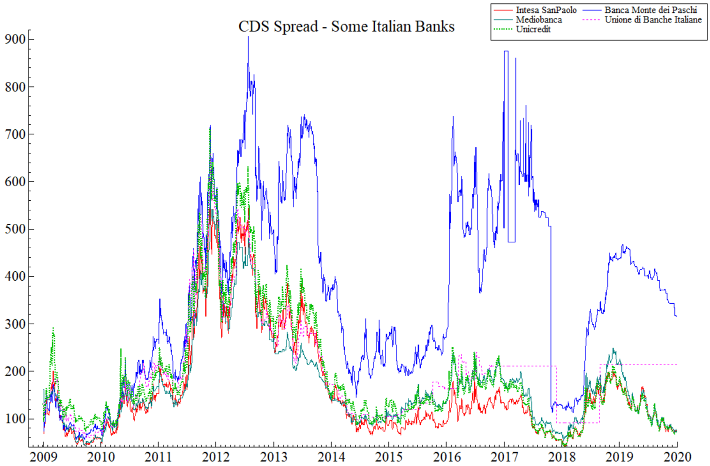
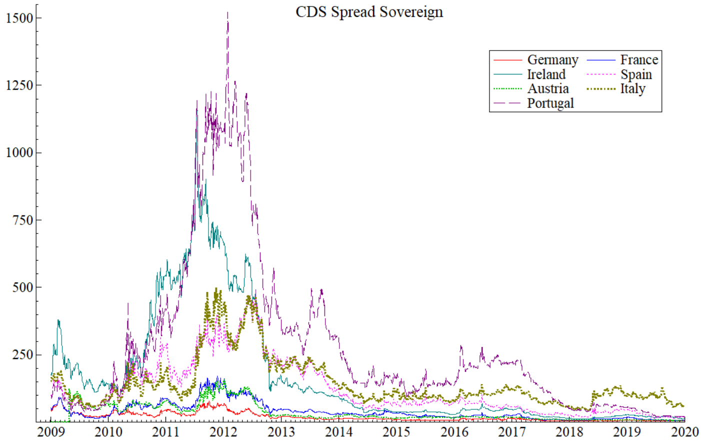


Figure 4: CDS Spread Sovereign (y-axis is quarterly basis point).



- Figures 3 and 4 show the average price of five-year CDSs on some Italian banks and on some Eurozone countries between 2009 and 2020;
- Notice the sharp run-up in prices in mid-June 2012 in relation to the sovereign debt crisis which hit the Euro zone;
- CDSs prices fell back when at a speech in London on July 26^{th}, 2012, the ECB president, Mario Draghi, gave an account of the euro-zone economy. He then made the momentous remark: *"Within our mandate, the ECB is ready to do whatever it takes to preserve the euro. And believe me, it will be enough."*;
- While CDSs were conceived as a form of bond insurance, it was not long before investors realized that they could be used to speculate on the financial health of particular companies.

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- Figure 5 shows coupon, price and yield of U.S. Treasury bonds on November 11th, 2021 from Bloomberg.

Figure 5: Coupon, price and yield of U.S. Treasury bonds.

NAME	COUPON	PRICE	YIELD
GB3:GOV **3 Month**	0.00	0.04	0.04%
GB6:GOV **6 Month**	0.00	0.06	0.06%
GB12:GOV **12 Month**	0.00	0.15	0.15%
GT2:GOV **2 Year**	0.38	99.73	0.51%
GT5:GOV **5 Year**	1.13	99.56	1.22%
GT10:GOV **10 Year**	1.38	98.39	1.55%
GT30:GOV **30 Year**	1.88	99.44	1.90%

The Yield Curve

- While yields to maturity on bonds of various maturities are reasonably similar, coupons rate do differ;
- Bonds with shorter maturities generally offer lower yields to maturity than longer-term bonds;
- The relationship between the yield to maturity and the term to maturity is called the **yield curve**;
- The relationship is also called the **term structure of interest rates** because it relates yields to maturity to the term (maturity) of each bond;
- Question: **Why should bonds of differing maturity offer different yields?** (i) **Future rates** and (ii) **Risk premiums**.

The Expectations Theory

- Suppose everyone in the market believes firmly that while the current one-year interest rate is 8%, the interest rate on one-year bonds next year will rise to 10%;
- **Question:** What would this belief imply about the proper yield to maturity on two-year issued today?
- An investor who buys the one-year bonds and rolls the proceeds into another one-year bonds in the following year will earn, on average, about 9% per year;
- This value is just the average of the 8% earned this year and the 10% expected for next year;
- More precisely, the investment will grow by a factor of 1.08 in the first year and 1.10 in the second year, for a total two-year growth factor of $1.08 * 1.10 = 1.188$. This corresponds to an annual growth rate of 8.995% (because $1.08995^2 = 1.188$).

The Expectations Theory

- For investments in two-year bonds to be competitive with the strategy of rolling over one-year bonds, these two-year bonds also must offer an average annual return of 8.995% over the two-year holding period;
- In this example, therefore, the yield curve will be upward-sloping; while one-year bonds offer an 8% yield to maturity, two-year bonds offer an 8.995% yield;
- This notion is the essence of the **expectations hypothesis** of the yield curve, which asserts that the slope of the yield curve is attributable to expectations of changes in short-term rates;
- Relatively, high yields on long-term bonds reflect expectations of future increases in rates, while relatively low yields on long-term bonds (a downward-sloping or inverted yield curve) reflect expectations of falling short-term rates;

The Expectations Theory - Implications

- One of the implications of the expectations hypothesis is that expected holding-period returns on bonds of all maturities ought to be about equal;
- Even if the yield curve is upward-sloping (so that tow-year bonds offer higher yields to maturity than one-year bonds), this does not necessarily mean investors expect higher rates of return on the two-year bonds;
- As we have seen, the higher initial yield to maturity on the two-year bonds is necessary to compensate investors for the fact that interest rates the next year will be even higher;
- Over the two-year period, and indeed over any holding period, this theory predicts that holding-period returns will be equalized across bonds of all maturities.

- **Example:** Suppose we buy the one-year zero-coupon with a current yield to maturity of 8%. If its face value is €1,000, its price will be €925.93, providing an 8% rate of return over the coming year. Suppose, instead, that we buy the two-year zero-coupon bond at its yield of 8.995%. Its price today is $1,000/(1.08995)^2 = 841.76$. After a year passes, the zero-coupon will have a remaining maturity of only one year; based on the forecast that the one-year yield next year will be 10%, it then will sell for $1,000/1.10 = 909.09$. The expected rate of return over the year is thus $(909.09 - 841.76)/841.76 = 8\%$, which is precisely the same return provided by the one-year bond. **This makes sense**: if risk considerations are ignored when pricing the two bonds, they ought to provide equal expected rates of return.

- In fact, advocates of the expectations hypothesis commonly invert this analysis to infer the market' expectation of future short-term rates. They note that we do not directly observe the expectation of next year' rate, but we can observe yields on bonds of different maturities;
- Suppose, as in the previous example, we see that one-year bonds offer yields of 8% and two-year bonds offer yields of 8.995%. Each Euro invested in the two-year zero would grow after two years to $1 * 1.08995^2 = 1.188$. A Euro invested in the one-year zero would grow by a factor of 1.08 in the first year and, then, if reinvested or "rolled over" into another one-year zero in the second year, would grow by an additional factor of $1 + r_2$. Final proceeds would be $1 * 1.08 * (1 + r_2)$.

- The final proceeds of the rollover strategy depend on the interest rate that actually transpires in year $t = 2$;
- However, we can solve for the second-year interest rate that makes the expected payoff of these two strategies equal;
- This *"break-even"* value is called the **forward rate** for the second year, f_2, and is derived as follows:

$$1.08995^2 = 1.08 * (1 + f_2) \qquad (1)$$

- which implies that f_2=10%. It is worth noticing that the forward rate equals the market' expectation of the year-2 short rate;
- We conclude that when the expected total return of a long-term bond equals that of rolling over a short-term bond, the forward rate equals the expected short-term interest rate. This is why the theory is called the **expectations hypothesis**;

- More generally, we obtain the forward rate by equating the return on an $n-$period zero-coupon bond with that of an $(n-1)$-period zero-coupon bond rolled over into a one-year bond in year n:

$$(1+y_n)^n = (1+y_{n-1})^{n-1}(1+f_n) \tag{2}$$

- The actual total returns on the two n-year strategies will be equal if the short-term interest rate in year n turns out to equal f_n;
- **Example:** Suppose that two-year maturity bonds offer yields to maturity of 6% and three-year bonds have yields of 7%. What is the forward rate for the third year?

- While the expectations hypothesis gives us a tool to infer expectations of future market interest rates form the yield curve, it tells us **nothing of what underlying considerations generated those expectations**;
- Ultimately, interest rates reflect investors' expectations of the state of the macroeconomy. Not surprisingly, then, forward rates and the yield curve have proven themselves to be useful inputs for economic forecasts;
- The slope of the yield curve is one of the more important components of the index of leading economic indicators used to predict the course of economic activity;
- Inverted yield curves, which imply falling interest rates, turn out to be among the best indicators of a coming recession.

The Liquidity Preference Theory

- The expectations hypothesis starts from the assertion that bonds are priced so that *"buy and hold"* investments in long-term bonds provide the same returns as rolling over a series of short-term bonds;
- However, the risks of long- and short-term bonds are not equivalent. Longer-term bonds are subject to greater interest rate risk than short-term bonds. As a result, investors in long-term bonds might require a risk premium to compensate them for this risk;
- In this case, the yield curve will be upward-sloping even in the absence of any expectations of future increases in rates;
- The source of the upward slope in the yield curve is investor demand for higher expected returns on assets that are perceived as riskier. This is called the **liquidity preference theory** of the term structure. The name derives from the fact that shorter-term bonds have more "liquidity" than longer-term bonds, in the sense that they offer greater price certainty and trade in more active markets with lower bid-ask spreads;

- The preference of investors for greater liquidity makes them willing to hold these shorter-term bonds even if they do not offer expected returns as high as those of longer-term bonds;
- We can think of a liquidity premium as resulting from the extra compensation investors demand for holding longer-term bonds with greater price risk;
- We measure it as the spread between the forward rate of interest and the expected short rate:

$$(f_n) = E(r_n) + Liquidity\ \ Premium \tag{3}$$

- In the absence of a liquidity premium, the forward rate would equal the expectation of the future short rate;
- However, generally, we expect the forward rate to be higher to compensate investors for the lower liquidity of longer-term bonds;
- Advocates of the liquidity preference theory also note that borrowers seem to prefer to issue long-term bonds. This allows them to lock in an interest rate on their borrowing for long periods, and thus they may be willing to pay higher yields on these issues;
- In sum, bond buyers demand higher rates on longer-term bonds, and bond issuers are willing to pay higher rates on those bonds. As a result, the yield curve generally slopes upward;

The Liquidity Preference Theory

- According to the liquidity preference theory, forward rates of interest will exceed the market' expectations of future interest rates;
- Even if rates are expected to remain unchanged, the yield curve will slope upward because of the liquidity premium;
- That upward slope would be mistakenly attributed to expectations of rising rates if one were to use the pure expectations hypothesis to interpret the yield curve.

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