Module 1: Credit Risk and Financing

3. Mathematics of Present and Forward Values

To be able to perform the correct financial calculations, we must be able to compute the value of investments or financial obligations at different moments in time.

This depends first of all on the way the interest to pay or receive is calculated. There are two types of methods: simple interest and compound interest.

The **simple interest** can be defined as the annual percentage of a loan amount that must be paid to the lender in addition to the principal amount of the loan. The total dollar amount of interest depends on the length of time it takes for the loan to be repaid. The key formula is the following:

$$\text{simple interest} = P \times r \times n$$

where P is the principal amount (amount borrowed), r the annual interest rate, and n the term of the loan in years.

The **compound interest rate** is more complicated because interest is accrued (i.e., accumulated over time) and interest is earned on the principal plus any interest that was paid previously. The key formula is the following:

$$\text{compound interest} = P \times (1+r)^t - P$$

where P is again the principal amount, r the annual interest rate, and t the number of years applied.

Students should notice that:

- simple interest is interest earned only on the initial investment amount; and
- compound interest is interest earned on the initial investment amount and on interests received. In other words, interest earns interest.

Future and present value:

If we'd like to be reasonably formal, we can introduce the notions of present value (PV) and forward value (FV). We also agree to measure time (t) in years, use n for the number of years, and express the desired interest rate/rate of return (r) as an annual percentage. Then, we have the following formulae:

For simple interest rate:

$$FV = PV \times (1 + nr).$$

For compound interest rate, instead, we have:

$$FV = PV \times (1+r)^t.$$

In the course, we will use mostly compound interest; thus, we will spend a little more time on it. The formula given earlier can also be reversed to yield

$$PV = \frac{FV}{(1+r)^t},$$

and, when required, it could also be used to recover the required interest rate given PV and FV as:

$$r = \left(\frac{FV}{PV}\right)^{1/t} - 1.$$

Suppose that r_m is the periodic nominal rate compounded m times per period ($m = 1$ is yearly, $m = 3$ is quarterly, $m = 12$ is monthly, etc.), and suppose that r_q is the equivalent periodic nominal rate compounded q times per period. Then, we have the following formula:

$$r_q = q \times \left[\left(1 + \frac{r_m}{m}\right)^{m/q} - 1\right].$$

Example. *Suppose that we deposit a sum of money at the local bank that pays us an annual interest rate of 5% that compounds monthly, i.e.,* $m = 12$. *Nevertheless, we have agreed with the bank that payments will be made quarterly, i.e.,* $q = 4$, *payments. What is the equivalent annual rate that coincides with quarterly compounding?*

Answer. *In this case,* $m = 12, r_m = r_{12} = 0.05, q = 4, r_q = r_4$. *Using the formula we wrote earlier, the calculation is simple:*

$$r_4 = 4 \times \left[\left(1 + \frac{0.05}{12}\right)^{12/4} - 1\right] = 0.050209 \ or \ 5.0209\%.$$

Let's check our calculations. Assume that we deposited $10,000. If the interest rate were compounded monthly and credited to our account monthly, then after one year, the value would be:

$$FV = 10,000 \times 1 + 5\%/12)^{12} = 10,511.62.$$

On the other hand, if the interest rate is compounded and paid quarterly, then we find:

$$FV = 10,000 \times 1 + 5\%/4)^{4} = 10,509.45,$$

Continuous compounding:

It is possible to compound the interest yearly, semi-yearly, quarterly, monthly, daily, every second, and ideally in a continuous manner. Assume that $m = 1$ so that $r_m = r$ is the yearly interest. And we assume that we compound the interest q times a year. If we start with a principal, PV, then the forward value, FV, over a period of length t, assuming that we compound the interests q times, is given by:

$$FV = PV\left(1 + \frac{r}{q}\right)^{qt}.$$

Now, if we take the natural log on both sides we get

$$\ln(FV) = \ln(PV) + qt\ln\left(1 + \frac{r}{q}\right).$$

We want to see what happens when $q \to \infty$, i.e. we compound interest with an infinite frequency. It is easy to see that

$$\lim_{q\to\infty} \frac{\ln(1 + r/q)}{r/q} = 1$$

and this is the key for our derivation. In fact. we have

$$\lim_{q\to\infty} \ln(FV) = \ln(PV) + \lim_{q\to\infty} qt \cdot \ln\left(1 + \frac{r}{q}\right)$$

or, with some routine algebraic manipulations,

$$\lim_{q\to\infty} \ln(FV) = \ln(PV) + \lim_{q\to\infty} tr\frac{\ln(1 + r/q)}{r/q} = \ln(PV) + tr.$$

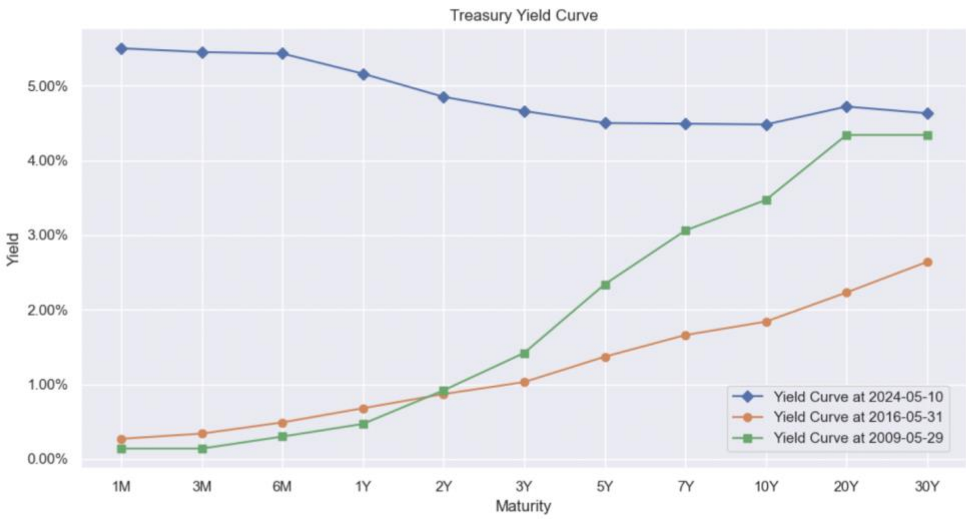
Thus we have shown that (using properties of logarithms):

$$\lim_{q\to\infty} ln(FV) = \ln(PV) + tr = \ln(PV) + \ln(e^{tr}) = \ln(PVe^{rt}).$$

Hence,

$$\lim_{q\to\infty} FV = PVe^{rt}$$

Yield curve:



As mentioned at the beginning of this section, the yield curve typically has a positive slope. In some cases, we may observe what is called an **inverted yield curve**, in which short-term interest rates are higher than long-term interest rates. An inverted yield curve is telling us that near-term investments are riskier than the long-term ones. Often, an inverted (Treasury) yield curve is a leading indicator of the approaching of an economic recession (for those with no background in Economics, imagine that the government wants to stimulate the economy to counter a recession and one way to do this is to lower interest rates; that is the cost of money for those who are willing to invest).

However, while we may be interested in investing for just 2 years, we are not willing to invest our money immediately. We want to invest for two years starting at the end of the first year. So we cannot assume that we will receive 5.5%. We want to find out what interest rate we are going to earn on such an investment in order to make comparisons. This leads us to deal with the concept of **forward interest rate** when dealing with an investment that will not take place until a predetermined period.

For this topic, notation is very important to avoid confusion, so we will use heavy notation that does not leave much room for guessing. Suppose that $B(0,t)$ is the price (market price, as we assume that the bonds are traded) at time 0 of a bond that pays $1 at time t. Similarly, we use $r(0,t)$ to denote the annual interest rate for an investment in which we enter today and that matures at time t. Using the principle of compound interest, we find:

$$B(0,t) = \frac{1}{(1+r(0,t))^t}$$

We could either solve this equation or, perhaps, we can get $r(0,t)$ from a yield curve.

If $r(0,t)$ is the rate at which we can invest today in a t period bond, we can define an implied forward rate between the years $s \geq 0$ and t with $t > s$ as the interest rate that applied to an investment we enter into at time s and that last $t-s$, i.e., reaches maturity at time t. We indicate this implied forward rate using the notation $f(0,s,t-s)$. Then, the formula for the forward rate in terms of the spot rates is given by:

$$f(0,s,t-s) = \left[\frac{(1+r(0,t))^t}{(1+r(0,s))^s}\right]^{1/(t-s)} -1,$$

and $f(0,s,t-s)$ is the forward rate as seen from date 0, starting at time s and with maturity at time t in $t-s$ years.

Going back to our example, we should be able to recognize immediately that for us $r(0,1) = 5\%$, $r(0,2) = 5.5\%$, and $r(0,3) = 5.8\%$.
Then, the formula just introduced yields

$$f(0,1,1) = \left[\frac{(1+5.5\%)^2}{(1+5\%)}\right]^1 -1 = 6.00\%.$$

$$f(0,1,2) = \left[\frac{(1+5.8\%)^3}{(1+5\%)^2}\right]^{1/2} -1 = 6.202\%.$$

The **nominal rate** is the actual interest rate you earn. Assume that in a 6-month period, we earn 3%.

The **inflation rate** is the rate at which prices increase. Let's assume that it is 2%.

Both rates are annualized, so they would prorate to the same 6-month amount.

Then, the inflation-adjusted or **real interest rate** can be found approximately using what is called the **Fisher equation**:

real interest rate = nominal rate − inflation rate

$$3\% - 2\% = 1\%.$$

The real interest rate is 1%. Although it feels like you earned 3%, in fact the $1,000 became less valuable six months later due to inflation. That interest payment was simply an amount that just barely outperformed inflation. Indeed, if the interest you received, say, was only 2%, then you would have had a real interest rate of 0. You would not have increased your purchasing power at all. But it can get worse: suppose the inflation rate was 5% over the 3-month period. Then, the real interest rate is

real interest rate = nominal rate − inflation rate

$$2\% - 5\% = -3\%$$

Counterparties and Credit risk:

Right now, we will only mention a few main types of risk:

- **Economic risk**: the risk that adverse changes in economic conditions negatively impact businesses, industries, or even entire economies. As investors, we must pay close attention to the economic conditions of those countries in which we plan to invest.
- **Equity risk**: the risk that stock prices will change in an unfavorable manner. If we are investors buying equities, we do so hoping to earn a return that exceeds the risk-free interest rate or else we would not be compensated for taking the risk.
- **Interest rate risk**: the risk that interest rates can change in an unfavorable manner. Imagine a bank that provides long-term mortgages, say 30-year mortgages, and assume that it does so at 5%. Suddenly, interest rates go up to 8%. In this case, the consumer is happy, but the bank not so much. Alternatively, suppose that you have bought a bond that pays an annual coupon of 4.5% and the newly issued bonds pay a coupon of 6.4%. Now, as an investor, you would not be happy, and if you were to sell your bonds, you would have to sell them below par value, which would lead to capital loss.
- **Model risk**: the risk that we use the wrong model to analyze a specific investment. If the model is wrong, it is quite doubtful that our practical solutions are going to be optimal. As quantitative analysts, we must always consider this risk and make sure we employ reliable modeling techniques while being on the lookout for what could go wrong.

The four risks we have listed above are just a few among many more that are possible. In the next sections, we will consider **credit risk** specifically.

3. Credit Risk

In this section, we introduce credit risk. **Credit risk** is the risk to the lender that the lender does not receive the full amount of principal and interest payments initially spelled out in the loan. Credit risk is a risk that there will be an expected loss due to the inability or even unwillingness of the borrower to repay their obligations. Credit risk tends to affect the lender and not so much the borrower.

5. Financial Institutions

There are distinct types of financial institutions. One way to consider distinct kinds of financial institutions is to look at the types of activities in which they engage. In doing so, we can categorize financial institutions according to the way in which they provide their primary services:

1. **Depository Institutions.** Depository institutions include banks and their close relatives, such as savings and loan companies, credit unions, trust companies, and mortgage loan companies.
2. **Contractual institutions.** Contractual institutions are those whose businesses provide long-term contractual services. The main types of these are insurance companies and pension funds.
3. **Investment institutions.** Investment institutions are those financial institutions that either originate or manage ongoing investments. These include underwriters, investment banks, mutual funds, closed-end funds, hedge funds, and unit investment trusts.

8. Basics of Bonds

What is a bond? A bond is a debt security by which the issuer/borrower is committed to paying back to the bondholder/lender the cash amount borrowed (the **principal** or **bond notional**) in addition to periodic interest calculated on the amount of a principal during a given period of time.

Let's see how a bond works with an example.

EXAMPLE *The U.S. Treasury has issued a bond today (1/1/2024) with the following key characteristics:*

- maturity date 12/31/2025;
- coupon rate 4%;
- nominal issued amount $20,000,000,000; and
- interest payment is semi-annual (typical of U.S. bonds, unlike Euro Treasury bonds that usually pay interest once a year).

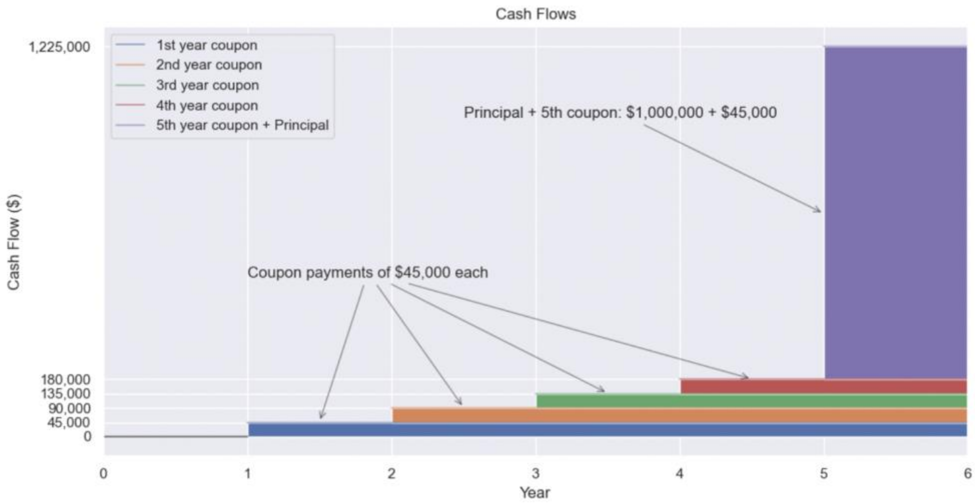
Write down the interest payments and the principal repayment with the relative dates.*

So, what are the differences between our savings example and the bond example? Both opportunities are examples of **fixed income** investments. It is called fixed income for the two reasons that comprise the term: that the rates being provided are **fixed** and that there is a stream of **income** consisting of the **interest** payments. The repayment of principal is not so much income as it is just the return of your original investment. In other words, so long as the issuer does not default, the bond will repay the amounts just as the bank would repay the amounts.

The difference between the two is that the bond is an asset and not merely an account. The bond can be traded. It is something for which you can see a market price. In the savings example, the CD is not a traded asset. Its value does not fluctuate over its lifetime. You cannot cash it out without severe penalties. The bond, on the other hand, can be sold to someone else, so in a sense, you can get its value liquidated to cash before the term to maturity. That is, the bond does not need to be held to maturity.

Pricing bond:

Figure 1: Cashflows Add Up Every Year.



Now, that we have all the cash flows well organized, we need to discount each of them and then we sum that up. As such, the value of the bonds can be calculated as:

$$45,000 \times \frac{1}{(1+5\%)^1} + 45,000 \times \frac{1}{(1+5\%)^2} +$$
$$45,000 \times \frac{1}{(1+5\%)^3} + 45,000 \times \frac{1}{(1+5\%)^4} +$$
$$(45,000 + 1,000,000) \times \frac{1}{(1+5\%)^5} = 978,352.62$$

Hence, we found out that the price of this bond
(at time 0, today) is $978,352.62, less than the nominal value of $1,000,000 at which we bought it. When this happens, we say that the bond is trading **below par**. If the bond traded above the par value, we would say that the bond is trading **above par** instead.

You can change discount rate, coupon rate, and even principal amount in the following spreadsheet and find the price of the bond.

Why is the price of the bond trading below par in our example? Well, our bond pays a coupon rate of 4.5%, but the current coupon rate level is 5%. Now, would you invest $1,000,000 to pay a bond with a coupon rate of 4.5% when you could buy a different one that pays a coupon rate of 5%? I bet that your answer is no. In other words, if you want to sell the bond to someone instead of holding on to it until maturity right now, you have to sell it below par or nobody would buy it.

An attentive student has probably noticed that the mathematical reason for the price being below par is that we are discounting interest payments at a higher rate than the coupon rate.

Go to the spreadsheet above and try changing 5% to 4%, 6%, or 4.5% and notice what happens to the bond price. Essentially, higher interest rates mean lower bond prices.

higher interest rates mean lower bond prices.

3. Implied Yields to Maturity

The **coupon rate** or **bond yield** for a bond trading at par (i.e. at face value) is very easy to calculate:

$$\text{coupon rate} = \frac{\text{annual coupon payment}}{\text{bond face value}}.$$

Suppose that we have a bond with the following characteristics:

- nominal value: $1,000.00;
- current market price: $1,000.00;
- coupon rate: = 4%;
- interest payment frequency: annual; and
- maturity: 4 years.

If we ask what is the bond yield in this case where the bond is trading at par value, the answer is very simple as it is the coupon rate, i.e., 4%.

However, this is not always the case; the price of bonds may change and we could be in a situation like the following:

- nominal value: $1,000.00
- current price: $950.00
- coupon rate: 4%
- payment frequency: annual; and
- maturity: 4 years.

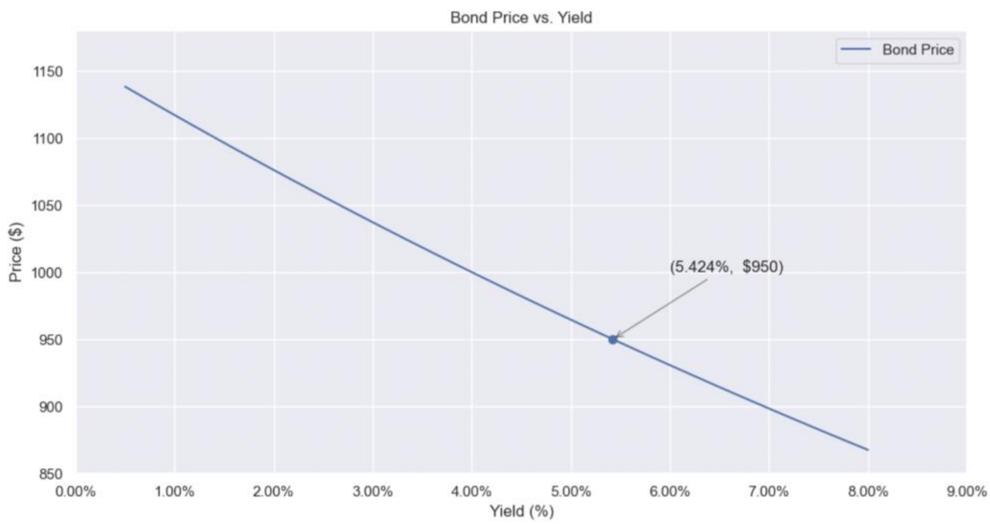
As we would pay the bond $950 and not $1,000, it is intuitive that we should expect a higher yield from the investment in this case. But how do we find the correct bond yield?

Assuming that the bond still has 4 years to maturity and that we hold it until it matures, we can calculate the implied bond yield to maturity (YTM) by solving the following equation with respect to x :

$$950 = \frac{40}{(1+x)^1} + \frac{40}{(1+x)^2} + \frac{40}{(1+x)^3} + \frac{1040}{(1+x)^4}.$$

This is a highly non-linear equation, but it can be solved using numerical analysis or a spreadsheet (for instance Goal Seek in Google Sheets). Doing this shows that the implied yield to maturity is 5.424%, quite a bit more than the coupon rate of 4%. You can use this spreadsheet to solve the problem.

Figure 2: Inverse Relationship between Bond Price and Yields



Is this all the math we need for bonds? We are close but not quite there yet. So far, we have assumed that the bonds pay annual interest rate coupons. What if they paid those coupons semi-annually as is mostly the case in the U.S.? The principles behind pricing a bond do not change. However, the formula is a tad more complex, and we will provide it in a moment.

Let

- P be the price of a bond that we want to compute;
- n be the number of years to maturity;
- c be the annual coupon rate;
- x be the current annual prevailing rate;
- M be the principal amount (also known as the notional or par amount) of the bond; and
- the interest payment frequency be semi-annual.

Then, the price P of the bond is found using the following formula

$$P = \sum_{j=1}^{2n} \frac{M \times c/2}{(1+x/2)^j} + \frac{M}{(1+x/2)^{2n}}.$$

Note that in the formula, all interest rates are divided by 2 and we have $2n$ payments as the bond pays two coupons every year.

The last equation can be easily used in a spreadsheet if one does not feel inclined to do some geometric series math.

Also, if we were given the current market price of the bond, say P_0 we could solve the equation above with respect to x and determine the implied YTM associated with a price of P_0 for the bond.

A serious student may be asking whether it is typical that the coupon rates and the current interest rates are always fixed. In many cases the coupon rates are fixed, but there are bonds for which the coupon rates could be indexed to account for inflation (i.e., like paying a real rate instead of a nominal one). Also the current rates, which we use for discounting, can and do change over time. This is not the end of the world. Yes, we will no longer be able to get nice elegant formulae to do our calculations, but spreadsheets are still viable tools. We can indicate the general formula, which would become

$$P = \sum_{j=1}^{T} \frac{CF_i}{(1+r(0,i))^i}$$

and which allows for the cash flows to change with the index i and for the interest rate we use to discount the cash flows to change with the length of time.

How do we get the $r(0,i)$ that appear in the formula? They are usually found from **zero-coupon bonds** of different maturities, if they are available and traded.

A zero-coupon bond, also known as a "zero," is a bond that does not make interest payments. Instead, it trades at a (usually deep) discount to its face value. For instance, we could have a zero-coupon bond like the following:

- face value: $1,000;
- maturity: 10 years; and
- current market price $630.

In other words, we can buy it for $630, we will receive no interest payments (note that a coupon rate is not specified), and in 10 years' time, $1,000 is returned to us. We can calculate our yield very simply using the math of present and forward values seen in Lesson 1:

$$\text{yield} = \left(\frac{1000}{630}\right)^{1/10} - 1 = 4.73\%.$$

Assuming that this zero-coupon bond is issued by a reliable issuer and it is fairly liquid (so that its market price is also reliable), we could use the result just found to say that $r(0,10) = 4.73\%$.

The buy side is both buying and selling securities, but they are doing so on behalf of investors.

5. Buy-Side vs. Sell-Side

The terms buy-side and sell-side at first seem to convey the idea of one side buying assets and the other side selling assets. This, however, is a misunderstanding. The buy-side refers to the market that is investing on behalf of others. The buy-side includes institutions that collect funds from investors, workers, pension holders, labor unions, etc., and seeks to invest on their behalf, with their stated investment interests and risk tolerances. The buy-side, in other words, is professionally managing client money. At times, those investment managers may decide to buy investments. At times, they want to realize the capital gains on those investments and sell the investments. As such, the buy side is both buying and selling securities, but they are doing so on behalf of investors.

The sell-side, on the other hand, is NOT acting on behalf of investors but rather is acting on behalf of the investment bank. The sell-side's primary responsibility is to make markets. **Market-making** means that they are willing to engage with the buy-side (or even other sell-side firms) by both offering securities to sell and bidding on securities to buy. You see, the buy-side is trading on behalf of customers; they are looking for opportunities that appeal to their customer base. The sell-side, on the other hand, is simply trading according to the needs and desires of the buy-side and other sell-side firms who want to trade. Sell-side trades make what is known as a **two-sided market**.

How does each side effectively make money? In broad terms, the buy-side makes profit by earning a fee for managing the funds. In addition to a management fee, they may collect fees related to the trading in the account or consulting with clients, and they might collect a performance incentive fee. If the fund earns above a certain amount (which may be 0%), then the fund may take a percentage of the amount earned. Effectively, the buy-side acts as a fiduciary for its clients by offering professional management and is paid both a fixed fee and potentially an incentive fee for good performance. The sell-side, however, makes money in a more complicated way. To understand this, let us look at an example by considering a buy-side firm called PDQ. Let us say that they wish to set up a brokerage account with a sell-side firm called ABC. ABC is willing to do two things at any given time:

ABC is willing to sell shares of our risky bond XYZ at $101.00

ABC is willing to buy shares of our risky bond XYZ at $100.50.

(Of course, that price may be displayed in a yield term.)

The price at which ABC is offering to sell is known as the **offer price**. Like everything, there is also another way to refer to this: the **ask price**. We will use offer price and ask price interchangeably since they mean the same thing.

The price at which ABC is willing to buy is known as the **bid price**. In the next section, we will discuss the difference between these

6. Bid-Ask Spread

The bid price is the price at which someone is willing to buy. The ask price is the price at which someone is willing to sell. The difference between these two prices is known as the **bid-ask spread**. The sell-side makes a profit by this bid-ask spread. Imagine that there was no bid-ask spread: you would be able to buy and sell at the exact same price. So which financial institution could afford to supply trading to market participants without earning any money for it? Well, none.

If you have ever been to an airport kiosk that provides a foreign exchange service, then you will understand this. Suppose you arrive at the airport wanting to convert euros to Japanese yen. Your 100 euros bought you 12,800 yen. Then, you find out that your flight got cancelled. So you return to the airport kiosk and convert the 12,800 yen back to euros, but you only get 95 euros. The kiosk makes money by selling you yen at a high price and buying back the yen at a low price. If you were to do this repeatedly, you would run out of money. The difference between the two prices is known as the bid-ask spread. This is how the foreign exchange kiosk attendant earns money. In addition to the bid-ask spread, they may have market transaction costs, such as commissions or transaction fees.

The same ideas apply to sell-side market makers. The bid-ask spread, and any transaction costs, are part of the revenue of the sell-side. You can see that the sell-side has a tough job because to buy and sell, they must have inventory amounts that may drive them to either hold too much of a security or run out of it and borrow the security. Indeed, it is possible to sell things that you don't even have. So, how is it possible to sell things that you do not have? How is it possible that the sell-side can consistently sell a security, even if they do not have any? For this, we turn to the next section: shorting.

The idea of buying low and selling high is very straightforward, but less so is that the order can be reversed. In other words, what if you were to “sell high, then buy low?” This is indeed a trading strategy. But how can you sell something you don’t own? This is known as shorting. **Shorting** refers to borrowing a security that you do not own, selling it in the marketplace, and receiving cash for it. The **short seller** then hopes and waits for the price to drop; if and when it does, the short seller buys the security at this lower price. When that happens, the short seller is **covering the short.** Once they take possession of the security, they return it to the party that lent it to them. If they sold at a high price and covered at a lower price, they still make a profit: selling price - buying price.

So shorting is somewhat of a complex transaction. It involves:

- Borrowing something that you do not own.
- Selling it in the marketplace.
- Paying the lender (owner of record) of the security a fee (that increases with time).
- Buying (covering) the short later.
- Returning the security to its original owner.

Short sellers trade because they think a security is overvalued. They prefer to sell it now at what they believe is an inflated price. They receive cash for it, which they can deposit in an account for any costs associated with the short. If all goes well, then the price does indeed drop and the short seller can cover the security, return it to the owner, and complete their responsibilities. Doing so has earned them whatever the capital gain is (high – low), less any transaction fees.

The lender of the security, in some ways, is like the lender of our loan examples. The borrower of the security, the short seller, is like the borrower of our loan examples. Therefore, we have seen this familiar scenario before. Instead of lending cash, we are lending securities. What is the same and what is different?

In principle, it might seem that borrowing shares creates a credit risk for the lender in the sense that the borrower may not be able to return the securities (like the cash borrower who is not able to pay back the loan). However, selling short is a bit more complicated and the credit risk is quite small if the shares are borrowed via a brokerage firm. Very few investors would lend shares to someone they barely know or do not know at all. To be able to borrow shares, we will need a **margin account**, i.e., an account with a brokerage firm that allows us to borrow money in order to buy stocks. Borrowing shares is, for all practical purposes, like a margin loan on which we pay interest on an outstanding debt (the value of the shares borrowed). To be able to open a margin account, we would need to be approved by the brokerage firm.

Example.

- *The shares of MNQ are currently trading at $80/share.*
- *Fund ABC's analysts believe that the shares are overvalued and that they should fall to $60/share.*
- *ABC's portfolio manager decides to short the shares.*
- *The portfolio manager contacts the fund's broker who is able to locate (that is the technical term used for finding the shares) shares of MNQ. The broker has 500,000 shares to lend at an annual interest rate of 5% as there are not many shares of MNQ available.*
- *The 500,000 shares are sold short at $79.20/share.*
- *After 6 months, the shares of MNQ have fallen but not as much as hoped, and they are trading at $72/share. The portfolio manager decides to unwind the position and buy back the shares, which are purchased back at $72.33/share.*

Compute Fund ABC's profit from this investment, assuming no interest payments to ABC's cash in margin account.

Answer. The amount invested (borrowing the shares) is

$$500,000 \times \$80 = \$40,000,000.00$$

The proceeds from the short sale are

$$500,000 \times \$79.20 = \$39,600,000.00$$

When we buy back the shares after 6 months, we spend

$$500,000 \times \$72.33 = \$36,165,500.00.$$

Hence, the profit from the short sale is

$$39,600,000.00 - 36,165,500.00 = \$3,434,500.00.$$

The amount of interest we need to pay for having borrowed the shares for 6 months (financing cost) is (using compound interest)

$$40,000,000 \times (1 + 5\%)^{0.5} - 40,000,000 = \$987,803.06.$$

Hence, the profit from the trade is $2,446.696.94.

4. Types of Risks

Each financial product has its own set of risks. Some of them we already considered in early lessons while others are new. In any case, we can use this as a review. Consider, for example, that you have a choice between depositing money in a savings account, such as a certificate of deposit, or purchasing a bond. As such, you want to know what the risks are. Let's consider four different risks.

4.1 Market Risk

Market risk is the risk due to price fluctuation, which makes the value of assets go down. If you have a savings account, then you are immune to market risk because you have a specified interest rate. However, if you own a bond, the prices do change. If you bought a bond and then try to sell it, you might find that you have to sell at a lower price. As a result, you would lose money due to market fluctuation. One safe way to avoid market risk in a bond is simply to hold the bond to maturity. If you hold a bond to maturity, then the bond price can change. So long as there is no default, you are immune to price fluctuations because you never sell the bond.

4.2 Reinvestment Risk

If you decide to go with the bond, then periodically, you will receive coupon interest. You may decide not to spend that coupon interest but rather to reinvest it. What will interest rates be like when you do sell? If interest rates go up, then that means you will be able to reinvest at a higher rate of interest, which is good. However, if interest rates go down, then you would reinvest at a lower rate of interest. The risk is there. **Reinvestment risk** is the risk that rates are lower when you have access to new investment funds. Reinvestment risk exists for CDs because, upon maturity, as you seek to renew a certificate of deposit, the rate may be lower than what you originally had.

4.3 Default Risk

Default risk is the risk that your bond issue fails to pay you back the stated interest and/or the principal. As we have seen, the certificate of deposit is insured by our trustworthy depository insurance corporation, so default risk is a non-issue. If you were the holder of a risk-free bond, then likewise, you need not worry about the default risk of those securities. However, if you are the buyer and/or holder of a risky bond, then you are certainly subject to the default risk of the bond issuer. If the bond issuer defaults, then the bond will be worth less. Even in the absence of a default, the fact that the bond issuer's credit rating declines causes the bond to be worth less as the bond is perceived as riskier than before.

Again, let's look at the difference between holding the bond to maturity versus trading the bond. If you simply hold the bond to maturity, then you run the risk that there may be a default. This means that you lose the interest and principal. If you only hold the bond for a brief period of time, then you are still subject to the credit risk. The decline in credit will

4.4 Inflation Risk

Inflation risk is the risk that the money you receive is simply worth less because inflation was higher than expected. For example, suppose either the certificate of deposit or the bond earned you 3% interest over the year. But what if inflation were 8% that year? Indeed, your real rate of return would be -5 percent. That is, had you gone to the marketplace, you could have purchased goods and services that now, by delaying a year, cost you more money; even though you have 3% more, those goods and services cost 8% more. In fact, people often find themselves in this situation in high-inflation environments. This is where central banks can help. When central banks find inflation to be high, they look to perform monetary policy, like raising interest rates, that will help to keep inflation under control.

4.5 Credit Risk Revisited

Lenders must consider several key types of risk when they originate loans:

- fraud risk;
- default risk;
- credit spread risk; and
- concentration risk

Altogether, these 4 risks are referred to as credit risk for banks or lenders in general.

Fraud risk has to do with the verification of the person or company that applies for a loan in order to distinguish legitimate applications from those that are fraudulent. Lenders need to check if the borrower is serious about repaying their debt. For instance, a client may ask to take out a loan in their name without any intention to repay it. Instead, the client may use the loan for an exotic vacation. Some would say that Countrywide Financial did not care about this at all as they often extended credit to individuals who could not really afford it. The following optional reading Owner-Occupancy Fraud and Mortgage Performance could be of interest for some students as it highlights instances of fraud.

Default risk was explained above in detail. It is worth noting that default risk is connected to **counterparty risk**. In some complicated transactions, the parties involved promise to exchange certain cash flows or exchange cash for assets. If one of the parties does not fulfill its obligations under the contract, it could lead to financial disruption for the other party. In turn, the latter party could default on its obligation toward a different third party, and so on. Therefore, lenders need to ascertain whether all parties involved can be counted on to fulfill their contractual obligations and/or need to decide how much credit to extend to the parties, if any.

Credit spread risk. Commercial bonds and risk-free government bonds or Treasury bills have a credit spread that depends on perceived levels of risk. If the spread increases, the credit risk for the borrower increases. The market value of the assets could decrease, which would result in losses for lenders and/or investors.

5. Types of Marketplaces

We have already discussed different types of maturities, products, and risks, so now, we'll close this lesson by showing that there are distinct types of marketplaces as well. Broadly speaking, there are two kinds. The first type of marketplace is an **exchange**. The second is what is called **over the counter**, abbreviated as **OTC**.

Exchanges have the following characteristics:

- They offer a variety of benefits that OTC markets do not have. The main advantages of exchanges are efficiency, transparency, equitability, and credit risk mitigation.
- They primarily provide a centralized marketplace, making trading efficient. They have very well-defined rules for handling the processing and clearing of trades.
- They provide transparency because all market participants have access to the order screens that contain the bid sizes and amounts, the offer sizes and amounts, and a record of the previous trades that took place.
- The transparency and availability of data makes trading fairer for market participants. Of course, big institutional investors may have bigger infrastructure with fast computers and smart algorithms to detect and process orders more efficiently than smaller individuals or institutions do.
- They solve the problem of credit risk. When you perform a transaction on an exchange, all the credit risk is eliminated. How? The credit risk is taken by the exchange itself. In other words, suppose someone named Mamadou borrowed a security from you in order to sell it short. Soon after Mamadou sells it, the price jumps up! Now, you have more credit risk because it just became more difficult for Mamadou to cover that short. The exchange can require Mamadou to post additional financing. Financing was one of the two challenges in this module (with the other being credit risk). The exchange continually monitors the value of that security and requires Mamadou to post additional funds, even as often as intraday. In doing so, you as the lender of the security would be assured that, even with price increases, you will be able to receive the security back because Mamadou cannot run out of money to cover it. The exchange enforces this by mandating intraday requirements such that Mamadou must post cash in an account to make sure he has sufficient funds available to cover that short. If Mamadou were not able to do so, the exchange could force the sale to immediately cover the security and return it to the lender. So, the exchange's monitoring and enforcement of margin helps to ensure that financing remains creditworthy.

Ideally, all securities would be exchange traded for the advantages of equitability, transparency, and the minimization of credit risk. When we turn to OTC markets, we see that trading occurs directly between counterparties. Yes, there may be brokers in between, but the brokers do not take credit risk. The brokers are there to facilitate and manage the transaction, not to assume the credit risk of either side. Likewise, the transparency is more difficult because OTC markets decentralize the process. For example, stocks that trade on a stock exchange only trade in that one place.

The counterparty is of greater interest in over-the-counter (OTC) transactions because of the increased risk of credit. In the event of a defaulted transaction in OTC markets, survivors will usually try to replace it with another agreement.