Fixed Income

Study Sessions 15 & 16

Weight on Exam	10%
SchweserNotes™ Reference	Book 5, Pages 1–150

Study Session 15: Fixed Income—Basic Concepts

Fixed-Income Securities: Defining Elements

Cross-Reference to CFA Institute Assigned Reading #51

Basic features of fixed income securities include:

- *Issuer.*
- *Maturity date*, also known as a bond's tenor.
- *Par value*, also known as *face value*, *maturity value*, or *redemption value*.
- *Coupon rate*.
- *Coupon frequency*, also known as a bond's *periodicity*.
- *Currency denomination* in which interest and principal will be paid. A *dual-currency bond* pays interest in one currency and principal in another.

The *trust deed* or *indenture* details the issuer's obligations and the bondholder's rights. Legal and regulatory issues addressed include:

- Legal information about the entity issuing the bond.
- Any *collateral* pledged to support repayment of the bond.
  - *Secured bonds* are backed by a claim to specific assets.
  - *Unsecured bonds* represent a claim to the overall assets and cash flows of the issuer.
- *Credit enhancements* increase the probability of repayment and can be internal (built into the structure of a bond issue) or external (provided by a third party).
- *Covenants* describing any actions the firm must take (affirmative covenants) and any actions the firm is prohibited from taking (negative covenants).

A country's *national bond market* includes bonds that trade in that country and are denominated in its currency. These include *domestic bonds* from domestic issuers and *foreign bonds* from foreign issuers.

Eurobonds are issued outside the jurisdiction of any one country and are denominated in a currency different from the currency of the countries in which they are sold. They are subject to less regulation and are often issued as *bearer bonds* (rather than *registered bonds*), which may offer a tax advantage.

Global bonds trade in both the eurobond market and a national bond market.

Interest income paid to bondholders is typically taxed as ordinary income at the same rate as wage and salary income. The interest income from most bonds issued by municipal governments in the United States is exempt from federal income tax and income tax in the state of issue.

When a bondholder sells a bond prior to maturity, the transaction may generate a *capital gain* or *loss*, depending on the sale price. Capital gains are often taxed at a lower rate than ordinary income. If the assets have been owned for more than a specified length of time, they are often taxed at an even lower rate.

Pure-discount bonds and other bonds sold at significant discounts to par when issued are termed *original issue discount* (OID) bonds. The increase in value of OID bonds due to the passage of time may be treated as taxable interest income and, as a result, these bonds can generate a tax liability even though no cash interest payment has been received.

How Fixed Income Cash Flows are Structured

A typical "plain vanilla" bond has a *bullet structure*. Periodic coupon interest payments are made over the life of the bond, and the principal value is paid with the final interest payment at maturity.

For a bond with an *amortizing structure*, the periodic payments include both interest and some repayment of principal. If a bond is *fully amortizing*, the principal is fully paid off when the last periodic payment is made. A bond can also be structured to be *partially amortizing* so there is a *balloon payment* at bond maturity that includes the unamortized principal.

A *floating-rate note* (FRN) has a coupon rate that is based on a *reference rate*, such as 90-day LIBOR, plus (or possibly minus) a margin that reflects the issuer's creditworthiness relative to the reference rate. A *variable-rate note* is an FRN with a variable margin. An *inverse floater* has a coupon rate that increases when the reference rate decreases and decreases when the reference rate increases.

An FRN may have a *cap*, which benefits the issuer by placing a limit on how high the coupon rate can rise. Often, FRNs with caps also have a *floor*, which benefits the bondholder by placing a minimum on the coupon rate, regardless of how low the reference rate falls.

An *index-linked bond* has coupon payments and/or a principal value that is based on a commodity index, an equity index, or some other published index number.

Some index-linked bonds are *principal-protected*, which means they will not pay less than their original par value at maturity, even if the index has decreased.

The most common type of index-linked bonds is *inflation-linked bonds* (or *linkers*) for which payments are based on the change in an inflation index, such as the Consumer Price Index (CPI) in the United States.

The different structures of inflation-indexed bonds include:

- *Indexed-annuity bonds.* Fully amortizing bonds with the periodic payments directly adjusted for inflation or deflation.
- *Indexed zero-coupon bonds.* The payment at maturity is adjusted for inflation.
- *Interest-indexed bonds.* The coupon rate is adjusted for inflation while the principal value remains unchanged.
- *Capital-indexed bonds.* This is the most common structure. An example is U.S. Treasury Inflation Protected Securities (TIPS). The coupon rate remains constant, and the principal value of the bonds is increased by the rate of inflation (or decreased by deflation). TIPS are principal-protected.

Other coupon structures include:

- *Step-up coupon bonds.* The coupon rate increases over time according to a predetermined schedule. These bonds are typically callable.
- *Credit-linked coupon bonds.* The coupon rate increases by a certain amount if the credit rating of the issuer falls, and decreases if the credit rating of the issuer improves.
- *Payment-in-kind bonds.* The issuer may make coupon payments by increasing the principal amount, essentially paying bond interest with more bonds.
- *Deferred coupon (split coupon) bonds.* Regular coupon payments do not begin until a period of time after issuance.

A *sinking fund* provision provides for the periodic retirement of a portion of the bonds issued over the life of the issue. In general, bonds with a sinking fund provision have less credit risk but greater reinvestment risk.

Contingency Provisions in Bonds

A contingency provision describes an action that may be taken if a specific event occurs. Contingency provisions in bond indentures are referred to as *embedded options*. Embedded options may benefit the bond issuer, increasing the required market yield, or benefit the bondholder, decreasing the required market yield. Bonds that do not have contingency provisions are referred to as *straight bonds* or *option-free bonds*.

A *call option* gives the issuer the right to redeem all or part of a bond issue at a specific call price. A *call schedule* specifies a callable bond's *call dates* and call prices. A call price may be par value or include a *call premium* above par. The time from issuance until a callable bond's first call date is referred to as the bond's period of *call protection* (or *lockout period*, *cushion*, or *deferment period*).

The issuer may exercise a call option because market yields have fallen in order to reduce interest expense. Bondholders have more reinvestment risk as a result, as they must reinvest the proceeds of called bonds at lower yields. For this reason, a callable bond must offer a higher yield (sell at a lower price) than an otherwise identical noncallable bond.

To avoid the higher interest rates required on callable bonds but still preserve the option to redeem bonds early for corporate (rather than financial) reasons, issuers have introduced bonds with *make-whole call provisions*. With a make-whole bond, the call price is not fixed but includes a lump-sum payment based on the present value of the future coupons the bondholder will not receive if the bond is called early. Thus, the issuer is unlikely to call the bond except when corporate circumstances, such as an acquisition or restructuring, require it.

There are three styles of exercise for callable bonds. Note that these are only style names and are not indicative of where the bonds are issued:

1. American style—the bonds can be called anytime after the first call date.

2. European style—the bonds can only be called on the call date specified.

3. Bermuda style—the bonds can be called on specified dates after the first call date, often on coupon payment dates.

A *put option* gives the bondholder the right to sell the bond back to the issuing company at a given price, typically par. Bondholders are likely to exercise a put option when the fair value of the bond is less than the put price because interest rates have risen or the credit quality of the issuer has fallen. Unlike a call option, a put option is exercised by the bondholder so a putable bond will trade at a lower yield (sell at a higher price) relative to an otherwise identical option-free bond.

Convertible bonds give bondholders the option to exchange the bond for a specific number of shares of the issuing corporation's common stock and can have the characteristics of both a debt and equity security as a result. The possibility of profit from increases in the value of the common shares reduces the required yield on the bonds, compared to the yield of an option-free bond. The value of a convertible bond is the value of the bond plus the value of the conversion option.

Contingent convertible bonds (referred to as "CoCos") are bonds that convert from debt to common equity automatically if a specific event occurs and can increase the equity of financial institutions when it falls below the percentage required by regulators.

Sometimes bonds, especially those of riskier, less mature companies, are sold with *warrants* attached. Warrants give their holders the right to buy the firm's common shares at a given price until an expiration date. Warrants provide potential gains to bondholders and do not require the bonds to be retired at exercise, as convertible bonds do.

Fixed-Income Markets: Issuance, Trading, and Funding

Cross-Reference to CFA Institute Assigned Reading #52

Interbank Rates

The most widely used reference rate for floating-rate bonds is the London Interbank Offered Rate (LIBOR), although other reference rates, such as Euribor, are also used. Libor rates are published daily for several currencies and for maturities of one day (overnight rates) to one year. Thus, there is no single "LIBOR rate" but rather a set of rates, such as "30-day U.S. dollar LIBOR" or "90-day Swiss franc LIBOR."

The rates are based on expected rates for unsecured loans from one bank to another in the interbank money market, based on a survey of banks.

For floating-rate bonds, the reference rate must match the frequency with which the coupon rate on the bond is reset. For example, a bond denominated in euros with a coupon rate that is reset twice each year might use six-month euro LIBOR or six-month Euribor as a reference rate.

Primary Market for Bonds

Primary market transactions are sales of newly issued bonds. Bonds can be registered with securities regulators for sale in a *public offering* or sold only to *qualified* investors in a *private placement*. A public offering is typically done with the help of an investment bank, which has expertise in executing a public offering.

In an *underwritten offering*, the investment bank (underwriter), or a *syndicate* of investment banks, purchases the entire bond issue from the issuing firm and then sells them to dealers and investors. Bonds are priced based on indications of interest from buyers. Some bonds are traded on a prior to issue (on a when-issued basis)

in what is called the *grey market*, which helps underwriters determine the offering price.

In a *best efforts offering*, the investment banks sell the bonds on a commission basis. Unlike an underwritten offering, the investment banks do not commit to purchase the whole issue.

Some bonds, especially government bonds, are sold through an auction. For example, U.S. Treasury securities are sold through single-price auctions with the majority of purchases made by *primary dealers*.

In a *shelf registration*, a bond issue is registered with securities regulators in its aggregate value with a master prospectus. Portions of the registered issue can then be issued over time when the issuer needs to raise funds. Individual offerings under a shelf registration require less disclosure than a separate registration of a bond issue.

Secondary Market for Bonds

Secondary markets refer to the trading of previously issued bonds. While some government bonds and corporate bonds are traded on exchanges, the great majority of bond trading in the secondary market is made in the dealer, or over-the-counter, market. Dealers post bid (purchase) prices and ask or offer (selling) prices for various bond issues. The difference between the bid and ask prices is the dealer's spread.

Bond trades are cleared through a clearing system, just as equities trades are. Settlement typically occurs on T + 2 or T + 3 for corporate bonds, on T + 1 or cash settlement for government and quasi-government bonds, and cash settlement for some money market securities.

Government and Agency Bonds

National governments or their treasuries issue *sovereign bonds* that are backed by the taxing power of the government. Both a sovereign's ability to collect taxes and its ability to print the local currency lead to higher ratings on bonds issued in the local currency compared to sovereign debt issued in the currency of a developed economy (e.g., USD or euros). Sovereign bonds include fixed-rate, floating-rate, and inflation-indexed bond issues.

Trading is most active and prices most informative for the most recently issued government securities of a particular maturity. These issues are referred to

as *on-the-run bonds* or *benchmark bonds*. Yields of other bonds are determined relative to the benchmark yields of sovereign bonds with similar maturities.

Nonsovereign government bonds are issued by states, provinces, counties, and sometimes by entities created to fund and provide services such as for the construction of hospitals, airports, and other municipal services. Payments on the bonds may be supported by the revenues of a specific project, from general tax revenues, or from special taxes or fees dedicated to the repayment of project debt. Nonsovereign bonds are typically of high credit quality, but sovereign bonds typically trade with lower yields because their credit risk is perceived to be less than that of nonsovereign bonds.

Agency bonds or *quasi-government bonds* are issued by entities created by national governments for specific purposes such as financing small businesses or providing mortgage financing. *Supranational bonds* are issued by supranational agencies (also known as multilateral agencies) such as the World Bank, the IMF, and the Asian Development Bank.

Corporate Debt

Bank loans to corporations are typically LIBOR-based variable-rate loans. When the loan involves only one bank, it is referred to as a *bilateral loan*. In contrast, when a loan is funded by several banks, it is referred to as a *syndicated loan*.

For larger creditworthy corporations, funding costs can be reduced by issuing short-term debt securities referred to as *commercial paper*. Firms use commercial paper to fund working capital and as a temporary source of funds prior to issuing longer term debt. Debt that is temporary until permanent financing can be secured is referred to as *bridge financing*. To get an acceptable credit rating from the ratings services on their commercial paper, corporations maintain *backup lines of credit* with banks.

Commercial paper is short-term unsecured debt, issued with maturities as short as one day (overnight paper), with most issues maturing in about 90 days. In the United States, commercial paper is issued with maturities of 270 days or less so it is exempt from SEC registration, and is typically issued as a pure discount security.

Eurocommercial paper (ECP) is issued in several countries with maturities as long as 364 days. ECP rates may be quoted as add-on or discount yields.

A bond issue is said to have a *term maturity structure* if all the bonds mature on the same date. An alternative is a *serial bond issue* in which bonds are issued with several maturity dates so a portion of the issue is redeemed periodically. The difference

between a serial bond issue and an issue with a sinking fund is that with a serial bond issue, investors know the dates when specific bonds will be redeemed.

In general, corporate bonds are referred to as short-term if they are issued with maturities of up to 5 years, medium-term when issued with maturities from 5 to 12 years, and long-term when maturities exceed 12 years.

Corporations issue debt securities called medium-term notes (MTNs), which are not necessarily medium-term in maturity. MTNs are issued in various maturities, ranging from nine months to periods as long as 100 years. MTNs are offered continuously through agents and can be customized to some extent to match a bond buyer's preferences. Most MTNs, other than long-term MTNs, are issued by financial corporations and most buyers are financial institutions.

Funding Alternatives for Banks

Retail customer deposits, including checking accounts, savings accounts, and money market mutual funds, are a short-term funding source for banks. In addition to funds from retail accounts, banks offer interest-bearing certificates of deposit (CDs) in a range of short-term maturities. Non-negotiable CDs cannot be sold.

Negotiable certificates of deposit can be sold. Large denomination (typically more than $1 million) negotiable CDs are an important funding source for banks. They typically have maturities of one year or less and are traded in domestic bond markets as well as in the eurobond market.

Banks may borrow *excess reserves* from other banks in the *central bank funds market*. Rates for these transactions (central bank funds rates) are strongly influenced by the effect of the central bank's open market operations on the money supply and the availability of short-term funds. In the United States, the central bank funds rate is called the *Fed funds rate*.

Other than reserves on deposit with the central bank, funds that are loaned by one bank to another are referred to as *interbank funds*. Interbank funds are loaned between banks for periods of one day to a year. These loans are unsecured and, as with many debt markets, liquidity may decrease severely during times of systemic financial distress.

Repurchase Agreements

In a *repurchase agreement* or *repo*, one party sells a security to a counterparty with a commitment to buy it back at a later date at a specified higher price. The

repurchase price is greater than the selling price and the difference is effectively the interest paid to the buyer. In effect, the buyer is lending funds to the seller with the security as collateral. The interest rate implied by the two prices is called the *repo rate*.

A repurchase agreement for one day is called an *overnight repo* and an agreement covering a longer period is called a *term repo*. The interest cost of a repo is customarily less than the rate on bank loans or other short-term borrowing.

A percentage difference between the market value of the security and the amount loaned is called the *repo margin* or the *haircut*. This margin protects the lender in the event that the value of the security decreases over the term of the repo agreement.

Viewed from the standpoint of a bond dealer, a *reverse repo agreement* refers to taking the opposite side of a repurchase transaction, lending funds by buying the collateral security rather than selling the collateral security to borrow funds.

The repo rate is:

- Higher, the longer the repo term.
- Lower, the higher the credit quality of the collateral security.
- Lower when the collateral security is delivered to the lender.
- Higher when the interest rates for alternative sources of funds are higher.

The repo margin is influenced by similar factors. The repo margin is:

- Higher, the longer the repo term.
- Lower, the higher the credit quality of the collateral security.
- Lower, the higher the credit quality of the borrower.
- Lower when the collateral security is in high demand or low supply.

Introduction to Fixed-Income Valuation

Cross-Reference to CFA Institute Assigned Reading #53

For an annual-coupon bond with N years to maturity:

$$\text{price} = \frac{\text{coupon}}{(1+\text{YTM})} + \frac{\text{coupon}}{(1+\text{YTM})^2} + \ldots + \frac{\text{coupon} + \text{principal}}{(1+\text{YTM})^N}$$

For a semiannual-coupon bond with N years to maturity:

$$\text{price} = \frac{\text{coupon}}{\left(1+\frac{\text{YTM}}{2}\right)} + \frac{\text{coupon}}{\left(1+\frac{\text{YTM}}{2}\right)^2} + \ldots + \frac{\text{coupon} + \text{principal}}{\left(1+\frac{\text{YTM}}{2}\right)^{\text{N}\times 2}}$$

A bond's price, YTM, coupon rate, and maturity are related as follows:

- Price and YTM are inversely related. An increase in YTM decreases the price and a decrease in YTM increases the price.
- If a bond's coupon rate is greater than its YTM, its price will be at a premium to par value. If a bond's coupon rate is less than its YTM, its price will be at a discount to par value.
- For a bond valued at a discount or premium, the price will converge to par value as the bond approaches maturity, assuming the issuer does not default.
- The percentage decrease in value when the YTM increases by a given amount is smaller than the increase in value when the YTM decreases by the same amount (the price-yield relationship is convex).
- Other things equal, the price of a bond with a lower coupon rate is more sensitive to a change in yield than is the price of a bond with a higher coupon rate.
- Other things equal, the price of a bond with a longer maturity is more sensitive to a change in yield than is the price of a bond with a shorter maturity.

The *constant-yield price trajectory* is the change in value as time passes for a discount or premium bond. It shows how the bond's price would change as time passes if its yield-to-maturity remained constant. If an investor sells a bond before maturity, a capital gain or loss is measured relative to the bond's constant-yield price trajectory.

Bonds can be valued using *spot rates*, which are market discount rates for a single payment to be received in the future. The discount rates for zero-coupon bonds are spot rates. We sometimes refer to spot rates as *zero-coupon rates* or *zero rates*.

The general equation for calculating a bond's value using spot rates (S_i) is:

$$\text{price} = \frac{\text{coupon}}{(1+S_1)} + \frac{\text{coupon}}{(1+S_2)^2} + \ldots + \frac{\text{coupon} + \text{principal}}{(1+S_N)^N}$$

This price calculated using spot rates is sometimes called the *no-arbitrage price* of a bond because if a bond is priced differently, there will be a profit opportunity from arbitrage among bonds.

The *flat price* of a bond does not include interest accrued between coupon dates. The flat price is also known as a bond's *clean price* or *quoted price*. The *full price* of a

bond includes interest accrued between coupon dates and is also known as the *dirty price* or *invoice price*.

Accrued interest since the last payment date can be calculated as the coupon payment times the portion of the current coupon period that has passed, based on actual calendar days (typically used for government bonds) or based on 30-day months and 360-day years (typically used for corporate bonds).

Matrix pricing is a method estimating bond YTMs using the YTMs of traded bonds that have credit quality very close to that of the non-traded or infrequently traded bonds of similar maturity and coupon. For example, the YTM for a non-traded six-year bond can be estimated by taking the average of the YTMs of similar seven-year and five-year bonds.

Yield Measures

The *effective yield* for a bond is the compound return.

Yields to maturity for bonds that make semiannual payments are quoted on a *semiannual bond basis*, which is two times the semiannual discount rate.

Yields calculated using the stated coupon payment dates are referred to as following *street convention*. When coupon dates fall on weekends and holidays, coupon payments are made the next business day. A yield calculated using these actual coupon payment dates is the *true yield*, which may be slightly lower than a street convention yield.

Current yield is a bond's annual coupon cash flows divided by the bond's flat price. This yield measure does not account for gains or losses as the bond's price moves toward its par value over time.

Simple yield is the sum of the annual coupon payment plus (minus) the straight-line amortization of a discount (premium), divided by the flat price. This yield measure assumes any discount or premium declines evenly over the remaining years to maturity.

For a callable bond, a *yield-to-call* can be calculated for each possible call date and price. The lowest of yield-to-maturity and the various yields-to-call is termed the *yield-to-worst*.

The *option-adjusted yield* for a callable bond is calculated by adding the value of the call option to the bond's flat price. The value of a callable bond is equal to the value

of the bond if it did not have the call option, minus the value of the call option. The option-adjusted yield will be less than the yield-to-maturity for a callable bond.

For an FRN, the coupon rate is the reference rate plus or minus a margin based on the credit risk of the bond. Interest is paid in arrears, with the coupon rate for the next period set using the current reference rate.

The margin used to calculate the bond coupon payments is known as the *quoted margin*. The margin required to return the FRN to its par value is the *required margin* (or *discount margin*). When the credit quality of an FRN is unchanged, the quoted margin is equal to the required margin and the FRN returns to its par value at each reset date. If the credit quality of the issuer decreases, the quoted margin will be less than the required margin and the FRN will sell at a discount. If credit quality has improved, the quoted margin will be greater than the required margin and the FRN will sell at a premium.

Yields on money market securities can be stated as a discount from face value or as add-on yields, and can be based on a 360-day or 365-day basis. These securities should be compared based on their *bond-equivalent yield*, which is an add-on yield based on a 365-day year.

Yield Curves, Spot Rates, and Forward Rates

A *yield curve* shows yields by maturity. The *term structure of interest rates* refers to the yields at different maturities for like securities or interest rates.

A yield curve for coupon bonds shows the YTMs for coupon bonds at various maturities. A spot rate yield curve or *zero curve* shows the YTMs for zero-coupon bonds at various maturities. A par bond yield curve or *par curve* may be constructed from the spot curve to show the coupon rate that a hypothetical coupon bond at each maturity would need to have to be priced at par.

Forward rates are yields for future periods, such as the rate of interest on a three-year loan that would be made two years from now.

An example of forward rate notation is "2y3y." The "2y" refers to the number of years from today when a loan would begin, and the "3y" refers to the tenor (length) of the loan. Thus, 2y3y is the three-year rate two years from today. Forward rates may also be expressed in months. "6m3m" is a three-month rate beginning six months from today.

A *forward yield curve* shows the future rates for bonds or money market securities for the same maturities for annual periods in the future.

Forward rates and spot rates are related because borrowing for N years should have the same cost as borrowing for shorter periods that add up to N years. For example, borrowing for two years at the two-year spot rate should have the same cost as borrowing for the first year at the one-year spot rate and for the second year at the one-year forward rate one year from now. That is, $(1 + S_2)^2 = (1 + S_1)(1 + 1y1y)$. Based on these relationships between spot and forward rates, we can calculate forward rates from spot rates, calculate spot rates from forward rates, or value a bond using forward rates in the same way we valued a bond using spot rates earlier.

Example: Forward rate from spot rates

The two-year spot rate is 5.5% and the three-year spot rate is 6.0%. Calculate the one-year forward rate two years from now (2y1y).

Answer:

$$(1+S_3)^3 = (1 + S_2)^2(1 + 2y1y)$$

$$2y1y = \frac{(1+S_3)^3}{(1+S_2)^2} - 1 = \frac{(1.060)^3}{(1.055)^2} - 1 = 7.01\%$$

A quick way to approximate the forward rate is to ignore compounding:

$$3 \times S_3 \approx 2 \times S_2 + 2y1y$$

$$2y1y \approx 3(6.0\%) - 2(5.5\%)$$
$$18\% - 11\% = 7\%$$

Example: Spot rate from forward rates

The one-year spot rate is 3.5%. One-year forward rates are: 1y1y = 3.8%, 2y1y = 4.2%, and 3y1y = 4.5%. Calculate the four-year spot rate.

Answer:

The cost of borrowing today for four years should be the same as the cost of a sequence of four one-year loans that begin today and in each of the next three years:

$$(1 + S_4)^4 = (1 + S_1)(1 + 1y1y)(1 + 2y1y)(1 + 3y1y)$$

$$S_4 = [(1.035)(1.038)(1.042)(1.045)]^{1/4} - 1 = 3.9993\%$$

Here, too, we can approximate the result if we ignore compounding:

$$4 \times S_4 \approx S_1 + 1y1y + 2y1y + 3y1y$$

$$S_4 \approx (3.5\% + 3.8\% + 4.2\% + 4.5\%) / 4 = 4.0\%$$

Yield Spreads

A yield spread is the difference between the YTMs of two different bonds. Yield spreads are typically quoted in basis points.

A yield spread relative to a benchmark bond is known as a *benchmark spread*. For fixed-coupon bonds, on-the-run government bond yields for the same or nearest maturity are frequently used as benchmarks. A yield spread over a government bond is also known as a *G-spread*.

An alternative to using government bond yields as benchmarks is to use the fixed rates for interest rate swaps in the same currency and with the same tenor as a bond. Yield spreads relative to swap rates are known as *interpolated spreads* or *I-spreads*.

G-spreads and I-spreads are theoretically correct only if the spot yield curve is flat. However, the spot yield curve is not likely to be flat and is typically upward-

sloping. A *zero-volatility spread* or *Z-spread* is derived by a method that accounts for the shape of the yield curve. The Z-spread is the single spread that, when added to each spot rate, produces a bond value that is equal to the current market value of a bond.

An *option-adjusted spread (OAS)* is used for bonds with embedded options. The OAS is the spread to the spot rate curve that the bond would have if it were option-free. For a callable bond, the OAS is less than the Z-spread and for a putable bond the OAS is greater than the Z-spread The OAS is the spread that accounts for differences between the liquidity and credit quality of the subject bond and the benchmark, with the effect on yield of any embedded options removed.

Introduction to Asset-Backed Securities

Cross-Reference to CFA Institute Assigned Reading #54

Securitization refers to a process by which financial assets (e.g., mortgages, accounts receivable, or automobile loans) are purchased by an entity that then issues *asset-backed securities* (ABS) for which the promised payments come from the cash flows from those financial assets.

The primary benefits of the securitization of financial assets are:

1. A reduction in funding costs for firms selling the financial assets to the securitizing entity.

2. An increase in the liquidity of the underlying financial assets.

Compared to a bank serving as a financial intermediary between borrowers and lenders, securitization also provides the following benefits:

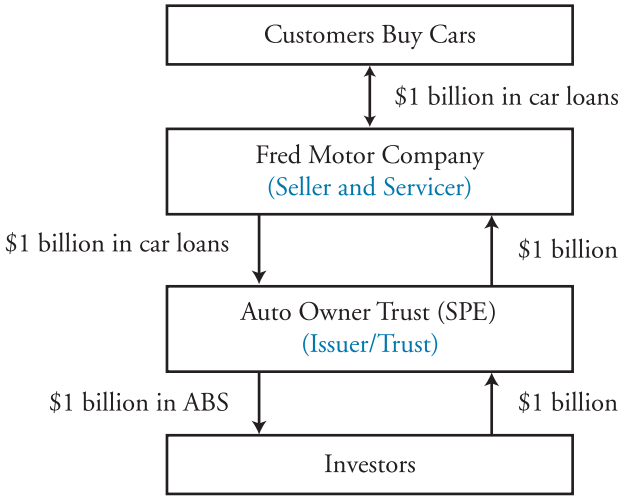
- Reduced intermediation costs.
- The investors' legal claim to the underlying financial assets is stronger.
- ABS are often actively traded, increasing the liquidity of the originating bank's assets.
- Banks are able to originate more loans compared to relying only on bank funds.
- Allows investors to better match their preferred risk, maturity, and return characteristics.
- Greater diversification and risk reduction compared to individual loans (whole loans).

Parties to a Securitization Transaction and Their Functions

- The seller (e.g., bank) originates the loans and sells the portfolio of loans to the **special purpose entity** (SPE).

- The **issuer/trust** is the SPE that buys the loans from the seller and issues ABS to investors.
- The **servicer** collects the payments from the underlying loans and may or may not be the issuer.

Figure 1: Structure of Fred Motor Company Asset Securitization



The ABS of a single SPE may have different priority of claims to the cash flow from the underlying assets, so that the most senior class (tranche) receives its promised payments before the next most senior tranche receives any cash flows, and so on. This is referred to as a **waterfall structure.**

Because the SPE is legally separate from the seller, financial distress or even bankruptcy of the seller may not affect the credit quality of the ABS. For this reason, the SPE is referred to as *bankruptcy remote* (from the seller). The credit rating of the ABS may be higher than the credit rating of the seller.

ABS are commonly backed by automobile loans, credit card receivables, mortgage and home equity loans, manufactured housing loans, student loans, Small Business Administration loans, corporate loans, corporate bonds, emerging market bonds, and structured financial products. ABS backed by mortgages are termed mortgage-backed securities (MBS).

Residential Mortgage Loans

Mortgage loans have real estate as collateral and typically have original maturities of 15–30 years in the United States and longer in some other countries.

A **fixed-rate mortgage** has an interest rate that is unchanged over the life of the mortgage.

An **adjustable-rate mortgage** (ARM), or variable-rate mortgage, has an interest rate that can change over the life of the mortgage. An **index-referenced mortgage** has an interest rate that changes based on a market determined reference rate.

A mortgage loan may have a fixed interest rate for some initial period that is adjusted after that. If the loan becomes an adjustable-rate mortgage after the initial fixed-rate period, it is called a **hybrid mortgage.** If the interest rate changes to a different fixed rate after the initial fixed-rate period, it is called a **rollover** or **renegotiable mortgage**.

A **convertible mortgage** is one for which the initial interest rate terms, fixed or adjustable, can be changed at the option of the borrower, to adjustable or fixed, for the remaining loan period.

A **fully amortizing** loan has no outstanding principal after the final payment is made. A **partially amortizing** loan includes some reduction of principal from each payment, but there is a principal payment to be made at maturity as well, called a **balloon** payment. An **interest-only** loan requires the repayment of the entire principal amount of the loan at maturity.

A loan may or may not have a **prepayment penalty**, an extra amount that is due when principal is repaid in greater amounts than scheduled in the loan payments. When there is no prepayment penalty, a decrease in interest rates can allow borrowers to refinance the loan at a lower interest rate and pay off (prepay) the remaining principal on the existing loan.

A prepayment penalty reduces the incentive to repay the loan principal early and protects the lender from receiving additional principal payments when rates are lower and less can be earned from reinvestment of the funds.

With a **non-recourse** loan, the only claim the lender has is to the property, which can be sold and the proceeds up to the amount of the amount owed used to satisfy the loan liability. With a **recourse** loan, the lender has a claim against the assets of the borrower for any excess of the amount owed above the proceeds from the property after it is repossessed and sold.

Residential Mortgage-backed Securities (RMBS)

Agency RMBS are issued by the Government National Mortgage Association (GNMA), the Federal National Mortgage Association (FNMA), and the Federal Home Loan Mortgage Corporation (FHLMC).

GNMA securities are guaranteed and are considered to be backed by the full faith and credit of the U.S. government. FNMA and FHLMC also guarantee the MBS they issue but are **government-sponsored enterprises** (GSE). Credit quality, while high, is considered slightly lower than that of GNMA securities.

Agency RMBS are **mortgage pass-through** securities in that the interest and principal payments received on the pool of mortgages underlying the MBS are passed along to securities holders in proportion to their ownership of the issue. Because of administrative fees, the **pass-through rate** that investors receive is less than the coupon rates on the underlying mortgages.

The mortgages in the pool typically have different maturities and different mortgage rates. The **weighted average maturity** (WAM) of the pool is equal to the principal-weighted average of the final maturities of all the mortgages in the pool. The **weighted average coupon** (WAC) of the pool is the principal-weighted average of the interest rates of all the mortgages in the pool.

To be included in agency MBS pools, mortgages must be **conforming loans**; that is, they meet certain required criteria including a minimum percentage down payment, a maximum loan-to-value (LTV) ratio, maximum size, minimum documentation required, and insurance purchased by the borrower. Loans that do not meet the standards are called **non-conforming loans** and can be securitized by private companies for **non-agency RMBS**.

The mortgages underlying agency RMBS have no prepayment penalties and are subject to **prepayment risk. Extension risk** refers to the risk of receiving principal repayments more slowly than expected, and **contraction risk** refers to the risk of a prepayment rate that is more rapid than expected (principal is returns earlier).

The **conditional prepayment rate** (CPR) is an annualized measure of prepayments. The **Public Securities Association** (**PSA**) *prepayment benchmark* is expressed as a monthly series of CPRs. A PSA of 50 means that prepayments are 50% of the PSA benchmark CPR, and a PSA of 130 means that prepayments are 130% of the PSA benchmark CPR.

To achieve a credit rating high enough to attract institutional lenders, some form of **credit enhancement** is typically included with ABS. **External credit enhancements**

are financial guarantees from third parties that support the performance of the ABS. **Internal credit enhancements** include:

- Reserve funds (either a cash reserve or excess spread of scheduled interest payments from the underlying securities over that promised to ABS holders).
- Overcollateralization (the outstanding principal amount of the ABS is less than that of the underlying securities).
- Senior and subordinated structures (credit risk is shifted from the senior tranche to the subordinated tranche).

Collateralized mortgage obligations (CMOs) are securities that are collateralized by RMBS. Each CMO has multiple tranches, each with a different risk exposure.

With **sequential tranches,** principal repayments flow first to one tranche until its principal balance is repaid and then to the second sequential tranche until its principal value is paid off, and so forth. All tranches receive interest on their beginning-of-period principal values.

A CMO structure can have a **planned amortization class (PAC) tranche** with reduced prepayment risk because **support tranches** take on more prepayment risk. If principal prepayments of the MBS accelerate, the additional payments go to the support tranches and if prepayments are low, principal payments to the support tranches are reduced. Under this structure the PAC tranche can maintain its promised payment schedule within certain bounds of PSA, and these bounds are the PAC's *initial collar.*

Commercial mortgage-backed securities (CMBS) are backed by income-producing real estate [e.g., apartments (multi-family), warehouses (industrial use property), shopping centers, office buildings, health care facilities, senior housing, or hotel/resort property].

Commercial mortgages are non-recourse loans, so the collateral property's value (ability to generate cash flows) is the only source of repayment of the loans. For this reason the credit rating for a CMBS is often focused on two measures: the property's **loan-to value (LTV)** ratio and **debt service coverage** ratio.

$$\text{loan-to-value ratio} = \frac{\text{current mortgage amount}}{\text{current appraised value}}$$

$$\text{debt-to-service coverage ratio} = \frac{\text{net operating income}}{\text{debt service}}$$

Either a lower LTV ratio or a higher debt service coverage ratio can increase the credit rating for a CMBS.

Most CMBS have a senior-subordinated structure so that credit risk is first absorbed by the least senior tranche and then by each more senior tranche in turn as necessary. With this structure, the most senior tranches carry relatively little credit risk, and the lowest priority tranches are quite risky and referred to as the *first-loss tranche* or *equity tranche*.

Call protection (prepayment protection) can be provided for CMBS either at the individual mortgage level or for the CMBS as a whole. Loan level call protection, in various amounts, can be provided by:

- A **prepayment lockout period** of three to five years, during which the loan cannot be prepaid.
- **Defeasance:** any prepayments are used to purchase Treasury securities that will generate cash flows to make future loan payments.
- **Prepayment penalty:** a percentage of the principal amount that must be paid if the loan is paid off early.
- **Yield maintenance (make whole) charges** require an extra payment in the event of an early loan payoff that fully compensates lenders from losses due to early retirement of principal in a lower interest rate environment.

Call protection at the CMBS level is sometimes provided with a senior-subordinated structure so that lower priority tranches receive prepayments first and are first to absorb losses from defaults on the underlying mortgages.

Non-Mortgage ABS

Auto loan ABS are backed by automobile loans, which are typically fully amortizing but with shorter maturities than residential mortgages. Prepayments result when autos are sold or traded in, stolen or wrecked and paid off from insurance proceeds, refinanced, or paid off early by the borrower.

Credit card ABS are backed by credit card receivables, which are revolving debt (non-amortizing). Credit card ABS typically have an initial **lockout period** (of as long as 10 years) during which only interest is paid to investors, and all principal payments on the receivables are used to purchase additional receivables. Credit card ABS can be fixed-rate or floating-rate securities.

Collateralized Debt Obligations

Collateralized debt obligations (CDOs) are structured securities backed by a pool of debt obligations that is managed by a collateral manager. CDOs include:

- Collateralized bond obligations (CBOs) backed by corporate and emerging market debt.
- Collateralized loan obligations (CLOs) backed by leveraged bank loans.
- Structured finance CDOs backed by residential or commercial MBS, ABS, or other CDOs.
- Synthetic CDOs backed by credit default swaps on structured securities.

CDOs issue three classes of bonds (tranches): senior bonds, mezzanine bonds, and subordinated bonds (sometimes called the equity or residual tranche). The subordinated tranche has characteristics more similar to those of equity investments than bond investments.

An investment in the equity or residual tranche can be viewed as a leveraged investment where borrowed funds (raised from selling the senior and mezzanine tranches) are used to purchase the debt securities in the CDO's collateral pool.

The collateral manager may use interest earned on portfolio securities, cash from maturing portfolio securities, and cash from the sale of portfolio securities to cover the promised payments to holders of the CDO's senior and mezzanine bonds. Any excess above that flows to the equity tranche.

In an *arbitrage CDO*, the return promised to the CDO securities is less than the promised return on the underlying securities, so that in the absence of default, this excess return is the cash flow to the residual tranche.

Study Session 16: Fixed Income—Analysis of Risk

Understanding Fixed-Income Risk and Return

Cross-Reference to CFA Institute Assigned Reading #55

The three sources of returns from investing in a fixed-rate bond are:

1. Coupon and principal payments.

2. Interest earned on reinvested coupon payments.

3. Capital gain or loss if the bond is sold prior to maturity.

For a bond that does not default, and assuming the rate earned on reinvested coupons is equal to the YTM:

- An investor who holds a fixed-rate bond to maturity will earn an annualized rate of return equal to the YTM of the bond when purchased.
- An investor who sells a bond prior to maturity will earn a rate of return equal to the YTM at purchase if the bond's YTM when sold is equal to the YTM of the bond when purchased.

If the YTM of the bond decreases (increases) shortly after issuance:

- An investor who sells the bond in the short term will have an increased (decreased) return due to the increase (decrease) in the sale price of the bond.
- An investor who holds the bond to maturity (or other suitably long term) will have a decreased (increased) return due to the decreased (increased) reinvestment income earned.

These results illustrate the trade-off between *market price risk* (the uncertainty about price due to uncertainty about market YTM) and *reinvestment risk* (uncertainty about the total of coupon payments and reinvestment income on those payments due to the uncertainty about future reinvestment rates). For an investor with a short investment horizon, market price risk is greater than reinvestment risk. For an investor with a long investment horizon, reinvestment risk is greater than market price risk.

The investment horizon at which these risks just offset is known as a bond's **Macaulay duration**. A bond's annual Macaulay duration is calculated as the weighted average of the number of years until each of the bond's promised cash flows is to be paid, where the weights are the present values of each cash flow as a percentage of the bond's full value. For a semiannual-pay bond, Macaulay duration is calculated as a number of semiannual periods and divided by two to get the annual Macaulay duration.

The difference between a bond's Macaulay duration and the bondholder's investment horizon is referred to as a *duration gap*. A positive duration gap (Macaulay duration greater than the investment horizon) exposes the investor to market price risk from increasing interest rates. A negative duration gap (Macaulay duration less than the investment horizon) exposes the investor to reinvestment risk from decreasing interest rates.

Modified duration is calculated as Macaulay duration divided by one plus the bond's yield to maturity. Modified duration provides an approximate percentage

change in a bond's price for a 1% change in yield to maturity. For a given change in YTM, the price change can be calculated as:

$$\text{approximate percentage change in bond price} = -\text{modified duration} \times \Delta\text{YTM}$$

We can approximate modified duration directly using bond values for an increase and for a decrease in YTM of the same size:

$$\text{approximate modified duration} = \frac{V_- - V_+}{2 \times V_0 \times \Delta\text{YTM}}$$

where:
V_0 = the initial price
V_- = the price of the bond if YTM is decreased by ΔYTM
V_+ = the price of the bond if the YTM is increased by ΔYTM

Modified duration is not appropriate for bonds with embedded options because their future cash flows may change depending on the level and path of interest rates. For these bonds we use **effective duration**, which uses the change in the benchmark yield curve, rather than the change in YTM, to generate V_- and V_+:

$$\text{effective duration} = \frac{V_- - V_+}{2 \times V_0 \times \Delta\text{curve}}$$

Other things equal, a bond's interest rate risk (as measured by duration) is:

- Usually greater with a longer maturity. We must say "usually" because there are instances where an increase in a discount coupon bond's maturity will decrease its Macaulay duration.
- Less with a higher coupon rate. When more of a bond's value will be from payments received sooner, the value of the bond is less sensitive to changes in yield.
- Less with a higher YTM. This is because the price-yield relationship is convex. At lower yields, the price-yield curve has a steeper slope, indicating that price is more sensitive to a given change in yield.
- Less with an embedded call or put option.

The duration concept may be applied to a bond portfolio. There are two approaches to estimating **portfolio duration**:

1. Calculate the weighted average number of periods until the portfolio's cash flows will be received. This approach is theoretically correct but is not often used in practice, and cannot be used if some portfolio bonds have embedded options.

2. Take a weighted average of the durations of the individual bonds in the portfolio, where the weights are the full price of each bond as a proportion of the total portfolio value. A limitation of this approach is that it assumes a parallel shift in the yield curve but the effective duration of bonds with embedded options can be used.

The **money duration** (also called *dollar duration*) of a bond position is expressed in currency units. Multiplying the money duration of a bond times a given change in YTM will provide an estimate of the change in bond value for that change in YTM. Money duration is sometimes expressed as money duration per 100 currency units of bond par value.

Duration is an adequate measure of bond price risk only for parallel shifts in the yield curve. The impact of nonparallel shifts can be measured using **key rate duration**. A key rate duration is the sensitivity of the value of a bond or portfolio to changes in the spot rate for a specific maturity, holding other spot rates constant. A bond or portfolio will have a key rate duration for each maturity range on the spot rate curve.

The **price value of a basis point** (PVBP) is the money change in the full price of a bond when its YTM changes by one *basis point*, or 0.01%. We can calculate the PVBP directly by calculating the average of the decrease in the full value of a bond when its YTM increases by one basis point and the increase in the full value when its YTM decreases by one basis point.

Because modified duration is a linear approximation of the relationship between yield and price, duration-based estimates of a bond's full price become increasingly poor for larger changes in YTM. Estimates of the price impact of a change in yield can be improved by including **convexity**, a measure of the curvature of the price-yield relation. A bond's convexity can be estimated as:

$$\text{approximate convexity} = \frac{V_- + V_+ - 2V_0}{(\Delta\text{YTM})^2 \times V_0}$$

Effective convexity, like effective duration, must be used for bonds with embedded options.

$$\text{effective convexity} = \frac{V_- + V_+ - 2V_0}{(\Delta\text{curve})^2 \times V_0}$$

The estimated price change including the convexity adjustment is:

$$\text{change in full bond price} = -(\text{annual modified duration})(\Delta\text{YTM}) + (1/2)(\text{annual convexity})(\Delta\text{YTM})^2$$

While the convexity of any option-free bond is positive, the convexity of a callable bond can be negative at low yields. The call price puts an effective limit on increases in bond value because at low yields the bond is likely to be called. For a bond with negative convexity, the price increase from a decrease in YTM is smaller than the price decrease from an increase in YTM.

Bondholders prefer greater convexity, other things equal. A bond with greater convexity is more price-sensitive to decreases in YTM, and less price-sensitive to increases in YTM, than a bond with less convexity. That is, with greater convexity a bond's price will increase more, and decrease less, in response to a given change in YTM.

In calculating duration and convexity, we implicitly assume the yield curve shifts in a parallel manner. In practice, this is often not the case. A shorter term bond can have more price volatility than a longer term bond with a greater duration if the volatility of the shorter term yield is greater. The *term structure of yield volatility* refers to the relation between the volatility of bond yields and their times to maturity.

Fundamentals of Credit Analysis

Cross-Reference to CFA Institute Assigned Reading #56

Credit risk refers to potential losses from the failure of a borrower to make promised payments and has two components: default risk and loss severity. **Default risk** is the probability that a borrower will fail to pay interest or principal when due. **Loss severity** refers to the value (in money or as a percentage) that a bond investor will lose if the issuer defaults.

The **expected loss** is equal to the default risk multiplied by the loss severity. Percentage loss severity is equal to one minus the **recovery rate**, the percentage of a bond's value an investor will receive if the issuer defaults.

Bonds with greater credit risk trade at higher yields than bonds thought to be free of credit risk. The difference in yield between a credit-risky bond and a credit-risk-free bond of similar maturity is called its **yield spread**. Bond prices decrease when their yield spreads increase.

The yield spread also compensates investors for liquidity risk. **Market liquidity risk** is the risk of receiving less than market value when selling bonds and is reflected in their bid-ask spreads. **Downgrade risk** refers to the risk that spreads will increase because the issuer has become less creditworthy so its credit rating is lowered.

The priority of a bond's claim to the issuer's assets and cash flows is referred to as its **seniority ranking**. Secured debt is backed by collateral, while unsecured debt (debentures) is a general claim against the issuer.

The seniority (and recovery rate) rankings for various types of debt securities (highest priority to lowest) are:

1. First lien or first mortgage.
2. Senior secured debt.
3. Junior secured debt.
4. Senior unsecured debt.
5. Senior subordinated debt.
6. Subordinated debt.
7. Junior subordinated debt.

All debt securities in the same category have the same priority and are said to rank **pari passu**. Strict priority of claims is not always applied in practice. In a bankruptcy, the court may approve a reorganization plan that does not strictly conform to the priority of claims.

Credit Ratings

Credit rating agencies assign ratings to corporate issuers based on the creditworthiness of their senior unsecured debt ratings, referred to as **corporate family ratings** (CFR), and to individual debt securities, referred to as **corporate credit ratings** (CCR). Higher ratings indicate a lower expected default rate. **Notching** is the practice of assigning different ratings to bonds of the same issuer.

Figure 2 shows ratings scales used by Standard & Poor's, Moody's, and Fitch. Bonds with ratings of Baa3/BBB– or higher are considered **investment grade**. Bonds rated Ba1/BB+ or lower are considered non-investment grade and are often called **high yield bonds** or **junk bonds**.