

FIXED-INCOME SECURITIES: DEFINING ELEMENTS

Study Session 15

EXAM FOCUS

Here your focus should be on learning the basic characteristics of debt securities and as much of the bond terminology as you can remember. Key items are the coupon structure of bonds and options embedded in bonds: call options, put options, and conversion (to common stock) options.

BOND PRICES, YIELDS, AND RATINGS

There are two important points about fixed-income securities that we will develop further along in the Fixed Income study sessions but may be helpful as you read this topic review.

- The most common type of fixed-income security is a bond that promises to make a series of interest payments in fixed amounts and to repay the principal amount at maturity. When market interest rates (i.e., yields on bonds) *increase*, the value of such bonds *decreases* because the present value of a bond's promised cash flows decreases when a higher discount rate is used.
 - Bonds are rated based on their relative probability of default (failure to make promised payments). Because investors prefer bonds with lower probability of default, bonds with lower credit quality must offer investors higher yields to compensate for the greater probability of default. Other things equal, a decrease in a bond's rating (an increased probability of default) will decrease the price of the bond, thus increasing its yield.
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LOS 51.a: Describe basic features of a fixed-income security.

The features of a fixed-income security include specification of:

- The issuer of the bond.
- The maturity date of the bond.
- The par value (principal value to be repaid).
- Coupon rate and frequency.
- Currency in which payments will be made.

Issuers of Bonds

There are several types of entities that issue bonds when they borrow money, including:

- **Corporations.** Often corporate bonds are divided into those issued by financial companies and those issued by nonfinancial companies.
- **Sovereign national governments.** A prime example is U.S. Treasury bonds, but many countries issue sovereign bonds.
- **Nonsovereign governments.** Issued by government entities that are not national governments, such as the state of California or the city of Toronto.
- **Quasi-government entities.** Not a direct obligation of a country's government or central bank. An example is the Federal National Mortgage Association (Fannie Mae).
- **Supranational entities.** Issued by organizations that operate globally such as the World Bank, the European Investment Bank, and the International Monetary Fund (IMF).

Bond Maturity

The maturity date of a bond is the date on which the principal is to be repaid. Once a bond has been issued, the time remaining until maturity is referred to as the **term to maturity** or **tenor** of a bond.

When bonds are issued, their terms to maturity range from one day to 30 years or more. Both Disney and Coca-Cola have issued bonds with original maturities of 100 years. Bonds that have no maturity date are called **perpetual bonds**. They make periodic interest payments but do not promise to repay the principal amount.

Bonds with original maturities of one year or less are referred to as **money market securities**. Bonds with original maturities of more than one year are referred to as **capital market securities**.

Par Value

The **par value** of a bond is the **principal amount** that will be repaid at maturity. The par value is also referred to as the *face value*, *maturity value*, *redemption value*, or *principal value* of a bond. Bonds can have a par value of any amount, and their prices are quoted as a percentage of par. A bond with a par value of \$1,000 quoted at 98 is selling for \$980.

A bond that is selling for more than its par value is said to be trading at a **premium** to par; a bond that is selling at less than its par value is said to be trading at a **discount** to par; and a bond that is selling for exactly its par value is said to be trading **at par**.

Coupon Payments

The coupon rate on a bond is the annual percentage of its par value that will be paid to bondholders. Some bonds make coupon interest payments annually, while others make semiannual, quarterly, or monthly payments. A \$1,000 par value semiannual-pay bond

with a 5% coupon would pay 2.5% of \$1,000, or \$25, every six months. A bond with a fixed coupon rate is called a **plain vanilla bond** or a **conventional bond**.

Some bonds pay no interest prior to maturity and are called **zero-coupon bonds** or **pure discount bonds**. *Pure discount* refers to the fact that these bonds are sold at a discount to their par value and the interest is all paid at maturity when bondholders receive the par value. A 10-year, \$1,000, zero-coupon bond yielding 7% would sell at about \$500 initially and pay \$1,000 at maturity. We discuss various other coupon structures later in this topic review.

Currencies

Bonds are issued in many currencies. Sometimes borrowers from countries with volatile currencies issue bonds denominated in euros or U.S. dollars to make them more attractive to a wide range of investors. A **dual-currency bond** makes coupon interest payments in one currency and the principal repayment at maturity in another currency. A **currency option bond** gives bondholders a choice of which of two currencies they would like to receive their payments in.

LOS 51.b: Describe content of a bond indenture.

LOS 51.c: Compare affirmative and negative covenants and identify examples of each.

The legal contract between the bond issuer (borrower) and bondholders (lenders) is called a **trust deed**, and in the United States and Canada, it is also often referred to as the **bond indenture**. The indenture defines the obligations of and restrictions on the borrower and forms the basis for all future transactions between the bondholder and the issuer.

The provisions in the bond indenture are known as *covenants* and include both *negative covenants* (prohibitions on the borrower) and *affirmative covenants* (actions the borrower promises to perform).

Negative covenants include restrictions on asset sales (the company can't sell assets that have been pledged as collateral), negative pledge of collateral (the company can't claim that the same assets back several debt issues simultaneously), and restrictions on additional borrowings (the company can't borrow additional money unless certain financial conditions are met).

Negative covenants serve to protect the interests of bondholders and prevent the issuing firm from taking actions that would increase the risk of default. At the same time, the covenants must not be so restrictive that they prevent the firm from taking advantage of opportunities that arise or responding appropriately to changing business circumstances.

Affirmative covenants do not typically restrict the operating decisions of the issuer. Common affirmative covenants are to make timely interest and principal payments to bondholders, to insure and maintain assets, and to comply with applicable laws and regulations.

LOS 51.d: Describe how legal, regulatory, and tax considerations affect the issuance and trading of fixed-income securities.

Bonds are subject to different legal and regulatory requirements depending on where they are issued and traded. Bonds issued by a firm domiciled in a country and also traded in that country's currency are referred to as **domestic bonds**. Bonds issued by a firm incorporated in a foreign country that trade on the **national bond market** of another country in that country's currency are referred to as **foreign bonds**. Examples include bonds issued by foreign firms that trade in China and are denominated in yuan, which are called *panda bonds*; and bonds issued by firms incorporated outside the United States that trade in the United States and are denominated in U.S. dollars, which are called *Yankee bonds*.

Eurobonds are issued outside the jurisdiction of any one country and denominated in a currency different from the currency of the countries in which they are sold. They are subject to less regulation than domestic bonds in most jurisdictions and were initially introduced to avoid U.S. regulations. Eurobonds should not be confused with bonds denominated in euros or thought to originate in Europe, although they can be both. Eurobonds got the "euro" name because they were first introduced in Europe, and most are still traded by firms in European capitals. A bond issued by a Chinese firm that is denominated in yen and traded in markets outside Japan would fit the definition of a Eurobond. Eurobonds that trade in the national bond market of a country other than the country that issues the currency the bond is denominated in, and in the Eurobond market, are referred to as **global bonds**.

Eurobonds are referred to by the currency they are denominated in. Eurodollar bonds are denominated in U.S. dollars, and euroyen bonds are denominated in yen. The majority of Eurobonds are issued in **bearer** form. Ownership of bearer bonds is evidenced simply by possessing the bonds, whereas ownership of **registered bonds** is recorded. Bearer bonds may be more attractive than registered bonds to those seeking to avoid taxes.

Other legal and regulatory issues addressed in a trust deed include:

- Legal information about the entity issuing the bond.
- Any assets (collateral) pledged to support repayment of the bond.
- Any additional features that increase the probability of repayment (credit enhancements).
- Covenants describing any actions the firm must take and any actions the firm is prohibited from taking.

Issuing Entities

Bonds are issued by several types of legal entities, and bondholders must be aware of which entity has actually promised to make the interest and principal payments. Sovereign bonds are most often issued by the treasury of the issuing country.

Corporate bonds may be issued by a well-known corporation such as Microsoft, by a subsidiary of a company, or by a holding company that is the overall owner of several operating companies. Bondholders must pay attention to the specific entity issuing the bonds because the credit quality can differ among related entities.

Sometimes an entity is created solely for the purpose of owning specific assets and issuing bonds to provide the funds to purchase the assets. These entities are referred to as **special purpose entities** (SPEs) in the United States and special purpose vehicles (SPVs) in Europe. Bonds issued by these entities are called **securitized bonds**. As an example, a firm could sell loans it has made to customers to an SPE that issues bonds to purchase the loans. The interest and principal payments on the loans are then used to make the interest and principal payments on the bonds.

Often, an SPE can issue bonds at a lower interest rate than bonds issued by the originating corporation. This is because the assets supporting the bonds are owned by the SPE and are used to make the payments to holders of the securitized bonds even if the company itself runs into financial trouble. For this reason, SPEs are called **bankruptcy remote vehicles** or entities.

Sources of Repayment

Sovereign bonds are typically repaid by the tax receipts of the issuing country. Bonds issued by nonsovereign government entities are repaid by either general taxes, revenues of a specific project (e.g., an airport), or by special taxes or fees dedicated to bond repayment (e.g., a water district or sewer district).

Corporate bonds are generally repaid from cash generated by the firm's operations. As noted previously, securitized bonds are repaid from the cash flows of the financial assets owned by the SPE.

Collateral and Credit Enhancements

Unsecured bonds represent a claim to the overall assets and cash flows of the issuer. **Secured bonds** are backed by a claim to specific assets of a corporation, which reduces their risk of default and, consequently, the yield that investors require on the bonds. Assets pledged to support a bond issue (or any loan) are referred to as **collateral**.

Because they are backed by collateral, secured bonds are *senior* to unsecured bonds. Among unsecured bonds, two different issues may have different priority in the event of bankruptcy or liquidation of the issuing entity. The claim of senior unsecured debt is below (after) that of secured debt but ahead of *subordinated*, or junior, debt.

Sometimes secured debt is referred to by the type of collateral pledged. **Equipment trust certificates** are debt securities backed by equipment such as railroad cars and oil drilling rigs. **Collateral trust bonds** are backed by financial assets, such as stocks and (other) bonds. Be aware that while the term **debentures** refers to unsecured debt in the United States and elsewhere, in Great Britain and some other countries the term refers to bonds collateralized by specific assets.

The most common type of securitized bond is a **mortgage-backed security (MBS)**. The underlying assets are a pool of mortgages, and the interest and principal payments from the mortgages are used to pay the interest and principal on the MBS.

In some countries, especially European countries, financial companies issue **covered bonds**. Covered bonds are similar to asset-backed securities, but the underlying assets (the cover pool), although segregated, remain on the balance sheet of the issuing corporation (i.e., no SPE is created). Special legislation protects the assets in the cover pool in the event of firm insolvency (they are bankruptcy remote). In contrast to an SPE structure, covered bonds also provide recourse to the issuing firm that must replace or augment non-performing assets in the cover pool so that it always provides for the payment of the covered bond's promised interest and principal payments.

Credit enhancement can be either internal (built into the structure of a bond issue) or external (provided by a third party). One method of internal credit enhancement is *overcollateralization*, in which the collateral pledged has a value greater than the par value of the debt issued. One limitation of this method of credit enhancement is that the additional collateral is also the underlying assets, so when asset defaults are high, the value of the excess collateral declines in value.

Two other methods of internal credit enhancement are a *cash reserve fund* and an *excess spread account*. A cash reserve fund is cash set aside to make up for credit losses on the underlying assets. With an excess spread account, the yield promised on the bonds issued is less than the promised yield on the assets supporting the ABS. This gives some protection if the yield on the financial assets is less than anticipated. If the assets perform as anticipated, the excess cash flow from the collateral can be used to retire (pay off the principal on) some of the outstanding bonds.

Another method of internal credit enhancement is to divide a bond issue into *tranches* (French for slices) with different seniority of claims. Any losses due to poor performance of the assets supporting a securitized bond are first absorbed by the bonds with the lowest seniority, then the bonds with the next-lowest priority of claims. The most senior tranches in this structure can receive very high credit ratings because the probability is very low that losses will be so large that they cannot be absorbed by the subordinated tranches. The subordinated tranches must have higher yields to compensate investors for the additional risk of default. This is sometimes referred to as *waterfall structure* because available funds first go to the most senior tranche of bonds, then to the next-highest priority bonds, and so forth.

External credit enhancements include surety bonds, bank guarantees, and letters of credit from financial institutions. *Surety bonds* are issued by insurance companies and are a promise to make up any shortfall in the cash available to service the debt. *Bank guarantees* serve the same function. A *letter of credit* is a promise to lend money to the

issuing entity if it does not have enough cash to make the promised payments on the covered debt. While all three of these external credit enhancements increase the credit quality of debt issues and decrease their yields, deterioration of the credit quality of the guarantor will also reduce the credit quality of the covered issue.

Taxation of Bond Income

Most often, the interest income paid to bondholders is taxed as ordinary income at the same rate as wage and salary income. The interest income from bonds issued by municipal governments in the United States, however, is most often exempt from national income tax and often from any state income tax in the state of issue.

When a bondholder sells a coupon bond prior to maturity, it may be at a gain or a loss relative to its purchase price. Such gains and losses are considered capital gains income (rather than ordinary taxable income). Capital gains are often taxed at a lower rate than ordinary income. Capital gains on the sale of an asset that has been owned for more than some minimum amount of time may be classified as *long-term* capital gains and 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. Because the gains over an OID bond's tenor as the price moves towards par value are really interest income, these bonds can generate a tax liability even when no cash interest payment has been made. In many tax jurisdictions, a portion of the discount from par at issuance is treated as taxable interest income each year. This tax treatment also allows that the tax basis of the OID bonds is increased each year by the amount of interest income recognized, so there is no additional capital gains tax liability at maturity.

Some tax jurisdictions provide a symmetric treatment for bonds issued at a premium to par, allowing part of the premium to be used to reduce the taxable portion of coupon interest payments.

LOS 51.e: Describe how cash flows of fixed-income securities are structured.

A typical bond has a **bullet** structure. Periodic interest payments (coupon payments) are made over the life of the bond, and the principal value is paid with the final interest payment at maturity. The interest payments are referred to as the bond's **coupons**. When the final payment includes a lump sum in addition to the final period's interest, it is referred to as a **balloon payment**.

Consider a \$1,000 face value 5-year bond with an annual coupon rate of 5%. With a bullet structure, the bond's promised payments at the end of each year would be as follows.

<i>Year</i>	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>
PMT	\$50	\$50	\$50	\$50	\$1,050
Principal Remaining	\$1,000	\$1,000	\$1,000	\$1,000	\$0

A loan structure in which the periodic payments include both interest and some repayment of principal (the amount borrowed) is called an **amortizing loan**. If a bond (loan) is **fully amortizing**, this means the principal is fully paid off when the last periodic payment is made. Typically, automobile loans and home loans are fully amortizing loans. If the 5-year, 5% bond in the previous table had a fully amortizing structure rather than a bullet structure, the payments and remaining principal balance at each year-end would be as follows (final payment reflects rounding of previous payments).

<i>Year</i>	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>
PMT	\$230.97	\$230.97	\$230.97	\$230.97	\$230.98
Principal Remaining	\$819.03	\$629.01	\$429.49	\$219.99	\$0

A bond can also be structured to be **partially amortizing** so that there is a balloon payment at bond maturity, just as with a bullet structure. However, unlike a bullet structure, the final payment includes just the remaining unamortized principal amount rather than the full principal amount. In the following table, the final payment includes \$200 to repay the remaining principal outstanding.

<i>Year</i>	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>
PMT	\$194.78	\$194.78	\$194.78	\$194.78	\$394.78
Principal Remaining	\$855.22	\$703.20	\$543.58	\$375.98	\$0

Sinking fund provisions provide for the repayment of principal through a series of payments over the life of the issue. For example, a 20-year issue with a face amount of \$300 million may require that the issuer retire \$20 million of the principal every year beginning in the sixth year.

Details of sinking fund provisions vary. There may be a period during which no sinking fund redemptions are made. The amount of bonds redeemed according to the sinking fund provision could decline each year or increase each year. Some bond indentures allow the company to redeem twice the amount required by the sinking fund provision, which is called a *doubling option* or an *accelerated sinking fund*.

The price at which bonds are redeemed under a sinking fund provision is typically par but can be different from par. If the market price is less than the sinking fund redemption price, the issuer can satisfy the sinking fund provision by buying bonds in the open market with a par value equal to the amount of bonds that must be redeemed. This would be the case if interest rates had risen since issuance so that the bonds were trading below the sinking fund redemption price.

Sinking fund provisions offer both advantages and disadvantages to bondholders. On the plus side, bonds with a sinking fund provision have less credit risk because the periodic redemptions reduce the total amount of principal to be repaid at maturity. The presence of a sinking fund, however, can be a disadvantage to bondholders when interest rates fall.

This disadvantage to bondholders can be seen by considering the case where interest rates have fallen since bond issuance, so the bonds are trading at a price above the sinking fund redemption price. In this case, the bond trustee will select outstanding bonds for redemption randomly. A bondholder would suffer a loss if her bonds were selected to be redeemed at a price below the current market price. This means the bonds have more *reinvestment risk* because bondholders who have their bonds redeemed can only reinvest the funds at the new, lower yield (assuming they buy bonds of similar risk).



Professor's Note: The concept of reinvestment risk is developed more in subsequent topic reviews. It can be defined as the uncertainty about the interest to be earned on cash flows from a bond that are reinvested in other debt securities. In the case of a bond with a sinking fund, the greater probability of receiving the principal repayment prior to maturity increases the expected cash flows during the bond's life and, therefore, the uncertainty about interest income on reinvested funds.

There are several coupon structures besides a fixed-coupon structure, and we summarize the most important ones here.

Floating-Rate Notes

Some bonds pay periodic interest that depends on a current market rate of interest. These bonds are called **floating-rate notes** (FRN) or **floaters**. The market rate of interest is called the **reference rate**, and an FRN promises to pay the reference rate plus some interest margin. This added margin is typically expressed in **basis points**, which are hundredths of 1%. A 120 basis point margin is equivalent to 1.2%.

As an example, consider a floating-rate note that pays the London Interbank Offer Rate (Libor) plus a margin of 0.75% (75 basis points) annually. If 1-year Libor is 2.3% at the beginning of the year, the bond will pay $2.3\% + 0.75\% = 3.05\%$ of its par value at the end of the year. The new 1-year rate at that time will determine the rate of interest paid at the end of the next year. Most floaters pay quarterly and are based on a quarterly (90-day) reference rate. A **variable-rate note** is one for which the margin above the reference rate is not fixed.

A floating-rate note 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 **inverse floater** has a coupon rate that increases when the reference rate decreases and decreases when the reference rate increases.

OTHER COUPON STRUCTURES

Step-up coupon bonds are structured so that the coupon rate increases over time according to a predetermined schedule. Typically, step-up coupon bonds have a *call feature* that allows the firm to redeem the bond issue at a set price at each step-up date. If the new higher coupon rate is greater than what the market yield would be at the call price, the firm will call the bonds and retire them. This means if market yields rise, a bondholder may, in turn, get a higher coupon rate because the bonds are less likely to be called on the step-up date.

Yields could increase because an issuer's credit rating has fallen, in which case the higher step-up coupon rate simply compensates investors for greater credit risk. Aside from this, we can view step-up coupon bonds as having some protection against increases in market interest rates to the extent they are offset by increases in bond coupon rates.

A **credit-linked coupon bond** carries a provision stating that the coupon rate will go up by a certain amount if the credit rating of the issuer falls and go down if the credit rating of the issuer improves. While this offers some protection against a credit downgrade of the issuer, the higher required coupon payments may make the financial situation of the issuer worse and possibly increase the probability of default.

A **payment-in-kind (PIK) bond** allows the issuer to make the coupon payments by increasing the principal amount of the outstanding bonds, essentially paying bond interest with more bonds. Firms that issue PIK bonds typically do so because they anticipate that firm cash flows may be less than required to service the debt, often because of high levels of debt financing (leverage). These bonds typically have higher yields because of a lower perceived credit quality from cash flow shortfalls or simply because of the high leverage of the issuing firm.

With a **deferred coupon bond**, also called a **split coupon bond**, regular coupon payments do not begin until a period of time after issuance. These are issued by firms that anticipate cash flows will increase in the future to allow them to make coupon interest payments.

Deferred coupon bonds may be appropriate financing for a firm financing a large project that will not be completed and generating revenue for some period of time after bond issuance. Deferred coupon bonds may offer bondholders tax advantages in some jurisdictions. Zero-coupon bonds can be considered a type of deferred coupon bond.

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. **Inflation-linked bonds** (also called **linkers**) are the most common type of index-linked bonds. Their payments are based on the change in an inflation index, such as the Consumer Price Index (CPI) in the United States. Indexed bonds that will not pay less than their original par value at maturity, even when the index has decreased, are termed **principal protected bonds**.

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).

To better understand the structure of capital-indexed bonds, consider a bond with a par value of \$1,000 at issuance, a 3% annual coupon rate paid semiannually, and a provision that the principal value will be adjusted for inflation (or deflation). If six months after issuance the reported inflation has been 1% over the period, the principal value of the bonds is increased by 1% from \$1,000 to \$1,010, and the six-month coupon of 1.5% is calculated as 1.5% of the new (adjusted) principal value of \$1,010 (i.e., $1,010 \times 1.5\% = \$15.15$).

With this structure we can view the coupon rate of 3% as a real rate of interest. Unexpected inflation will not decrease the purchasing power of the coupon interest payments, and the principal value paid at maturity will have approximately the same purchasing power as the \$1,000 par value did at bond issuance.

LOS 51.f: Describe contingency provisions affecting the timing and/or nature of cash flows of fixed-income securities and identify whether such provisions benefit the borrower or the lender.

A **contingency provision** in a contract describes an action that may be taken if an event (the contingency) actually occurs. Contingency provisions in bond indentures are referred to as **embedded options**, embedded in the sense that they are an integral part of the bond contract and are not a separate security. Some embedded options are exercisable at the option of the issuer of the bond and, therefore, are valuable to the issuer; others are exercisable at the option of the purchaser of the bond and, thus, have value to the bondholder.

Bonds that do not have contingency provisions are referred to as **straight** or **option-free** bonds.

A **call option** gives the *issuer* the right to redeem all or part of a bond issue at a specific price (call price) if they choose to. As an example of a call provision, consider a 6% 20-year bond issued at par on June 1, 2012, for which the indenture includes the following *call schedule*:

- The bonds can be redeemed by the issuer at 102% of par after June 1, 2017.
- The bonds can be redeemed by the issuer at 101% of par after June 1, 2020.
- The bonds can be redeemed by the issuer at 100% of par after June 1, 2022.

For the 5-year period from the issue date until June 2017, the bond is not callable. We say the bond has five years of *call protection*, or that the bond is *call protected* for five years. This 5-year period is also referred to as a *lockout period*, a *cushion*, or a *deferment period*.

June 1, 2017, is referred to as the *first call date*, and the *call price* is 102 (102% of par value) between that date and June 2020. The amount by which the call price is above par is referred to as the *call premium*. The call premium at the first call date in this example is 2%, or \$20 per \$1,000 bond. The call price declines to 101 (101% of par) after June 1, 2020. After, June 1, 2022, the bond is callable at par, and that date is referred to as the *first par call date*.

For a bond that is currently callable, the call price puts an upper limit on the value of the bond in the market.

A call option has value to the issuer because it gives the issuer the right to redeem the bond and issue a new bond (borrow) if the market yield on the bond declines. This could occur either because interest rates in general have decreased or because the credit quality of the bond has increased (default risk has decreased).

Consider a situation where the market yield on the previously discussed 6% 20-year bond has declined from 6% at issuance to 4% on June 1, 2017 (the first call date). If the bond did not have a call option, it would trade at approximately \$1,224. With a call price of 102, the issuer can redeem the bonds at \$1,020 each and borrow that amount at the current market yield of 4%, reducing the annual interest payment from \$60 per bond to \$40.80.



Professor's Note: This is analogous to refinancing a home mortgage when mortgage rates fall in order to reduce the monthly payments.

The issuer will only choose to exercise the call option when it is to their advantage to do so. That is, they can reduce their interest expense by calling the bond and issuing new bonds at a lower yield. Bond buyers are disadvantaged by the call provision and have more reinvestment risk because their bonds will only be called (redeemed prior to maturity) when the proceeds can be reinvested only at a lower yield. For this reason, a callable bond must offer a higher yield (sell at a lower price) than an otherwise identical noncallable bond. The difference in price between a callable bond and an otherwise identical noncallable bond is equal to the value of the call option to the issuer.

There are three *styles of exercise* for callable bonds:

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.

Note that these are only style names and are not indicative of where the bonds are issued.

To avoid the higher interest rates required on callable bonds but still preserve the option to redeem bonds early when corporate or operating events require it, issuers 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.

With a make-whole call provision, the calculated call price is unlikely to be lower than the market value of the bond. Therefore the issuer is unlikely to call the bond except when corporate circumstances, such as an acquisition or restructuring, require it. The make-whole provision does not put an upper limit on bond values when interest rates fall as does a regular call provision. The make-whole provision actually penalizes the issuer for calling the bond. The net effect is that the bond can be called if necessary, but it can also be issued at a lower yield than a bond with a traditional call provision.

Puttable Bonds

A **put option** gives the *bondholder* the right to sell the bond back to the issuing company at a prespecified price, typically par. Bondholders are likely to exercise such 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. Exercise styles used are similar to those we enumerated for callable bonds.

Unlike a call option, a put option has value to the bondholder because the choice of whether to exercise the option is the bondholder's. For this reason, a puttable bond will sell at a higher price (offer a lower yield) compared to an otherwise identical option-free bond.

Convertible Bonds

Convertible bonds, typically issued with maturities of 5-10 years, give bondholders the option to exchange the bond for a specific number of shares of the issuing corporation's common stock. This gives bondholders the opportunity to profit from increases in the value of the common shares. Regardless of the price of the common shares, the value of a convertible bond will be at least equal to its bond value without the conversion option. Because the conversion option is valuable to bondholders, convertible bonds can be issued with lower yields compared to otherwise identical straight bonds.

Essentially, the owner of a convertible bond has the downside protection (compared to equity shares) of a bond, but at a reduced yield, and the upside opportunity of equity shares. For this reason convertible bonds are often referred to as a *hybrid security*, part debt and part equity.

To issuers, the advantages of issuing convertible bonds are a lower yield (interest cost) compared to straight bonds and the fact that debt financing is converted to equity financing when the bonds are converted to common shares. Some terms related to convertible bonds are:

- **Conversion price.** The price per share at which the bond (at its par value) may be converted to common stock.
- **Conversion ratio.** Equal to the par value of the bond divided by the conversion price. If a bond with a \$1,000 par value has a conversion price of \$40, its *conversion ratio* is $1,000/40 = 25$ shares per bond.

- **Conversion value.** This is the market value of the shares that would be received upon conversion. A bond with a conversion ratio of 25 shares when the current market price of a common share is \$50 would have a conversion value of $25 \times 50 = \$1,250$.

Even if the share price increases to a level where the conversion value is significantly above the bond's par value, bondholders might not convert the bonds to common stock until they must because the interest yield on the bonds is higher than the dividend yield on the common shares received through conversion. For this reason, many convertible bonds have a call provision. Because the call price will be less than the conversion value of the shares, by exercising their call provision, the issuers can force bondholders to exercise their conversion option when the conversion value is significantly above the par value of the bonds.

Warrants

An alternative way to give bondholders an opportunity for additional returns when the firm's common shares increase in value is to include **warrants** with straight bonds when they are issued. Warrants give their holders the right to buy the firm's common shares at a given price over a given period of time. As an example, warrants that give their holders the right to buy shares for \$40 will provide profits if the common shares increase in value above \$40 prior to expiration of the warrants. For a young firm, issuing debt can be difficult because the downside (probability of firm failure) is significant, and the upside is limited to the promised debt payments. Including warrants, which are sometimes referred to as a "sweetener," makes the debt more attractive to investors because it adds potential upside profits if the common shares increase in value.

Contingent Convertible Bonds

Contingent convertible bonds (referred to as "CoCos") are bonds that convert from debt to common equity automatically if a specific event occurs. This type of bond has been issued by some European banks. Banks must maintain specific levels of equity financing. If a bank's equity falls below the required level, they must somehow raise more equity financing to comply with regulations. CoCos are often structured so that if the bank's equity capital falls below a given level, they are automatically converted to common stock. This has the effect of decreasing the bank's debt liabilities and increasing its equity capital at the same time, which helps the bank to meet its minimum equity requirement.

KEY CONCEPTS

LOS 51.a

Basic features of a fixed income security include the issuer, maturity date, par value, coupon rate, coupon frequency, and currency.

- Issuers include corporations, governments, quasi-government entities, and supranational entities.
- Bonds with original maturities of one year or less are money market securities. Bonds with original maturities of more than one year are capital market securities.
- Par value is the principal amount that will be repaid to bondholders at maturity. Bonds are trading at a premium if their market price is greater than par value or trading at a discount if their price is less than par value.
- Coupon rate is the percentage of par value that is paid annually as interest. Coupon frequency may be annual, semiannual, quarterly, or monthly. Zero-coupon bonds pay no coupon interest and are pure discount securities.
- Bonds may be issued in a single currency, dual currencies (one currency for interest and another for principal), or with a bondholder's choice of currency.

LOS 51.b

A bond indenture or trust deed is a contract between a bond issuer and the bondholders, which defines the bond's features and the issuer's obligations. An indenture specifies the entity issuing the bond, the source of funds for repayment, assets pledged as collateral, credit enhancements, and any covenants with which the issuer must comply.

LOS 51.c

Covenants are provisions of a bond indenture that protect the bondholders' interests. Negative covenants are restrictions on a bond issuer's operating decisions, such as prohibiting the issuer from issuing additional debt or selling the assets pledged as collateral. Affirmative covenants are administrative actions the issuer must perform, such as making the interest and principal payments on time.

LOS 51.d

Legal and regulatory matters that affect fixed income securities include the places where they are issued and traded, the issuing entities, sources of repayment, and collateral and credit enhancements.

- Domestic bonds trade in the issuer's home country and currency. Foreign bonds are from foreign issuers but denominated in the currency of the country where they trade. Eurobonds are issued outside the jurisdiction of any single country and denominated in a currency other than that of the countries in which they trade.
- Issuing entities may be a government or agency; a corporation, holding company, or subsidiary; or a special purpose entity.
- The source of repayment for sovereign bonds is the country's taxing authority. For non-sovereign government bonds, the sources may be taxing authority or revenues from a project. Corporate bonds are repaid with funds from the firm's operations. Securitized bonds are repaid with cash flows from a pool of financial assets.

- Bonds are secured if they are backed by specific collateral or unsecured if they represent an overall claim against the issuer's cash flows and assets.
- Credit enhancement may be internal (overcollateralization, excess spread, tranches with different priority of claims) or external (surety bonds, bank guarantees, letters of credit).

Interest income is typically taxed at the same rate as ordinary income, while gains or losses from selling a bond are taxed at the capital gains tax rate. However, the increase in value toward par of original issue discount bonds is considered interest income. In the United States, interest income from municipal bonds is usually tax-exempt at the national level and in the issuer's state.

LOS 51.e

A bond with a bullet structure pays coupon interest periodically and repays the entire principal value at maturity.

A bond with an amortizing structure repays part of its principal at each payment date. A fully amortizing structure makes equal payments throughout the bond's life. A partially amortizing structure has a balloon payment at maturity, which repays the remaining principal as a lump sum.

A sinking fund provision requires the issuer to retire a portion of a bond issue at specified times during the bonds' life.

Floating-rate notes have coupon rates that adjust based on a reference rate such as Libor.

Other coupon structures include step-up coupon notes, credit-linked coupon bonds, payment-in-kind bonds, deferred coupon bonds, and index-linked bonds.

LOS 51.f

Embedded options benefit the party who has the right to exercise them. Call options benefit the issuer, while put options and conversion options benefit the bondholder.

Call options allow the issuer to redeem bonds at a specified call price.

Put options allow the bondholder to sell bonds back to the issuer at a specified put price.

Conversion options allow the bondholder to exchange bonds for a specified number of shares of the issuer's common stock.

CONCEPT CHECKERS

1. A bond's indenture:
 - A. contains its covenants.
 - B. is the same as a debenture.
 - C. relates only to its interest and principal payments.
2. A dual-currency bond pays coupon interest in a currency:
 - A. of the bondholder's choice.
 - B. other than the home currency of the issuer.
 - C. other than the currency in which it repays principal.
3. Which of the following bond covenants is *most accurately* described as an affirmative covenant? The bond issuer must not:
 - A. violate laws or regulations.
 - B. sell assets pledged as collateral.
 - C. issue more debt with the same or higher seniority.
4. An investor buys a pure-discount bond, holds it to maturity, and receives its par value. For tax purposes, the increase in the bond's value is *most likely* to be treated as:
 - A. a capital gain.
 - B. interest income.
 - C. tax-exempt income.
5. A 10-year bond pays no interest for three years, then pays \$229.25, followed by payments of \$35 semiannually for seven years, and an additional \$1,000 at maturity. This bond is a:
 - A. step-up bond.
 - B. zero-coupon bond.
 - C. deferred-coupon bond.
6. Which of the following statements is *most accurate* with regard to floating-rate issues that have caps and floors?
 - A. A cap is an advantage to the bondholder, while a floor is an advantage to the issuer.
 - B. A floor is an advantage to the bondholder, while a cap is an advantage to the issuer.
 - C. A floor is an advantage to both the issuer and the bondholder, while a cap is a disadvantage to both the issuer and the bondholder.
7. Which of the following *most accurately* describes the maximum price for a currently callable bond?
 - A. Its par value.
 - B. The call price.
 - C. The present value of its par value.

For more questions related to this topic review, log in to your Schweser online account and launch SchweserPro™ QBank; and for video instruction covering each LOS in this topic review, log in to your Schweser online account and launch the OnDemand video lectures, if you have purchased these products.

ANSWERS – CONCEPT CHECKERS

1. **A** An indenture is the contract between the company and its bondholders and contains the bond's covenants.
2. **C** Dual-currency bonds pay coupon interest in one currency and principal in a different currency. These currencies may or may not include the home currency of the issuer. A currency option bond allows the bondholder to choose a currency in which to be paid.
3. **A** Requiring the issuer to comply with all laws and regulations is an example of an affirmative covenant. Negative covenants are restrictions on actions a bond issuer can take. Examples include preventing an issuer from selling assets that have been pledged as collateral or from issuing additional debt with an equal or higher priority of claims.
4. **B** Tax authorities typically treat the increase in value of a pure-discount bond toward par as interest income to the bondholder. In many jurisdictions this interest income is taxed periodically during the life of the bond even though the bondholder does not receive any cash until maturity.
5. **C** This pattern describes a deferred-coupon bond. The first payment of \$229.25 is the value of the accrued coupon payments for the first three years.
6. **B** A cap is a maximum on the coupon rate and is advantageous to the issuer. A floor is a minimum on the coupon rate and is, therefore, advantageous to the bondholder.
7. **B** Whenever the price of the bond increases above the strike price stipulated on the call option, it will be optimal for the issuer to call the bond. Theoretically, the price of a currently callable bond should never rise above its call price.

FIXED-INCOME MARKETS: ISSUANCE, TRADING, AND FUNDING

Study Session 15

EXAM FOCUS

This topic review introduces many terms and definitions. Focus on different types of issuers, features of the various debt security structures, and why different sources of funds have different interest costs. Understand well the differences between fixed-rate and floating-rate debt and how rates are determined on floating-rate debt and for repurchase agreements.

LOS 52.a: Describe classifications of global fixed-income markets.

Global bond markets can be classified by several bond characteristics, including type of issuer, credit quality, maturity, coupon, currency, geography, indexing, and taxable status.

Type of issuer. Common classifications are government and government related bonds, corporate bonds, and structured finance (securitized bonds). Corporate bonds are often further classified as issues from financial corporations and issues from nonfinancial corporations. The largest issuers by total value of bonds outstanding in global markets are financial corporations and governments.

Credit quality. Standard & Poor's (S&P), Moody's, and Fitch all provide credit ratings on bonds. For S&P and Fitch, the highest bond ratings are AAA, AA, A, and BBB, and are considered *investment grade bonds*. The equivalent ratings by Moody's are Aaa through Baa3. Bonds BB+ or lower (Ba1 or lower) are termed high-yield, speculative, or "junk" bonds. Some institutions are prohibited from investing in bonds of less than investment grade.

Original maturities. Securities with original maturities of one year or less are classified as **money market securities**. Examples include U.S. Treasury bills, commercial paper (issued by corporations), and negotiable certificates of deposit, or CDs (issued by banks). Securities with original maturities greater than one year are referred to as **capital market securities**.

Coupon structure. Bonds are classified as either floating-rate or fixed-rate bonds, depending on whether their coupon interest payments are stated in the bond indenture or depend on the level of a short-term market *reference rate* determined over the life of the bond. Purchasing floating-rate debt is attractive to some institutions that have

variable-rate sources of funds (liabilities), such as banks. This allows these institutions to avoid the balance sheet effects of interest rate increases that would increase the cost of funds but leave the interest income at a fixed rate. The value of fixed-rate bonds (assets) held would fall in the value, while the value of their liabilities would be much less affected.

Currency denomination. A bond's price and returns are determined by the interest rates in the bond's currency. The majority of bonds issued are denominated in either U.S. dollars or euros.

Geography. Bonds may be classified by the markets in which they are issued. Recall the discussion in the previous topic review of domestic (or national) bond markets, foreign bonds, and eurobonds, and the differences among them. Bond markets may also be classified as **developed markets** or **emerging markets**. Emerging markets are countries whose capital markets are less well-established than those in developed markets. Emerging market bonds are typically viewed as riskier than developed market bonds and therefore, have higher yields.

Indexing. As discussed previously, the cash flows on some bonds are based on an index (**index-linked bonds**). Bonds with cash flows determined by inflation rates are referred to as inflation-indexed or inflation-linked bonds. Inflation-linked bonds are issued primarily by governments but also by some corporations of high credit quality.

Tax status. In various countries, some issuers may issue bonds that are exempt from income taxes. In the United States, these bonds can be issued by municipalities and are called **municipal bonds**, or *munis*. Tax exempt bonds are sold with lower yields than taxable bonds of similar risk and maturity, to reflect the impact of taxes on the after-tax yield of taxable bonds.

LOS 52.b: Describe the use of interbank offered rates as reference rates in floating-rate debt.

The most widely used reference rate for floating-rate bonds is the London Interbank Offer 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**. An average is calculated from a survey of 18 banks' expected borrowing rates in the interbank market, after excluding the highest and lowest quotes.

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 6-month euro Libor or 6-month Euribor as a reference rate.

LOS 52.c: Describe mechanisms available for issuing bonds in primary markets.

Sales of newly issued bonds are referred to as **primary market** transactions. Newly issued bonds can be registered with securities regulators for sale to the public, a **public offering**, or sold only to qualified investors, a **private placement**.

A public offering of bonds in the primary market is typically done with the help of an investment bank. The investment bank has expertise in the various steps of a public offering, including:

- Determining funding needs.
- Structuring the debt security.
- Creating the bond indenture.
- Naming a bond trustee (a trust company or bank trust department).
- Registering the issue with securities regulators.
- Assessing demand and pricing the bonds given market conditions.
- Selling the bonds.

Bonds can be sold through an **underwritten offering** or a **best efforts offering**. In an underwritten offering, the entire bond issue is purchased from the issuing firm by the investment bank, termed the underwriter in this case. While smaller bond issues may be sold by a single investment bank, for larger issues, the *lead underwriter* heads a **syndicate** of investment banks who collectively establish the pricing of the issue and are responsible for selling the bonds to dealers, who in turn sell them to investors. The syndicate takes the risk that the bonds will not all be sold.

A new bond issue is publicized and dealers indicate their interest in buying the bonds, which provides information about appropriate pricing. Some bonds are traded on a *when issued* basis in what is called the **grey market**. Such trading prior to the offering date of the bonds provides additional information about the demand for and market clearing price (yield) for the new bond issue.

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 (i.e., underwrite the issue).

Some bonds, especially government bonds, are sold through an auction.



Professor's Note: Recall that auction procedures were explained in detail in the prerequisite readings for Economics.

U.S. Treasury securities are sold through single price auctions with the majority of purchases made by **primary dealers** that participate in purchases and sales of bonds with the Federal Reserve Bank of New York to facilitate the open market operations of the Fed. Individuals can purchase U.S. Treasury securities through the periodic auctions as well, but are a small part of the total.

In a **shelf registration**, a bond issue is registered with securities regulators in its aggregate value with a master prospectus. Bonds can then be issued over time when the issuer needs to raise funds. Because individual offerings under a shelf registration require less disclosure than a separate registration of a bond issue, only financially sound companies are granted this option. In some countries, bonds registered under a shelf registration can be sold only to qualified investors.

LOS 52.d: Describe secondary markets 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. The average spread is often between 10 and 12 basis points but varies across individual bonds according to their liquidity and may be more than 50 basis points for an illiquid issue.¹

Bond trades are cleared through a clearing system, just as equities trades are. Settlement (the exchange of bonds for cash) for government bonds is either the day of the trade (cash settlement) or the next business day (T + 1). Corporate bonds typically settle on T + 2 or T + 3, although in some markets it is longer.

LOS 52.e: Describe securities issued by sovereign governments.

National governments or their treasuries issue bonds backed by the taxing power of the government that are referred to as **sovereign bonds**. Bonds issued in the currency of the issuing government carry high credit ratings and are considered to be essentially free of default risk. Both a sovereign's ability to collect taxes and its ability to print the currency support these high credit ratings.

Sovereign nations also issue bonds denominated in currencies different from their own. Credit ratings are often higher for a sovereign's local currency bonds than for example, its euro or U.S. dollar-denominated bonds. This is because the national government cannot print the developed market currency and the developed market currency value of local currency tax collections is dependent on the exchange rate between the two currencies.

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 and also as **benchmark** bonds because the yields of other bonds are determined relative to the "benchmark" yields of sovereign bonds of similar maturities.

Sovereign governments issue fixed-rate, floating-rate, and inflation-indexed bonds.

¹ Fixed Income Markets: Issuance, Trading, and Funding, Choudhry, M.; Mann, S.; and Whitmer, L.; in CFA Program 2017 Level I Curriculum, Volume 5 (CFA Institute, 2016).

LOS 52.f: Describe securities issued by non-sovereign governments, quasi-government entities, and supranational agencies.

Non-sovereign 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.

Non-sovereign bonds are typically of high credit quality, but sovereign bonds typically trade with lower yields (higher prices) because their credit risk is perceived to be less than that of non-sovereign bonds.



Professor's Note: We will examine the credit quality of sovereign and non-sovereign government bonds in our topic review of "Fundamentals of Credit Analysis."

Agency or quasi-government bonds are issued by entities created by national governments for specific purposes such as financing small businesses or providing mortgage financing. In the United States, bonds are issued by government-sponsored enterprises (GSEs), such as the Federal National Mortgage Association and the Tennessee Valley Authority.

Some quasi-government bonds are backed by the national government, which gives them high credit quality. Even those not backed by the national government typically have high credit quality although their yields are marginally higher than those of sovereign bonds.

Supranational bonds are issued by supranational agencies, also known as *multilateral agencies*. Examples are the World Bank, the IMF, and the Asian Development Bank. Bonds issued by supranational agencies typically have high credit quality and can be very liquid, especially large issues of well-known entities.

LOS 52.g: Describe types of debt issued by corporations.

Bank Debt

Most corporations fund their businesses to some extent with bank loans. These 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** and the group of banks is the syndicate. There is a secondary market in syndicated loan interests that are also securitized, creating bonds that are sold to investors.

Commercial Paper

For larger creditworthy corporations, funding costs can be reduced by issuing short-term debt securities referred to as **commercial paper**. For these firms, the interest cost of commercial paper is less than the interest on a bank loan. Commercial paper yields more than short-term sovereign debt because it has, on average, more credit risk and less liquidity.

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**.

Commercial paper is a short-term, unsecured debt instrument. In the United States, commercial paper is issued with maturities of 270 days or less, because debt securities with maturities of 270 days or less are exempt from SEC registration. Eurocommercial paper (ECP) is issued in several countries with maturities as long as 364 days. Commercial paper is issued with maturities as short as one day (overnight paper), with most issues maturing in about 90 days.

Commercial paper is often reissued or *rolled over* when it matures. The risk that a company will not be able to sell new commercial paper to replace maturing paper is termed *rollover risk*. The two important circumstances in which a company will face rollover difficulties are (1) there is a deterioration in a company's actual or perceived ability to repay the debt at maturity, which will significantly increase the required yield on the paper or lead to less-than-full subscription to a new issue, and (2) significant systemic financial distress, as was experienced in the 2008 financial crisis, that may "freeze" debt markets so that very little commercial paper can be sold at all.

In order to get an acceptable credit rating from the ratings services on their commercial paper, corporations maintain **backup lines of credit** with banks. These are sometimes referred to as *liquidity enhancement* or *backup liquidity lines*. The bank agrees to provide the funds when the paper matures, if needed, except in the case of a *material adverse change* (i.e., when the company's financial situation has deteriorated significantly).

Similar to U.S. T-bills, commercial paper in the United States is typically issued as a pure discount security, making a single payment equal to the face value at maturity. Prices are quoted as a percentage discount from face value. In contrast, ECP rates may be quoted as either a discount yield or an *add-on yield*, that is, the percentage interest paid at maturity in addition to the par value of the commercial paper.



Professor's Note: Recall from Quantitative Methods that a 180-day T-bill quoted at a discount yield of 2% for the 180-day period is priced at \$980 per \$1,000 face value. The effective 180-day return is $1,000 / 980 - 1 = 2.041\%$. For ECP with a 180-day, add-on yield of 2%, the effective return is simply 2%.

Corporate Bonds

In the previous topic review, we discussed several features of corporate bonds. Corporate bonds are issued with various coupon structures and with both fixed-rate and floating-rate coupon payments. They may be secured by collateral or unsecured and may have call, put, or conversion provisions.

We also discussed a sinking fund provision as a way to reduce the credit risk of a bond by redeeming part of the bond issue periodically over a bond's life. An alternative to a sinking fund provision is to issue a **serial bond issue**. With a serial bond issue, bonds are issued with several maturity dates so that a portion of the issue is redeemed periodically. An important difference between a serial bond issue and an issue with a sinking fund is that with a serial bond issue, investors know at issuance when specific bonds will be redeemed. A bond issue that does not have a serial maturity structure is said to have a **term maturity structure** with all the bonds maturing on the same date.

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. Issuers provide *maturity ranges* (e.g., 18 months to two years) for MTNs they wish to sell and provide yield quotes for those ranges. Investors interested in purchasing the notes make an offer to the issuer's agent, specifying the face value and an exact maturity within one of the ranges offered. The agent then confirms the issuer's willingness to sell those MTNs and effects the transaction.

MTNs can have fixed- or floating-rate coupons, but longer-maturity MTNs are typically fixed-rate bonds. Most MTNs, other than long-term MTNs, are issued by financial corporations and most buyers are financial institutions. MTNs can be structured to meet an institution's specifications. While custom bond issues have less liquidity, they provide slightly higher yields compared to an issuer's publicly traded bonds.

LOS 52.h: Describe short-term funding alternatives available to banks.

Customer deposits (retail deposits) are a short-term funding source for banks. Checking accounts provide transactions services and immediate availability of funds but typically pay no interest. Money market mutual funds and savings accounts provide less liquidity or less transactions services, or both, and pay periodic interest.

In addition to funds from retail accounts, banks offer interest-bearing **certificates of deposit** (CDs) that mature on specific dates and are offered in a range of short-term maturities. Nonnegotiable CDs cannot be sold and withdrawal of funds often incurs a significant penalty.

Negotiable certificates of deposit can be sold. At the wholesale level, 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.

Another source of short-term funding for banks is to borrow excess reserves from other banks in the **central bank funds market**. Banks in most countries must maintain a portion of their funds as reserves on deposit with the central bank. At any point in time, some banks may have more than the required amount of reserves on deposit, while others require more reserve deposits. In the market for central bank funds, banks with excess reserves lend them to other banks for periods of one day (overnight funds) and for longer periods up to a year (term funds). **Central bank funds rates** refer to rates for these transactions, which are strongly influenced by the effect of the central bank's open market operations on the money supply and availability of short-term funds.

In the United States, the central bank funds rate is called the Fed funds rate and this rate influences the interest rates of many short-term debt securities.

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.

LOS 52.i: Describe repurchase agreements (repos) and the risks associated with them.

A **repurchase (repo) agreement** is an arrangement by which 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 accounts for the interest charged by the buyer, who is, in effect, lending funds to the seller with the security as collateral. The interest rate implied by the two prices is called the *repo rate*, which is the annualized percentage difference between the two prices. 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.

As an example, consider a firm that enters into a repo agreement to sell a 4%, 12-year bond with a par value of \$1 million and a market value of \$970,000 for \$940,000 and to repurchase it 90 days later (the **repo date**) for \$947,050.

The implicit interest rate for the 90-day loan period is $947,050 / 940,000 - 1 = 0.75\%$ and the *repo rate* would be expressed as the equivalent annual rate.

The percentage difference between the market value and the amount loaned is called the **repo margin** or the **haircut**. In our example, it is $940,000 / 970,000 - 1 = -3.1\%$. This margin protects the lender in the event that the value of the security decreases over the term of the repo agreement.

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.

The reason the supply and demand conditions for the collateral security affects pricing is that some lenders want to own a specific bond or type of bond as collateral. For a bond that is high demand, lenders must compete for bonds by offering lower repo lending rates.

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.

KEY CONCEPTS

LOS 52.a

Global bond markets can be classified by:

- **Type of issuer:** Government (and government-related), corporate (financial and nonfinancial), securitized.
- **Credit quality:** Investment grade, noninvestment grade.
- **Original maturity:** Money market (one year or less), capital market (more than one year).
- **Coupon:** Fixed rate, floating rate.
- **Currency and geography:** Domestic, foreign, global, eurobond markets; developed, emerging markets.
- **Other classifications:** Indexing, taxable status.

LOS 52.b

Interbank lending rates, such as London Interbank Offered Rate (Libor), are frequently used as reference rates for floating-rate debt. An appropriate reference rate is one that matches a floating-rate note's currency and frequency of rate resets, such as 6-month U.S. dollar Libor for a semiannual floating-rate note issued in U.S. dollars.

LOS 52.c

Bonds may be issued in the primary market through a public offering or a private placement.

A public offering using an investment bank may be underwritten, with the investment bank or syndicate purchasing the entire issue and selling the bonds to dealers; or on a best-efforts basis, in which the investment bank sells the bonds on commission. Public offerings may also take place through auctions, which is the method commonly used to issue government debt.

A private placement is the sale of an entire issue to a qualified investor or group of investors, which are typically large institutions.

LOS 52.d

Bonds that have been issued previously trade in secondary markets. While some bonds trade on exchanges, most are traded in dealer markets. Spreads between bid and ask prices are narrower for liquid issues and wider for less liquid issues.

Trade settlement is typically T + 2 or T + 3 for corporate bonds and either cash settlement or T + 1 for government bonds.

LOS 52.e

Sovereign bonds are issued by national governments and backed by their taxing power. Sovereign bonds may be denominated in the local currency or a foreign currency.

LOS 52.f

Non-sovereign government bonds are issued by governments below the national level, such as provinces or cities, and may be backed by taxing authority or revenues from a specific project.

Agency or quasi-government bonds are issued by government sponsored entities and may be explicitly or implicitly backed by the government.

Supranational bonds are issued by multilateral agencies that operate across national borders.

LOS 52.g

Debt issued by corporations includes bank debt, commercial paper, corporate bonds, and medium-term notes.

Bank debt includes bilateral loans from a single bank and syndicated loans from multiple banks.

Commercial paper is a money market instrument issued by corporations of high credit quality.

Corporate bonds may have a term maturity structure (all bonds in an issue mature at the same time) or a serial maturity structure (bonds in an issue mature on a predetermined schedule) and may have a sinking fund provision.

Medium-term notes are corporate issues that can be structured to meet the requirements of investors.

LOS 52.h

Short-term funding alternatives available to banks include:

- **Customer deposits**, including checking accounts, savings accounts, and money market mutual funds.
- **Negotiable CDs**, which may be sold in the wholesale market.
- **Central bank funds market**. Banks may buy or sell excess reserves deposited with their central bank.
- **Interbank funds**. Banks make unsecured loans to one another for periods up to a year.

LOS 52.i

A repurchase agreement is a form of short-term collateralized borrowing in which one party sells a security to another party and agrees to buy it back at a predetermined future date and price. The repo rate is the implicit interest rate of a repurchase agreement. The repo margin, or haircut, is the difference between the amount borrowed and the value of the security.

Repurchase agreements are an important source of short-term financing for bond dealers. If a bond dealer is lending funds instead of borrowing, the agreement is known as a reverse repo.

CONCEPT CHECKERS

1. An analyst who describes a fixed-income security as being a structured finance instrument is classifying the security by:
 - A. credit quality.
 - B. type of issuer.
 - C. taxable status.
2. Libor rates are determined:
 - A. by countries' central banks.
 - B. by money market regulators.
 - C. in the interbank lending market.
3. In which type of primary market transaction does an investment bank sell bonds on a commission basis?
 - A. Single-price auction.
 - B. Best-efforts offering.
 - C. Underwritten offering.
4. Secondary market bond transactions *most likely* take place:
 - A. in dealer markets.
 - B. in brokered markets.
 - C. on organized exchanges.
5. Sovereign bonds are described as on-the-run when they:
 - A. are the most recent issue in a specific maturity.
 - B. have increased substantially in price since they were issued.
 - C. receive greater-than-expected demand from auction bidders.
6. Bonds issued by the World Bank would *most likely* be:
 - A. quasi-government bonds.
 - B. global bonds.
 - C. supranational bonds.
7. With which of the following features of a corporate bond issue does an investor *most likely* face the risk of redemption prior to maturity?
 - A. Serial bonds.
 - B. Sinking fund.
 - C. Term maturity structure.
8. Smith Bank lends Johnson Bank excess reserves on deposit with the central bank for a period of three months. Is this transaction said to occur in the interbank market?
 - A. Yes.
 - B. No, because the interbank market refers to loans for more than one year.
 - C. No, because the interbank market does not include reserves at the central bank.

9. In a repurchase agreement, the percentage difference between the repurchase price and the amount borrowed is *most accurately* described as the:
- A. haircut.
 - B. repo rate.
 - C. repo margin.

For more questions related to this topic review, log in to your Schweser online account and launch SchweserPro™ QBank; and for video instruction covering each LOS in this topic review, log in to your Schweser online account and launch the OnDemand video lectures, if you have purchased these products.

ANSWERS – CONCEPT CHECKERS

1. **B** Fixed-income sector classifications by type of issuer include government, corporate, and structured finance instruments.
2. **C** Libor rates are determined in the market for interbank lending.
3. **B** In a best-efforts offering, an investment bank or banks do not underwrite (i.e., purchase all of) a bond issue, but rather sell the bonds on a commission basis. Bonds sold by auction are offered directly to buyers by the issuer, typically a government.
4. **A** The secondary market for bonds is primarily a dealer market in which dealers post bid and ask prices.
5. **A** Sovereign bonds are described as *on-the-run* or *benchmark* when they represent the most recent issue in a specific maturity.
6. **C** Bonds issued by the World Bank, which is a multilateral agency operating globally, are termed supranational bonds.
7. **B** With a sinking fund, the issuer must redeem part of the issue prior to maturity, but the specific bonds to be redeemed are not known. Serial bonds are issued with a schedule of maturities and each bond has a known maturity date. In an issue with a term maturity structure, all the bonds are scheduled to mature on the same date.
8. **C** The interbank market refers to short-term borrowing and lending among banks of funds other than those on deposit at a central bank. Loans of reserves on deposit with a central bank are said to occur in the central bank funds market.
9. **B** The repo rate is the percentage difference between the repurchase price and the amount borrowed. The repo margin or haircut is the percentage difference between the amount borrowed and the value of the collateral.

INTRODUCTION TO FIXED-INCOME VALUATION

Study Session 15

EXAM FOCUS

The concepts introduced here are very important for understanding the factors that determine the value of debt securities and various yield measures. The relationships between yield to maturity, spot rates, and forward rates are core material and come up in many contexts throughout the CFA curriculum. Yield spread measures also have many applications. Note that while several of the required learning outcomes have the command word “calculate” in them, a good understanding of the underlying concepts is just as important for exam success on this material.

LOS 53.a: Calculate a bond’s price given a market discount rate.

Calculating the Value of an Annual Coupon Bond

The value of a coupon bond can be calculated by summing the present values of all of the bond’s promised cash flows. The market discount rate appropriate for discounting a bond’s cash flows is called the bond’s **yield-to-maturity (YTM)** or **redemption yield**. If we know a bond’s yield-to-maturity, we can calculate its value, and if we know its value (market price), we can calculate its yield-to-maturity.

Consider a newly issued 10-year, \$1,000 par value, 10% coupon, annual-pay bond. The coupon payments will be \$100 at the end of each year the \$1,000 par value will be paid at the end of year 10. First, let’s value this bond assuming the appropriate discount rate is 10%. The present value of the bond’s cash flows discounted at 10% is:

$$\frac{100}{1.1} + \frac{100}{1.1^2} + \frac{100}{1.1^3} + \dots + \frac{100}{1.1^9} + \frac{1,100}{1.1^{10}} = 1,000$$

The calculator solution is:

$$N = 10; PMT = 100; FV = 1,000; I/Y = 10; CPT \rightarrow PV = -1,000$$

where:

N = number of years

PMT = the *annual* coupon payment

I/Y = the *annual* discount rate

FV = the par value or selling price at the end of an assumed holding period



Professor's Note: Take note of a couple of points here. The discount rate is entered as a whole number in percent, 10, not 0.10. The 10 coupon payments of \$100 each are taken care of in the $N = 10$ and $PMT = 100$ entries. The principal repayment is in the $FV = 1,000$ entry. Lastly, note that the PV is negative; it will be the opposite sign to the sign of PMT and FV . The calculator is just "thinking" that to receive the payments and future value (to own the bond), you must pay the present value of the bond today (you must buy the bond). That's why the PV amount is negative; it is a cash outflow to a bond buyer.

Now let's value that same bond with a discount rate of 8%:

$$\frac{100}{1.08} + \frac{100}{1.08^2} + \frac{100}{1.08^3} + \dots + \frac{100}{1.08^9} + \frac{1,100}{1.08^{10}} = 1,134.20$$

The calculator solution is:

$$N = 10; PMT = 100; FV = 1,000; I/Y = 8; CPT \rightarrow PV = -1,134.20$$

If the market discount rate for this bond were 8%, it would sell at a premium of \$134.20 above its par value. *When bond yields decrease, the present value of a bond's payments, its market value, increases.*

If we discount the bond's cash flows at 12%, the present value of the bond is:

$$\frac{100}{1.12} + \frac{100}{1.12^2} + \frac{100}{1.12^3} + \dots + \frac{100}{1.12^9} + \frac{1,100}{1.12^{10}} = 887.00$$

The calculator solution is:

$$N = 10; PMT = 100; FV = 1,000; I/Y = 12; CPT \rightarrow PV = -887$$

If the market discount rate for this bond were 12%, it would sell at a discount of \$113 to its par value. *When bond yields increase, the present value of a bond's payments, its market value, decreases.*



Professor's Note: It's worth noting here that a 2% decrease in yield-to-maturity increases the bond's value by more than a 2% increase in yield decreases the bond's value. This illustrates that the bond's price-yield relationship is convex, as we will explain in more detail in a later topic review.

Calculating the value of a bond with semiannual coupon payments. Let's calculate the value of the same bond with semiannual payments.

Rather than \$100 per year, the security will pay \$50 every six months. With an annual YTM of 8%, we need to discount the coupon payments at 4% per period which results in a present value of:

$$\frac{50}{1.04} + \frac{50}{1.04^2} + \frac{50}{1.04^3} + \dots + \frac{50}{1.04^{19}} + \frac{1,050}{1.04^{20}} = 1,135.90$$

The calculator solution is:

$$N = 20; PMT = 50; FV = 1,000; I/Y = 4; CPT \rightarrow PV = -1,135.90$$

The value of a zero-coupon bond is simply the present value of the maturity payment. With a discount rate of 3% per period, a 5-period zero-coupon bond with a par value of \$1,000 has a value of:

$$\frac{1,000}{1.03^5} = \$862.61$$

LOS 53.b: Identify the relationships among a bond's price, coupon rate, maturity, and market discount rate (yield-to-maturity).

So far we have used a bond's cash flows and an assumed yield-to-maturity in order to calculate the value of the bond. Given a bond's price in the market, we can calculate its yield-to-maturity because it's a one-to-one relationship between the two. We can say that the YTM is the discount rate that makes the present value of a bond's cash flows equal to its price. For a 5-year, annual pay 7% bond that is priced in the market at \$1,020.78, the YTM will satisfy the following equation:

$$\frac{70}{1 + YTM} + \frac{70}{(1 + YTM)^2} + \frac{70}{(1 + YTM)^3} + \frac{70}{(1 + YTM)^4} + \frac{1,070}{(1 + YTM)^5} = 1,020.78$$

We can calculate the YTM (discount rate) that satisfies this equality as:

$$N = 5; PMT = 70; FV = 1,000; PV = -1,020.78; CPT \rightarrow I/Y = 6.5\%$$

By convention, the YTM on a semiannual coupon bond is expressed as two times the semiannual discount rate. For a 5-year, semiannual pay 7% coupon bond, we can calculate the semiannual discount rate as YTM/2 and then double it to get the YTM expressed as an annual yield.

$$\frac{35}{1 + \frac{YTM}{2}} + \frac{35}{(1 + \frac{YTM}{2})^2} + \frac{35}{(1 + \frac{YTM}{2})^3} + \dots + \frac{35}{(1 + \frac{YTM}{2})^9} + \frac{1,035}{(1 + \frac{YTM}{2})^{10}} = 1,020.78$$

$$N = 10; PMT = 35; FV = 1,000; PV = -1,020.78; CPT \rightarrow I/Y = 3.253\%$$

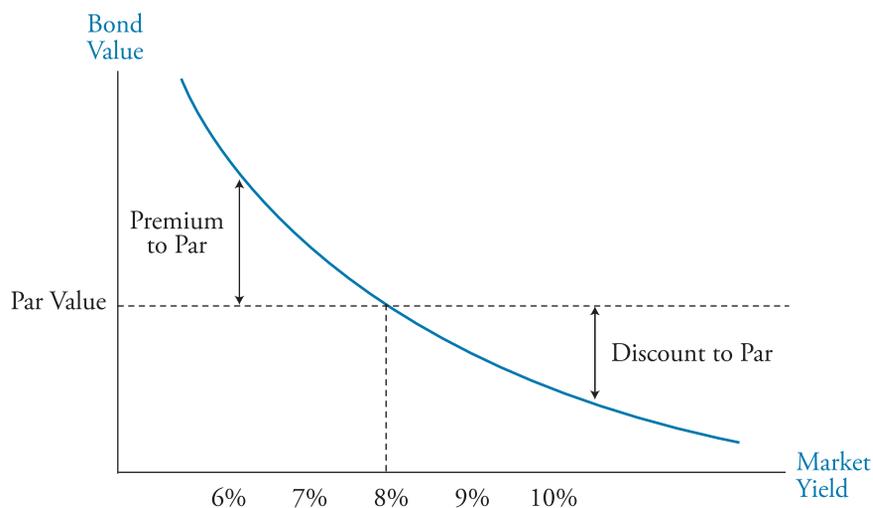
The YTM is $3.253 \times 2 = 6.506\%$.

We can summarize the relationships between price and yield as follows:

1. At a point in time, a decrease (increase) in a bond's YTM will increase (decrease) its price.
2. 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.
3. 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).
4. 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.
5. 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.

Figure 1 illustrates the convex relationship between a bond's price and its yield-to-maturity:

Figure 1: Market Yield vs. Bond Value for an 8% Coupon Bond



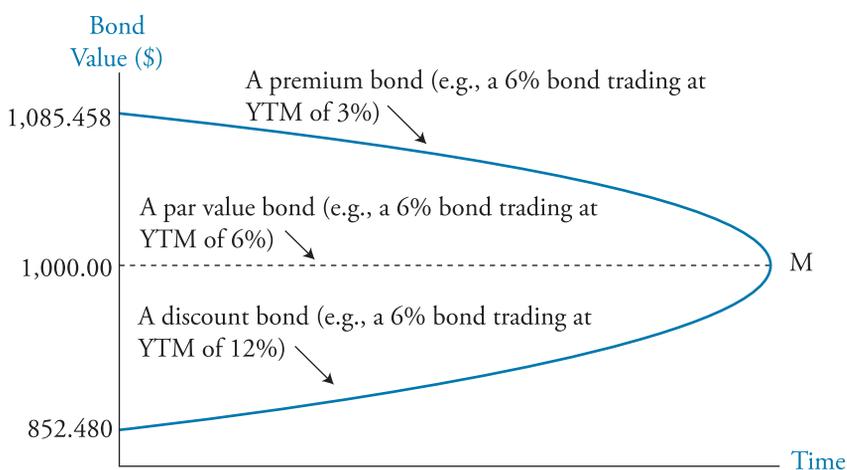
Relationship Between Price and Maturity

Prior to maturity, a bond can be selling at a significant discount or premium to par value. However, regardless of its required yield, the price will converge to par value as maturity approaches. Consider a bond with \$1,000 par value and a 3-year life paying 6% semiannual coupons. The bond values corresponding to required yields of 3%, 6%, and 12% as the bond approaches maturity are presented in Figure 2.

Figure 2: Bond Values and the Passage of Time

<i>Time to Maturity (in years)</i>	<i>YTM = 3%</i>	<i>YTM = 6%</i>	<i>YTM = 12%</i>
3.0	\$1,085.46	\$1,000.00	\$852.48
2.5	1,071.74	1,000.00	873.63
2.0	1,057.82	1,000.00	896.05
1.5	1,043.68	1,000.00	919.81
1.0	1,029.34	1,000.00	945.00
0.5	1,014.78	1,000.00	971.69
0.0	1,000.00	1,000.00	1,000.00

The change in value associated with the passage of time for the three bonds represented in Figure 2 is presented graphically in Figure 3. This convergence to par value at maturity is known as the **constant-yield price trajectory** because it shows how the bond's price would change as time passes if its yield-to-maturity remained constant.

Figure 3: Premium, Par, and Discount Bonds

LOS 53.c: Define spot rates and calculate the price of a bond using spot rates.

The yield-to-maturity is calculated as if the discount rate for every bond cash flow is the same. In reality, discount rates depend on the time period in which the bond payment will be made. **Spot rates** are the market discount rates for a single payment to be received in the future. The discount rates for zero-coupon bonds are spot rates and we sometimes refer to spot rates as *zero-coupon rates* or simply *zero rates*.

In order to price a bond with spot rates, we sum the present values of the bond's payments, each discounted at the spot rate for the number of periods before it will be paid. The general equation for calculating a bond's value using spot rates (S_t) is:

$$\frac{CPN_1}{1+S_1} + \frac{CPN_2}{(1+S_2)^2} + \dots + \frac{CPN_N + FV_N}{(1+S_N)^N} = PV$$

Example: Valuing a bond using spot rates

Given the following spot rates, calculate the value of a 3-year, 5% annual-coupon bond.

Spot rates
 1-year: 3%
 2-year: 4%
 3-year: 5%

Answer:

$$\frac{50}{1.03} + \frac{50}{(1.04)^2} + \frac{1,050}{(1.05)^3} = 48.54 + 46.23 + 907.03 = \$1,001.80$$

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.

Because the bond value is slightly greater than its par value, we know its YTM is slightly less than its coupon rate of 5%. Using the price of 1,001.80, we can calculate the YTM for this bond as:

$$N = 3; PMT = 50; FV = 1,000; PV = -1,001.80; CPT \rightarrow I/Y = 4.93\%$$

LOS 53.d: Describe and calculate the flat price, accrued interest, and the full price of a bond.

The coupon bond values we have calculated so far are calculated one period before the next coupon payment will be made. For most bond trades, the settlement date, which is when cash is exchanged for the bond, will fall between coupon payment dates. As time passes (and future coupon payment dates get closer), the value of the bond will increase.

Consider a bond with a 5% coupon that has a 5% yield-to-maturity. Just after each coupon is paid, the bond value will be its par value. As time passes and the future payment dates get closer, the bond's value will increase. The rate of increase in the bond's value is equal to the bond's YTM so that the value of this bond between coupon payment dates is $\text{par} \times (1 + \text{YTM})^{t/T}$, where t is the number of days from the last coupon payment date until the date the bond trade will settle, and T is the number of days

between the last coupon payment and the next. We refer to this as the **full price** (also called the *invoice price*) of the bond.

Let's work an example for a specific bond:

Example: Calculating the full price of a bond

A 5% bond makes coupon payments on June 15 and December 15 and is trading with a YTM of 4%. The bond is purchased and will settle on August 21 when there will be four coupons remaining until maturity. Calculate the full price of the bond using actual days.

Step 1: Calculate the value of the bond on the last coupon date (coupons are semiannual, so we use $4/2 = 2\%$ for the periodic discount rate):

$$N = 4; PMT = 25; FV = 1,000; I/Y = 2; CPT \rightarrow PV = -1,019.04$$

Step 2: Adjust for the number of days since the last coupon payment:

Days between June 15 and December 15 = 183 days.

Days between June 15 and settlement on August 21 = 67 days.

$$\text{Full price} = 1,019.04 \times (1.02)^{67/183} = 1,026.46.$$

The accrued interest since the last payment date can be calculated as the coupon payment times the portion of the coupon period that has passed between the last coupon payment date and the settlement date of the transaction. For the bond in the previous example, the accrued interest on the settlement date of August 21 is:

$$\$25 (67 / 183) = \$9.15$$

The full price (invoice price) minus the accrued interest is referred to as the **flat price** of the bond.

$$\text{full price} = \text{flat price} + \text{accrued interest}$$

So for the bond in our example, the flat price = $1,026.46 - 9.15 = 1,017.31$.

The flat price of the bond is also referred to as the bond's **clean price**, and the full price is referred to as the **dirty price**.

Note that the calculation of accrued interest does not discount the accrued interest to its present value so that the value of the bond on its last payment date (1,019.04) plus the accrued interest of \$9.15 is greater than the full price of the bond, $1,019.04 + 9.15 = 1,028.19 > 1,026.46$.

So far, in calculating accrued interest, we used the actual number of days between coupon payments and the actual number of days between the last coupon date and the settlement date. This actual/actual method is used most often with government bonds.

The 30/360 method is most often used for corporate bonds. This method assumes that there are 30 days in each month and 360 days in a year.

To calculate the accrued interest through the August 21 settlement date on the bond in our example (that has coupon payment dates on June 15 and December 15), we would calculate $2 \times 30 = 60$ days between June 15 and August 15 and then add the 6 days from August 15 to August 21 to get 66 days. Assuming 30 days per month, there are 180 days between coupon dates.

The accrued interest on the bond using the 30/360 method is $25 \times 66 / 180 = \$9.166$, slightly more than the accrued interest of \$9.15 calculated using the actual/actual method.

LOS 53.e: Describe matrix pricing.

Matrix pricing is a method of estimating the required yield-to-maturity (or price) of bonds that are currently not traded or infrequently traded. The procedure is to use the YTM's of traded bonds that have credit quality very close to that of a nontraded or infrequently traded bond and are similar in maturity and coupon, to estimate the required YTM.

Example: Pricing an illiquid bond

Rob Phelps, CFA, is estimating the value of a nontraded 4%, annual-pay, BB rated bond that has five years remaining until maturity. He has obtained the following yields-to-maturity on similar corporate bonds:

BB rated, 4-year annual-pay, 5% coupon bond: YTM = 4.738%

BB rated, 6-year annual-pay, 4% coupon bond: YTM = 5.232%

BB rated, 6-year annual-pay, 6% coupon bond: YTM = 5.284%

Estimate the value of the nontraded bond.

Answer:

Step 1: Take the average YTM of the 6-year bonds, $(5.232 + 5.284) / 2 = 5.258\%$.

Step 2: Average the YTM of the 4-year bond with the *average* 6-year bond yield, $(4.738 + 5.258) / 2 = 4.998\%$.

Step 3: Price the nontraded bond with a YTM of 4.998%.

$$N = 5; PMT = 40; FV = 1,000; I/Y = 4.998; CPT \rightarrow PV = -956.79$$

The estimated value is \$956.79 per \$1,000 par value.

In using the averages in the preceding example, we have used a simple form of *linear interpolation*. Because the maturity of the nontraded bond is five years, we use the simple average of the YTM's for the 4-year and 6-year bonds.

Consider a case where we are estimating the value of a 5-year, 5% annual-pay coupon bond and have the YTM's of otherwise very similar bonds with 4-year and 7-year maturities, 4.738% and 5.336%, respectively. In this case, we estimate the YTM on the 5-year bond as the yield on the 4-year bond, plus one-third of the difference between the YTM of the 4-year bond and the YTM of the 7-year bond. Note that the difference in maturity between the 4-year bond and the 5-year bond is one year and the difference between the maturities of the 4-year and 7-year bonds is three years.

The calculation is:

$$4.738\% + \frac{(5-4)}{(7-4)}(5.336\% - 4.738\%)$$

$$= 4.738\% + \frac{1}{3}(0.598\%) = 4.937\%$$

$$N = 5; PMT = 50; FV = 1,000; I/Y = 4.937; CPT \rightarrow PV = -1,002.73$$

A variation of matrix pricing used for pricing new bond issues focuses on the spreads between bond yields and the yields of a benchmark bond of similar maturity that is essentially default risk free. Often the yields on Treasury bonds are used as benchmark yields for U.S. dollar-denominated corporate bonds. When estimating the YTM for the new issue bond, the appropriate spread to the yield of a Treasury bond of the same maturity is estimated and added to the yield of the benchmark issue.

Example: Estimating the spread for a new 6-year, A rated bond issue

Consider the following market yields:

- 5-year, U.S. Treasury bond, YTM 1.48%
- 5-year, A rated corporate bond, YTM 2.64%
- 7-year, Treasury bond, YTM 2.15%
- 7-year, A rated corporate bond, YTM 3.55%
- 6-year Treasury bond, YTM 1.74%

Estimate the required yield on a newly issued 6-year, A rated corporate bond

Answer:

1. Calculate the spreads to the benchmark (Treasury) yields.
 Spread on the 5-year corporate bond is $2.64 - 1.48 = 1.16\%$.
 Spread on the 7-year corporate bond is $3.55 - 2.15 = 1.40\%$.
2. Calculate the average spread because the 6-year bond is the midpoint of five and seven years.
 Average spread = $(1.16 + 1.40) / 2 = 1.28\%$.
3. Add the average spread to the YTM of the 6-year Treasury (benchmark) bond.
 $1.74 + 1.28 = 3.02\%$, which is our estimate of the YTM on the newly issued 6-year, A rated bond.

LOS 53.f: Calculate and interpret yield measures for fixed-rate bonds, floating-rate notes, and money market instruments.

Yield Measures for Fixed-Rate Bonds

We have previously covered the coupon rate and yield-to-maturity for fixed-rate bonds. The **effective yield** for a bond depends on how many coupon payments are made each year and is simply the compound return. How frequently coupon payments are made is referred to as the **periodicity** of the annual rate.

An annual-pay bond with an 8% YTM has an effective yield of 8%.

A semiannual-pay bond (periodicity of two) with an 8% YTM has a yield of 4% every six months and an effective yield of $1.04^2 - 1 = 8.16\%$.

A quarterly-pay bond (periodicity of four) with an 8% yield-to-maturity has a yield of 2% every three months and an effective yield of $1.02^4 - 1 = 8.24\%$.



Professor's Note: This follows the method described in Quantitative Methods for calculating the effective annual yield given a stated annual rate and the number of compounding periods per year.

Most bonds in the United States make semiannual coupon payments (periodicity of two), and yields (YTM) are quoted on a **semiannual bond basis**, which is simply two times the semiannual discount rate. It may be necessary to adjust the quoted yield on a bond to make it comparable with the yield on a bond with a different periodicity. This is illustrated in the following example.

Example: Adjusting yields for periodicity

An Atlas Corporation bond is quoted with a YTM of 4% on a semiannual bond basis. What yields should be used to compare it with a quarterly-pay bond and an annual-pay bond?

Answer:

The first thing to note is that 4% on a semiannual bond basis is an effective yield of 2% per 6-month period.

To compare this with the yield on an annual-pay bond, which is an effective annual yield, we need to calculate the effective annual yield on the semiannual coupon bond, which is $1.02^2 - 1 = 4.04\%$.

For the annual YTM on the quarterly-pay bond, we need to calculate the effective quarterly yield and multiply by four. The quarterly yield (yield per quarter) that is equivalent to a yield of 2% per six months is $1.02^{1/2} - 1 = 0.995\%$. The quoted annual rate for the equivalent yield on a quarterly bond basis is $4 \times 0.995 = 3.98\%$.

Note that we have shown that the effective annual yields are the same for:

- An annual coupon bond with a yield of 4.04% on an annual basis (periodicity of one).
- A semiannual coupon bond with a yield of 4.0% on a semiannual basis (periodicity of two).
- A quarterly coupon bond with a yield of 3.98% on quarterly basis (periodicity of four).

Bond yields calculated using the stated coupon payment dates are referred to as following the **street convention**. Because some coupon dates will fall on weekends and holidays, coupon payments will actually be made the next business day. The yield calculated using these actual coupon payment dates is referred to as the **true yield**. Some coupon payments will be made later when holidays and weekends are taken into account, so true yields will be slightly lower than street convention yields, if only by a few basis points.

When calculating spreads between government bond yields and the yield on a corporate bond, the corporate bond yield is often restated to its yield on actual/actual basis to match the day count convention used on government bonds (rather than the 30/360 day count convention used for calculating corporate bond yields).

Current yield is simple to calculate, but offers limited information. This measure looks at just one source of return: *a bond's annual interest income*—it does not consider capital gains/losses or reinvestment income. The formula for the current yield is:

$$\text{current yield} = \frac{\text{annual cash coupon payment}}{\text{bond price}}$$

Example: Computing current yield

Consider a 20-year, \$1,000 par value, 6% *semiannual-pay* bond that is currently trading at a flat price of \$802.07. Calculate the current yield.

Answer:

The *annual* cash coupon payments total:

$$\begin{aligned} \text{annual cash coupon payment} &= \text{par value} \times \text{stated coupon rate} = \\ & \$1,000 \times 0.06 = \$60 \end{aligned}$$

Because the bond is trading at \$802.07, the current yield is:

$$\text{current yield} = \frac{60}{802.07} = 0.0748, \text{ or } 7.48\%.$$

Note that current yield is based on *annual* coupon interest so that it is the same for a semiannual-pay and annual-pay bond with the same coupon rate and price.

The current yield does not account for gains or losses as the bond's price moves toward its par value over time. A bond's **simple yield** takes a discount or premium into account by assuming that any discount or premium declines evenly over the remaining years to maturity. The sum of the annual coupon payment plus (minus) the straight-line amortization of a discount (premium) is divided by the flat price to get the simple yield.

For a callable bond, an investor's yield will depend on whether and when the bond is called. The **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 following example illustrates these calculations.

Example: Yield-to-call and yield-to-worst

Consider a 10-year, semiannual-pay 6% bond trading at 102 on January 1, 2014. The bond is callable according to the following schedule:

- Callable at 102 on or after January 1, 2019.
- Callable at 100 on or after January 1, 2022.

Calculate the bond's YTM, yield-to-first call, yield-to-first par call, and yield-to-worst.

Answer:

The *yield-to-maturity* on the bond is calculated as:

$$N = 20; PMT = 30; FV = 1,000; PV = -1,020; CPT \rightarrow I/Y = 2.867\%$$

$$2 \times 2.867 = 5.734\% = YTM$$

To calculate the *yield-to-first call*, we calculate the yield-to-maturity using the number of semiannual periods until the first call date (10) for N and the call price (1,020) for FV :

$$N = 10; PMT = 30; FV = 1,020; PV = -1,020; CPT \rightarrow I/Y = 2.941\%$$

$$2 \times 2.941 = 5.882\% = \text{yield-to-first call}$$

To calculate the *yield-to-first par call* (second call date), we calculate the yield-to-maturity using the number of semiannual periods until the first par call date (16) for N and the call price (1,000) for FV :

$$N = 16; PMT = 30; FV = 1,000; PV = -1,020; CPT \rightarrow I/Y = 2.843\%$$

$$2 \times 2.843 = 5.686\% = \text{yield-to-first par call}$$

The lowest yield, 5.686%, is realized if the bond is called at par on January 1, 2022, so the *yield-to-worst* is 5.686%.

The **option-adjusted yield** is calculated by adding the value of the call option to the bond's current 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 (because the issuer *owns* the call option).

The option-adjusted yield will be less than the yield-to-maturity for a callable bond because callable bonds have higher yields to compensate bondholders for the issuer's call option. The option-adjusted yield can be used to compare the yields of bonds with various embedded options to each other and to similar option-free bonds.

Floating-Rate Note Yields

The values of floating rate notes (FRNs) are more stable than those of fixed-rate debt of similar maturity because the coupon interest rates are reset periodically based on a reference rate. Recall that the coupon rate on a floating-rate note is the reference rate plus or minus a margin based on the credit risk of the bond relative to the credit risk of the reference rate instrument. The coupon rate for the next period is set using the

current reference rate for the reset period, and the payment at the end of the period is based on this rate. For this reason, we say that interest is paid *in arrears*.

If an FRN is issued by a company that has more (less) credit risk than the banks quoting Libor, a margin is added to (subtracted from) Libor, the reference rate. The liquidity of an FRN and its tax treatment can also affect the margin.

We call the margin used to calculate the bond coupon payments the **quoted margin** and we call the margin required to return the FRN to its par value the **required margin** (also called the **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 when the next coupon payment is reset to the current market rate (plus or minus the appropriate margin).

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 to its par value. If credit quality has improved, the quoted margin will be greater than the required margin and the FRN will sell at a premium to its par value.

A somewhat simplified way of calculating the value of an FRN on a reset date is to use the current reference rate plus the quoted margin to estimate the future cash flows for the FRN and to discount these future cash flows at the reference rate plus the required (discount) margin. The following example illustrates this method. There are more complex models that produce better estimates of value.

Example: Pricing a floating-rate note on a reset date

A semiannual \$1,000 par value FRN has two years to maturity, the reference rate is 180-day Libor, and the quoted margin is 60 basis points. 180-day Libor today (a coupon payment and reset date) is 3% and the required (discount) margin is 86 basis points. Calculate the value of the FRN.

Answer:

In a simplified pricing model, all future coupon payments are based on the reference rate on reset date and then discounted using this reference rate and the required margin.

Note that both Libor and the margins are quoted on an annual basis and must be divided by two to get the coupon rate for the FRN because it pays two coupons each year.

$$\text{Coupon rate} = (180\text{-day Libor} + \text{quoted margin}) / 2 = (3.00\% + 0.60\%) / 2 = 1.80\%.$$

$$\text{Coupon payments} = 1.80\% \times 1,000 = \$18 \text{ every six months for two years.}$$

The appropriate discount rate is $(180\text{-day Libor} + \text{discount margin}) / 2 = (3.00\% + 0.86\%) / 2 = 1.93\%$.

The estimated value of the FRN today can then be calculated as:

$$N = 4; \text{PMT} = 18; \text{I/Y} = 1.93; \text{FV} = 1,000; \text{CPT} \rightarrow \text{PV} = -995.04$$

Because the discount margin is greater than the quoted margin, the FRN will trade at a discount.

Yields for Money Market Instruments

Recall that 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. U.S. Treasury bills are quoted as annualized discounts from face value based on a 360-day year. Libor and bank CD rates are quoted as add-on yields. We need to be able to:

- Calculate the actual payment on a money market security given its yield and knowledge of how the yield was calculated.
- Compare the yields on two securities that are quoted on different yield bases.

Both discount basis and add-on yields in the money market are quoted as simple annual interest. The following example illustrates the required calculations and quote conventions.

Example: Money market yields

1. A \$1,000 90-day T-bill is priced with an annualized discount of 1.2%. Calculate its market price and its annualized add-on yield based on a 365-day year.
2. A \$1 million negotiable CD with 120 days to maturity is quoted with an add-on yield of 1.4% based on a 365-day year. Calculate the payment at maturity for this CD and its bond equivalent yield.
3. A bank deposit for 100 days is quoted with an add-on yield of 1.5% based on a 360-day year. Calculate the bond equivalent yield and the yield on a semiannual bond basis.

Answer:

1. The discount from face value is $1.2\% \times 90 / 360 \times 1,000 = \3 so the current price is $1,000 - 3 = \$997$.

The equivalent add-on yield for 90 days is $3 / 997 = 0.3009\%$. The annualized add-on yield based on a 365-day year is $365 / 90 \times 0.3009 = 1.2203\%$. This add-on yield based on a 365-day year is referred to as the **bond equivalent yield** for a money market security.

2. The add-on interest for the 120-day period is $120 / 365 \times 1.4\% = 0.4603\%$.

At maturity, the CD will pay $\$1 \text{ million} \times (1 + 0.004603) = \$1,004,603$.

The quoted yield on the CD is the bond equivalent yield because it is an add-on yield annualized based on a 365-day year.

3. Because the yield of 1.5% is an annualized effective yield calculated based on a 360-day year, the bond equivalent yield, which is based on a 365-day year, is:

$$(365 / 360) \times 1.5\% = 1.5208\%$$

We may want to compare the yield on a money market security to the YTM of a semiannual-pay bond. The method is to convert the money market security's holding period return to an effective semiannual yield, and then double it.

Because the yield of 1.5% is calculated as the add-on yield for 100 days times $100 / 360$, the 100-day holding period return is $1.5\% \times 100 / 360 = 0.4167\%$. The effective annual yield is $1.004167^{365/100} - 1 = 1.5294\%$, the equivalent semiannual yield is $1.015294^{1/2} - 1 = 0.7618\%$, and the annual yield on a semiannual bond basis is $2 \times 0.7618\% = 1.5236\%$.

Because the periodicity of the money market security, $365 / 100$, is greater than the periodicity of 2 for a semiannual-pay bond, the simple annual rate for the money market security, 1.5%, is less than the yield on a semiannual bond basis, which has a periodicity of 2.

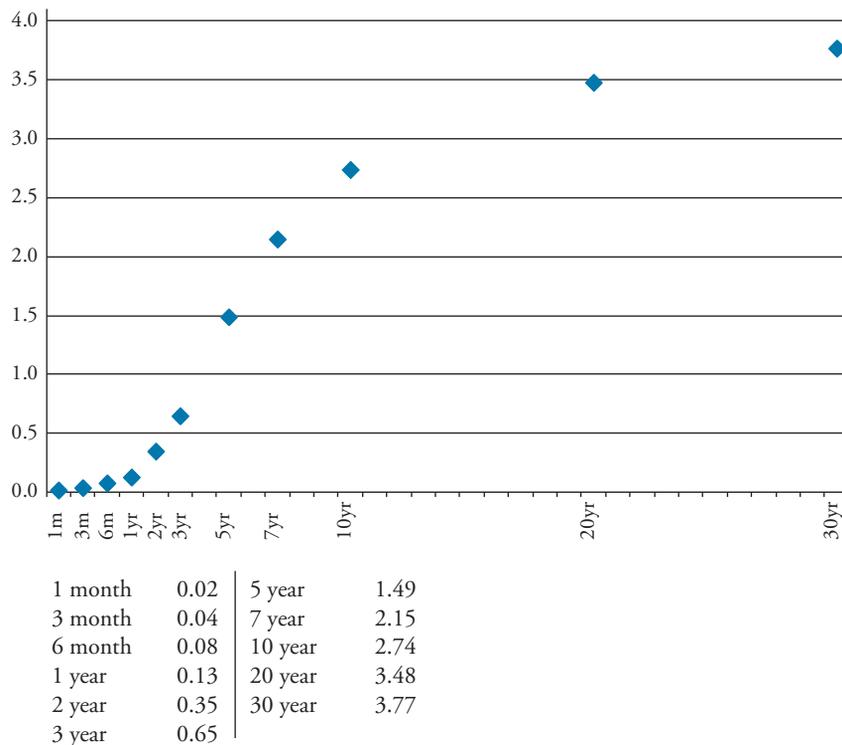
LOS 53.g: Define and compare the spot curve, yield curve on coupon bonds, par curve, and forward curve.

A **yield curve** shows yields by maturity. Yield curves are constructed for yields of various types and it's very important to understand exactly which yield is being shown. The **term structure** of interest rates refers to the yields at different maturities (terms) for like securities or interest rates. The yields on U.S. Treasury coupon bonds by maturity can be found at *treasury.gov*, and several yield curves are available at *Bloomberg.com*.

The **spot rate yield curve** (spot curve) for U.S. Treasury bonds is also referred to as the *zero curve* (for zero-coupon) or *strip curve* (because zero-coupon U.S. Treasury bonds are also called *stripped Treasuries*). Recall that spot rates are the appropriate yields, and therefore appropriate discount rates, for single payments to be made in the future. Yields on zero-coupon government bonds are spot rates. Earlier in this topic review, we calculated the value of a bond by discounting each separate payment by the spot rate corresponding to the time until the payment will be received. Spot rates are usually quoted on a semiannual bond basis, so they are directly comparable to YTM's quoted for coupon government bonds.

A **yield curve for coupon bonds** shows the YTM's for coupon bonds at various maturities. Yields are calculated for several maturities and yields for bonds with maturities between these are estimated by linear interpolation. Figure 4 shows a yield curve for coupon Treasury bonds constructed from yields on 1-month, 3-month, 6-month, 1-year, 2-year, 3-year, 5-year, 7-year, 10-year, 20 year, and 30-year maturities. Yields are expressed on a semiannual bond basis.

Figure 4: U.S. Treasury Yield Curve as of August 1, 2013



Source: <http://www.treasury.gov/resource-center>

A **par bond yield curve**, or *par curve*, is not calculated from yields on actual bonds but is constructed from the spot curve. The yields reflect the coupon rate that a hypothetical bond at each maturity would need to have to be priced at par. Alternatively, they can be viewed as the YTM of a par bond at each maturity.

Consider a 3-year annual-pay bond and spot rates for one, two, and three years of S_1 , S_2 , and S_3 . The following equation can be used to calculate the coupon rate necessary for the bond to be trading at par.

$$\frac{PMT}{1 + S_1} + \frac{PMT}{(1 + S_2)^2} + \frac{PMT + 100}{(1 + S_3)^3} = 100$$

With spot rates of 1%, 2%, and 3%, a 3-year annual par bond will have a payment that will satisfy:

$\frac{PMT}{1.01} + \frac{PMT}{(1.02)^2} + \frac{PMT + 100}{(1.03)^3} = 100$, so the payment is 2.96 and the par bond coupon rate is 2.96%.

Forward rates are yields for future periods. The rate of interest on a 1-year loan that would be made two years from now is a forward rate. A **forward yield curve** shows the future rates for bonds or money market securities for the same maturities for annual periods in the future. Typically, the forward curve would show the yields of 1-year securities for each future year, quoted on a semiannual bond basis.

LOS 53.h: Define forward rates and calculate spot rates from forward rates, forward rates from spot rates, and the price of a bond using forward rates.

A forward rate is a borrowing/lending rate for a loan to be made at some future date. The notation used must identify both the length of the lending/borrowing period and when in the future the money will be loaned/borrowed. Thus, $1y1y$ is the rate for a 1-year loan one year from now; $2y1y$ is the rate for a 1-year loan to be made two years from now; $3y2y$ is the 2-year forward rate three years from now; and so on.

The Relationship Between Short-Term Forward Rates and Spot Rates

The idea here is that *borrowing for three years at the 3-year spot rate, or borrowing for one-year periods in three successive years, should have the same cost.* The S_i are the current spot rates for i periods.

This relation is illustrated as $(1 + S_3)^3 = (1 + S_1)(1 + 1y1y)(1 + 2y1y)$. Thus, $S_3 = [(1 + S_1)(1 + 1y1y)(1 + 2y1y)]^{1/3} - 1$, which is the geometric mean return we covered in Quantitative Methods.

Example: Computing spot rates from forward rates

If the current 1-year spot rate is 2%, the 1-year forward rate one year from today ($1y1y$) is 3%, and the 1-year forward rate two years from today ($2y1y$) is 4%, what is the 3-year spot rate?

Answer:

$$S_3 = [(1.02)(1.03)(1.04)]^{1/3} - 1 = 2.997\%$$

This can be interpreted to mean that a dollar compounded at 2.997% for three years would produce the same ending value as a dollar that earns compound interest of 2% the first year, 3% the next year, and 4% for the third year.



Professor's Note: You can get a very good approximation of the 3-year spot rate with the simple average of the forward rates. In the previous example, we calculated 2.997% and the simple average of the three annual rates is:

$$\frac{2 + 3 + 4}{3} = 3\%.$$

Forward Rates Given Spot Rates

We can use the same relationships we use to calculate spot rates from forward rates to calculate forward rates from spot rates.

Our basic relation between forward rates and spot rates (for two periods) is:

$$(1 + S_2)^2 = (1 + S_1)(1 + 1y1y)$$

This again tells us that an investment has the same expected yield (borrowing has the same expected cost) whether we invest (borrow) for two periods at the 2-period spot rate, S_2 , or for one period at the current 1-year rate, S_1 , and for the next period at the forward rate, $1y1y$. Given two of these rates, we can solve for the other.

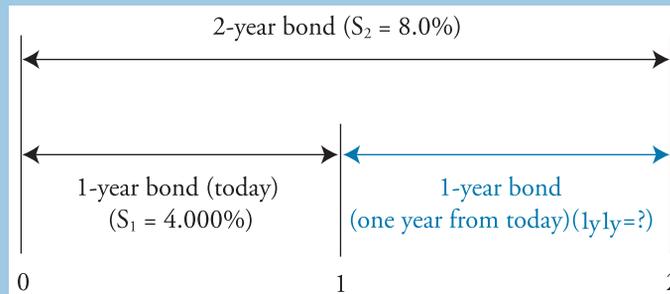
Example: Computing a forward rate from spot rates

The 2-period spot rate, S_2 , is 8%, and the 1-period spot rate, S_1 , is 4%. Calculate the forward rate for one period, one period from now, $1y1y$.

Answer:

The following figure illustrates the problem.

Finding a Forward Rate



From our original equality, $(1 + S_2)^2 = (1 + S_1)(1 + 1y1y)$, we can get

$$\frac{(1 + S_2)^2}{(1 + S_1)} = (1 + 1y1y)$$

Or, because we know that both choices have the same payoff in two years:

$$(1.08)^2 = (1.04)(1 + 1y1y)$$

$$(1 + 1y1y) = \frac{(1.08)^2}{(1.04)}$$

$$1y1y = \frac{(1.08)^2}{(1.04)} - 1 = \frac{1.1664}{1.04} - 1 = 12.154\%$$

In other words, investors are willing to accept 4.0% on the 1-year bond today (when they could get 8.0% on the 2-year bond today) only because they can get 12.154% on a 1-year bond one year from today. This future rate that can be locked in today is a forward rate.

Similarly, we can back other forward rates out of the spot rates. We know that:

$$(1 + S_3)^3 = (1 + S_1)(1 + 1y1y)(1 + 2y1y)$$

And that:

$$(1 + S_2)^2 = (1 + S_1)(1 + 1y1y), \text{ so we can write } (1 + S_3)^3 = (1 + S_2)^2(1 + 2y1y)$$

This last equation says that investing for three years at the 3-year spot rate should produce the same ending value as investing for two years at the 2-year spot rate, and then for a third year at $2y1y$, the 1-year forward rate, two years from now.

Solving for the forward rate, $2y1y$, we get:

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

Example: Forward rates from spot rates

Let's extend the previous example to three periods. The current 1-year spot rate is 4.0%, the current 2-year spot rate is 8.0%, and the current 3-year spot rate is 12.0%. Calculate the 1-year forward rates one and two years from now.

Answer:

We know the following relation must hold:

$$(1 + S_2)^2 = (1 + S_1)(1 + 1y1y)$$

We can use it to solve for the 1-year forward rate one year from now:

$$(1.08)^2 = (1.04)(1 + 1y1y), \text{ so } 1y1y = \frac{(1.08)^2}{(1.04)} - 1 = 12.154\%$$

We also know that the relations:

$$(1 + S_3)^3 = (1 + S_1)(1 + 1y1y)(1 + 2y1y)$$

and, equivalently $(1 + S_3)^3 = (1 + S_2)^2(1 + 2y1y)$ must hold.

Substituting values for S_3 and S_2 , we have:

$$(1.12)^3 = (1.08)^2 \times (1 + 2y1y)$$

so that the 1-year forward rate two years from now is:

$$2y1y = \frac{(1.12)^3}{(1.08)^2} - 1 = 20.45\%$$

We can check our results by calculating:

$$S_3 = [(1.04)(1.12154)(1.2045)]^{1/3} - 1 = 12.00\%$$

This may all seem a bit complicated, but the basic relation, that borrowing for successive periods at 1-period rates should have the same cost as borrowing at multiperiod spot rates, can be summed up as:

$$(1 + S_2)^2 = (1 + S_1)(1 + 1y1y) \text{ for two periods, and } (1 + S_3)^3 = (1 + S_2)^2(1 + 2y1y) \text{ for three periods.}$$

 *Professor's Note: Simple averages also give decent approximations for calculating forward rates from spot rates. In the preceding example, we had spot rates of 4% for one year and 8% for two years. Two years at 8% is 16%, so if the first-year rate is 4%, the second-year rate is close to $16 - 4 = 12\%$ (actual is 12.154). Given a 2-year spot rate of 8% and a 3-year spot rate of 12%, we could approximate the 1-year forward rate from time two to time three as $(3 \times 12) - (2 \times 8) = 20$. That may be close enough (actual is 20.45) to answer a multiple-choice question and, in any case, serves as a good check to make sure the exact rate you calculate is reasonable.*

We can also calculate implied forward rates for loans for more than one period. Given spot rates of: 1-year = 5%, 2-year = 6%, 3-year = 7%, and 4-year = 8%, we can calculate $2y2y$.

The implied forward rate on a 2-year loan two years from now, $2y2y$, is:

$$\left[\frac{(1 + S_4)^4}{(1 + S_2)^2} \right]^{1/2} - 1 = \left(\frac{1.08^4}{1.06^2} \right)^{1/2} - 1 = 10.04\%.$$

Professor's Note: The approximation works for multi-period forward rates as well.



The difference between four years at 8% (= 32%) and two years at 6% (= 12%) is 20%. Because that difference is for two years, we divide by two to get an annual rate of 10%, $\frac{(4 \times 8 - 6 \times 2)}{2} = 10$, which is very close to the exact solution of 10.04%.

Valuing a Bond Using Forward Rates

Example: Computing a bond value using forward rates

The current 1-year rate, S_1 , is 4%, the 1-year forward rate for lending from time = 1 to time = 2 is $1y1y = 5\%$, and the 1-year forward rate for lending from time = 2 to time = 3 is $2y1y = 6\%$. Value a 3-year annual-pay bond with a 5% coupon and a par value of \$1,000.

Answer:

$$\begin{aligned} \text{bond value} &= \frac{50}{1 + S_1} + \frac{50}{(1 + S_1)(1 + 1y1y)} + \frac{1,050}{(1 + S_1)(1 + 1y1y)(1 + 2y1y)} = \\ &= \frac{50}{1.04} + \frac{50}{(1.04)(1.05)} + \frac{1,050}{(1.04)(1.05)(1.06)} = \$1,000.98 \end{aligned}$$

Professor's Note: If you think this looks a little like valuing a bond using spot rates, as we did for arbitrage-free valuation, you are correct. The discount factors are equivalent to spot rate discount factors.



If we have a semiannual coupon bond, the calculation methods are the same, but we would use the semiannual discount rate rather than the annualized rate and the number of periods would be the number of semiannual periods.

LOS 53.i: Compare, calculate, and interpret yield spread measures.

A **yield spread** is the difference between the yields 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 example, if a 5-year corporate bond has a yield of 6.25% and its benchmark, the 5-year Treasury note, has a yield of 3.50%, the corporate bond has a benchmark spread of $625 - 350 = 275$ basis points.

For fixed-coupon bonds, on-the-run government bond yields for the same or nearest maturity are frequently used as benchmarks. The benchmark may change during a bond's life. For a 5-year corporate bond, when issued, the benchmark spread is stated relative to a 5-year government bond yield, but two years later (when it has three years remaining to maturity) its benchmark spread will be stated relative to a 3-year government bond yield. 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 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**. I-spreads are frequently stated for bonds denominated in euros.



Professor's Note: For bonds with tenors that do not match an on-the run government bond, yield spreads may be quoted relative to an "interpolated government bond yield." These are still G-spreads.

As we noted in an earlier topic review, floating-rate securities typically use Libor as a benchmark rate.

Yield spreads are useful for analyzing the factors that affect a bond's yield. If a corporate bond's yield increases from 6.25% to 6.50%, this may have been caused by factors that affect all bond yields (macroeconomic factors) or by firm-specific or industry-specific (microeconomic) factors. If a bond's yield increases but its yield spread remains the same, the yield on its benchmark must have also increased, which suggests macroeconomic factors caused bond yields in general to increase. However, if the yield spread increases, this suggests the increase in the bond's yield was caused by microeconomic factors such as credit risk or the issue's liquidity.



Professor's Note: Recall from our discussion of the Fisher effect in Economics that an interest rate is composed of the real risk-free rate, the expected inflation rate, and a risk premium. We can think of macroeconomic factors as those that affect the real risk-free rate and expected inflation, and microeconomic factors as those that affect the credit and liquidity risk premium.

Zero-Volatility and Option-Adjusted Spreads

A disadvantage of *G*-spreads and *I*-spreads is that they are theoretically correct only if the spot yield curve is flat so that yields are approximately the same across maturities. Normally, however, the spot yield curve is upward-sloping (i.e., longer-term yields are higher than shorter-term yields).

A method for deriving a bond's yield spread to a benchmark spot yield curve that accounts for the shape of the yield curve is to add an equal amount to each benchmark spot rate and value the bond with those rates. When we find an amount which, when added to the benchmark spot rates, produces a value equal to the market price of the

bond, we have the appropriate yield curve spread. A yield spread calculated this way is known as a **zero-volatility spread** or **Z-spread**.

Example: Zero-volatility spread

1-, 2-, and 3-year spot rates on Treasuries are 4%, 8.167%, and 12.377%, respectively. Consider a 3-year, 9% annual coupon corporate bond trading at 89.464. The YTM is 13.50%, and the YTM of a 3-year Treasury is 12%. Compute the G-spread and the Z-spread of the corporate bond.

Answer:

The G-spread is:

$$\text{G-spread} = \text{YTM}_{\text{Bond}} - \text{YTM}_{\text{Treasury}} = 13.50 - 12.00 = 1.50\%.$$

To compute the Z-spread, set the present value of the bond's cash flows equal to today's market price. Discount each cash flow at the appropriate zero-coupon bond spot rate *plus* a fixed spread ZS. Solve for ZS in the following equation and you have the Z-spread:

$$89.464 = \frac{9}{(1.04 + \text{ZS})^1} + \frac{9}{(1.08167 + \text{ZS})^2} + \frac{109}{(1.12377 + \text{ZS})^3} \Rightarrow$$

$$\text{ZS} = 1.67\% \text{ or } 167 \text{ basis points}$$

Note that this spread is found by trial-and-error. In other words, pick a number "ZS," plug it into the right-hand side of the equation, and see if the result equals 89.464. If the right-hand side equals the left, then you have found the Z-spread. If not, adjust "ZS" in the appropriate direction and recalculate.

An **option-adjusted spread** (OAS) is used for bonds with embedded options. Loosely speaking, the option-adjusted spread takes the option yield component out of the Z-spread measure; the OAS is the spread to the government spot rate curve that the bond would have if it were option-free.

If we calculate an OAS for a callable bond, it will be less than the bond's Z-spread. The difference is the extra yield required to compensate bondholders for the call option. That extra yield is the option value. Thus, we can write:

$$\text{option value} = \text{Z-spread} - \text{OAS}$$

$$\text{OAS} = \text{Z-spread} - \text{option value}$$

KEY CONCEPTS

LOS 53.a

The price of a bond is the present value of its future cash flows, discounted at the bond's yield-to-maturity.

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

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

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

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

LOS 53.b

A bond's price and YTM are inversely related. An increase in YTM decreases the price and a decrease in YTM increases the price.

A bond will be priced at a discount to par value if its coupon rate is less than its YTM, and at a premium to par value if its coupon rate is greater than its YTM.

Prices are more sensitive to changes in YTM for bonds with lower coupon rates and longer maturities, and less sensitive to changes in YTM for bonds with higher coupon rates and shorter maturities.

A bond's price moves toward par value as time passes and maturity approaches.

LOS 53.c

Spot rates are market discount rates for single payments to be made in the future.

The no-arbitrage price of a bond is calculated using (no-arbitrage) spot rates as follows:

$$\text{no-arbitrage price} = \frac{\text{coupon}}{(1 + S_1)} + \frac{\text{coupon}}{(1 + S_2)^2} + \dots + \frac{\text{coupon} + \text{principal}}{(1 + S_N)^N}$$

LOS 53.d

The full price of a bond includes interest accrued between coupon dates. The flat price of a bond is the full price minus accrued interest.

Accrued interest for a bond transaction is calculated as the coupon payment times the portion of the coupon period from the previous payment date to the settlement date.

Methods for determining the period of accrued interest include actual days (typically used for government bonds) or 30-day months and 360-day years (typically used for corporate bonds).

LOS 53.e

Matrix pricing is a method used to estimate the yield-to-maturity for bonds that are not traded or infrequently traded. The yield is estimated based on the yields of traded bonds with the same credit quality. If these traded bonds have different maturities than the bond being valued, linear interpolation is used to estimate the subject bond's yield.

LOS 53.f

The effective yield of a bond depends on its periodicity, or annual frequency of coupon payments. For an annual-pay bond the effective yield is equal to the yield-to-maturity. For bonds with greater periodicity, the effective yield is greater than the yield-to-maturity.

A YTM quoted on a semiannual bond basis is two times the semiannual discount rate.

Bond yields that follow street convention use the stated coupon payment dates. A true yield accounts for coupon payments that are delayed by weekends or holidays and may be slightly lower than a street convention yield.

Current yield is the ratio of a bond's annual coupon payments to its price. Simple yield adjusts current yield by using straight-line amortization of any discount or premium.

For a callable bond, a yield-to-call may be calculated using each of its call dates and prices. The lowest of these yields and YTM is a callable bond's yield-to-worst.

Floating rate notes have a *quoted margin* relative to a reference rate, typically Libor. The quoted margin is positive for issuers with more credit risk than the banks that quote Libor and may be negative for issuers that have less credit risk than loans to these banks. The *required margin* on a floating rate note may be greater than the quoted margin if credit quality has decreased, or less than the quoted margin if credit quality has increased.

For money market instruments, yields may be quoted on a discount basis or an add-on basis, and may use 360-day or 365-day years. A bond-equivalent yield is an add-on yield based on a 365-day year.

LOS 53.g

A yield curve shows the term structure of interest rates by displaying yields across different maturities.

The spot curve is a yield curve for single payments in the future, such as zero-coupon bonds or stripped Treasury bonds.

The par curve shows the coupon rates for bonds of various maturities that would result in bond prices equal to their par values.

A forward curve is a yield curve composed of forward rates, such as 1-year rates available at each year over a future period.

LOS 53.h

Forward rates are current lending/borrowing rates for short-term loans to be made in future periods.

A spot rate for a maturity of N periods is the geometric mean of forward rates over the N periods. The same relation can be used to solve for a forward rate given spot rates for two different periods.

To value a bond using forward rates, discount the cash flows at times 1 through N by the product of one plus each forward rate for periods 1 to N , and sum them.

For a 3-year annual-pay bond:

$$\text{price} = \frac{\text{coupon}}{(1 + S_1)} + \frac{\text{coupon}}{(1 + S_1)(1 + 1y1y)} + \frac{\text{coupon} + \text{principal}}{(1 + S_1)(1 + 1y1y)(1 + 2y1y)}$$

LOS 53.i

A yield spread is the difference between a bond's yield and a benchmark yield or yield curve. If the benchmark is a government bond yield, the spread is known as a government spread or G -spread. If the benchmark is a swap rate, the spread is known as an interpolated spread or I -spread.

A zero-volatility spread or Z -spread is the percent spread that must be added to each spot rate on the benchmark yield curve to make the present value of a bond equal to its price.

An option-adjusted spread or OAS is used for bonds with embedded options. For a callable bond, the OAS is equal to the Z -spread minus the call option value in basis points.

CONCEPT CHECKERS

1. A 20-year, 10% annual-pay bond has a par value of \$1,000. What is the price of the bond if it has a yield-to-maturity of 15%?
 - A. \$685.14.
 - B. \$687.03.
 - C. \$828.39.
2. An analyst observes a 5-year, 10% semiannual-pay bond. The face amount is £1,000. The analyst believes that the yield-to-maturity on a semiannual bond basis should be 15%. Based on this yield estimate, the price of this bond would be:
 - A. £828.40.
 - B. £1,189.53.
 - C. £1,193.04.
3. An analyst observes a 20-year, 8% option-free bond with semiannual coupons. The required yield-to-maturity on a semiannual bond basis was 8%, but suddenly it decreased to 7.25%. As a result, the price of this bond:
 - A. increased.
 - B. decreased.
 - C. stayed the same.
4. A \$1,000, 5%, 20-year annual-pay bond has a YTM of 6.5%. If the YTM remains unchanged, how much will the bond value increase over the next three years?
 - A. \$13.62.
 - B. \$13.78.
 - C. \$13.96.
5. A market rate of discount for a single payment to be made in the future is a:
 - A. spot rate.
 - B. simple yield.
 - C. forward rate.
6. If spot rates are 3.2% for one year, 3.4% for two years, and 3.5% for three years, the price of a \$100,000 face value, 3-year, annual-pay bond with a coupon rate of 4% is *closest* to:
 - A. \$101,420.
 - B. \$101,790.
 - C. \$108,230.
7. An investor paid a full price of \$1,059.04 each for 100 bonds. The purchase was between coupon dates, and accrued interest was \$23.54 per bond. What is each bond's flat price?
 - A. \$1,000.00.
 - B. \$1,035.50.
 - C. \$1,082.58.

8. Cathy Moran, CFA, is estimating a value for an infrequently traded bond with 6 years to maturity, an annual coupon of 7%, and a single-B credit rating. Moran obtains yields-to-maturity for more liquid bonds with the same credit rating:
- 5% coupon, 8 years to maturity, yielding 7.20%.
 - 6.5% coupon, 5 years to maturity, yielding 6.40%.
- The infrequently traded bond is *most likely* trading at:
- par value.
 - a discount to par value.
 - a premium to par value.
9. Based on semiannual compounding, what would the YTM be on a 15-year, zero-coupon, \$1,000 par value bond that's currently trading at \$331.40?
- 3.750%.
 - 5.151%.
 - 7.500%.
10. An analyst observes a Widget & Co. 7.125%, 4-year, semiannual-pay bond trading at 102.347% of par (where par is \$1,000). The bond is callable at 101 in two years. What is the bond's yield-to-call?
- 3.167%.
 - 5.664%.
 - 6.334%.
11. A floating-rate note has a quoted margin of +50 basis points and a required margin of +75 basis points. On its next reset date, the price of the note will be:
- equal to par value.
 - less than par value.
 - greater than par value.
12. Which of the following money market yields is a bond-equivalent yield?
- Add-on yield based on a 365-day year.
 - Discount yield based on a 360-day year.
 - Discount yield based on a 365-day year.
13. Which of the following yield curves is *least likely* to consist of observed yields in the market?
- Forward yield curve.
 - Par bond yield curve.
 - Coupon bond yield curve.
14. The 4-year spot rate is 9.45%, and the 3-year spot rate is 9.85%. What is the 1-year forward rate three years from today?
- 8.258%.
 - 9.850%.
 - 11.059%.

15. Given the following spot and forward rates:
- Current 1-year spot rate is 5.5%.
 - One-year forward rate one year from today is 7.63%.
 - One-year forward rate two years from today is 12.18%.
 - One-year forward rate three years from today is 15.5%.
- The value of a 4-year, 10% annual-pay, \$1,000 par value bond is *closest* to:
- A. \$996.
 - B. \$1,009.
 - C. \$1,086.
16. A corporate bond is quoted at a spread of +235 basis points over an interpolated 12-year U.S. Treasury bond yield. This spread is a(n):
- A. G-spread.
 - B. I-spread.
 - C. Z-spread.

For more questions related to this topic review, log in to your Schweser online account and launch SchweserPro™ QBank; and for video instruction covering each LOS in this topic review, log in to your Schweser online account and launch the OnDemand video lectures, if you have purchased these products.

CHALLENGE PROBLEMS

1. What is the yield on a semiannual bond basis of an annual-pay 7% coupon bond priced at par?

2. What is the equivalent annual-pay YTM for a 7% coupon semiannual-pay bond?

3. The yield-to-maturity on a quoted on a semiannual bond basis on 6-month, 1-year, and 18-month T-bills are 2.80%, 3.20%, and 4.02%, respectively. A 1.5-year, 4% Treasury note is selling at par. If a 1.5-year semiannual-pay corporate bond with a 7% coupon is selling for 102.395, what is the spread over the Treasury note for this bond? Is the zero-volatility spread (in basis points) 127, 130, or 133?

4. Assume the following spot rates are quoted on a semiannual basis.

<i>Years to Maturity</i>	<i>Spot Rates</i>
0.5	4.0%
1.0	4.4%
1.5	5.0%
2.0	5.4%

- A. What is the 6-month forward rate one year from now?

- B. What is the 1-year forward rate one year from now?

- C. What is the value of a 2-year, 4.5% coupon, semiannual-pay bond?

5. Assume the current 6-month rate is 3.5% and the 6-month forward rates (all on a semiannual bond basis) are those in the following table.

<i>Periods From Now</i>	<i>Forward Rates</i>
1	3.8%
2	4.0%
3	4.4%
4	4.8%

- A. Calculate the corresponding spot rates.
- B. What is the value of a 1.5 year, 4% semiannual-pay bond based on spot rates?

CONCEPT CHECKERS – ANSWERS

1. **B** $N = 20; I/Y = 15; FV = 1,000; PMT = 100; CPT \rightarrow PV = -\$687.03.$
2. **A** $N = 10; I/Y = 7.5; FV = 1,000; PMT = 50; CPT \rightarrow PV = -\$828.40.$
3. **A** The price-yield relationship is inverse. If the required yield decreases, the bond's price will increase, and vice versa.
4. **A** With 20 years to maturity, the value of the bond with an annual-pay yield of 6.5% is $N = 20, PMT = 50, FV = 1,000, I/Y = 6.5, CPT \rightarrow PV = -834.72.$ With $N = 17, CPT \rightarrow PV = -848.34,$ so the value will increase \$13.62.
5. **A** A spot rate is a discount rate for a single future payment. Simple yield is a measure of a bond's yield that accounts for coupon interest and assumes straight-line amortization of a discount or premium. A forward rate is an interest rate for a future period, such as a 3-month rate six months from today.
6. **A**
$$\text{bond value} = \frac{4,000}{1.032} + \frac{4,000}{(1.034)^2} + \frac{104,000}{(1.035)^3} = \$101,419.28$$
7. **B** The full price includes accrued interest, while the flat price does not. Therefore, the flat (or clean) price is $1,059.04 - 23.54 = \$1,035.50.$
8. **C** Using linear interpolation, the yield on a bond with six years to maturity should be $6.40\% + (1 / 3)(7.20\% - 6.40\%) = 6.67\%.$ A bond with a 7% coupon and a yield of 6.67% is at a premium to par value.
9. **C** $N = 30; FV = 1,000; PMT = 0; PV = -331.40; CPT \rightarrow I/Y = 3.750 \times 2 = 7.500\%.$
Alternatively,
$$\left[\left(\frac{1,000}{331.4} \right)^{\frac{1}{30}} - 1 \right] \times 2 = 7.5\%$$
10. **C** $N = 4; FV = 1,010; PMT = 35.625; PV = -1,023.47; CPT \rightarrow I/Y = 3.167 \times 2 = 6.334\%.$
11. **B** If the required margin is greater than the quoted margin, the credit quality of the issue has decreased and the price on the reset date will be less than par value.
12. **A** An add-on yield based on a 365-day year is a bond-equivalent yield.
13. **B** Par bond yield curves are based on the theoretical yields that would cause bonds at each maturity to be priced at par. Coupon bond yields and forward interest rates can be observed directly from market transactions.
14. **A** $(1.0945)^4 = (1.0985)^3 \times (1 + 3y1y)$
$$3y1y = \frac{(1.0945)^4}{(1.0985)^3} - 1 = 8.258\%$$

Approximate forward rate = $4(9.45\%) - 3(9.85\%) = 8.25\%.$

15. B Bond value =

$$\frac{100}{1.055} + \frac{100}{(1.055)(1.0763)} + \frac{100}{(1.055)(1.0763)(1.1218)} + \frac{1,100}{(1.055)(1.0763)(1.1218)(1.155)}$$

= 1,009.03

16. A G-spreads are quoted relative to an actual or interpolated government bond yield. I-spreads are quoted relative to swap rates. Z-spreads are calculated based on the shape of the benchmark yield curve.

CHALLENGE PROBLEMS – ANSWERS

1. semiannual bond basis YTM = 2 × semiannual discount rate

$$\text{semiannual discount rate} = (1.07)^{1/2} - 1 = 0.344 = 3.44\%$$

$$\text{semiannual bond basis YTM} = 2 \times 3.44\% = 6.88\%$$

2. annual-pay YTM = $\left(1 + \frac{0.07}{2}\right)^2 - 1 = 0.0712 = 7.12\%$

3. Compute the YTM on the corporate bond:

$$N = 1.5 \times 2 = 3; PV = -102.395; PMT = 7 / 2 = 3.5; FV = 100; CPT \rightarrow I/Y = 2.6588 \times 2 = 5.32\%$$

$$G\text{-spread} = YTM_{\text{Bond}} - YTM_{\text{Treasury}} = 5.32\% - 4.0\% = 1.32\%, \text{ or } 132 \text{ bp}$$

Solve for the zero-volatility spread by setting the present value of the bond's cash flows equal to the bond's price, discounting each cash flow by the Treasury spot rate plus a fixed Z-spread.

$$102.4 = \frac{3.5}{1 + \frac{0.028 + ZS}{2}} + \frac{3.5}{\left(1 + \frac{0.032 + ZS}{2}\right)^2} + \frac{103.5}{\left(1 + \frac{0.0402 + ZS}{2}\right)^3}$$

Substituting each of the choices into this equation gives the following bond values:

<i>Z-Spread</i>	<i>Bond Value</i>
127 bp	102.4821
130 bp	102.4387
133 bp	102.3953

A Z-spread of 133 bp produces a value closest to the bond's price.

$$4. \quad A. \quad \left(1 + \frac{S_{1.5}}{2}\right)^3 = \left(1 + \frac{S_{1.0}}{2}\right)^2 \left(1 + \frac{12m6m}{2}\right)$$

$$\left(1 + \frac{12m6m}{2}\right) = \frac{\left(1 + \frac{S_{1.5}}{2}\right)^3}{\left(1 + \frac{S_{1.0}}{2}\right)^2} = \frac{1.025^3}{1.022^2} = 1.03103$$

$$12m6m = 0.03103 \times 2 = 0.0621 = 6.21\%$$

- B. 1y1y here refers to the 1-year rate, one year from today, expressed on a semiannual bond basis.

$$\frac{1y1y}{2} = \sqrt{\frac{\left(1 + \frac{S_2}{2}\right)^4}{\left(1 + \frac{S_1}{2}\right)^2}} - 1$$

$$\frac{1y1y}{2} = \sqrt{\frac{\left(1 + \frac{0.054}{2}\right)^4}{\left(1 + \frac{0.044}{2}\right)^2}} - 1 = 0.0320$$

$$1y1y = 2 \times 0.0320 = 6.40\%$$

Note that the approximation $2 \times 5.4 - 4.4 = 6.4$ works very well here and is quite a bit less work.

- C. Discount each of the bond's cash flows (as a percent of par) by the appropriate spot rate:

$$\text{bond value} = \frac{2.25}{1 + \frac{0.040}{2}} + \frac{2.25}{\left(1 + \frac{0.044}{2}\right)^2} + \frac{2.25}{\left(1 + \frac{0.050}{2}\right)^3} + \frac{102.25}{\left(1 + \frac{0.054}{2}\right)^4}$$

$$= \frac{2.25}{1.02} + \frac{2.25}{1.0445} + \frac{2.25}{1.0769} + \frac{102.25}{1.1125} = 98.36$$

$$5. \quad A. \quad \left(1 + \frac{S_{1.0}}{2}\right)^2 = \left(1 + \frac{S_{0.5}}{2}\right) \left(1 + \frac{6m6m}{2}\right) = \left(1 + \frac{0.035}{2}\right) \left(1 + \frac{0.038}{2}\right) = 1.0368$$

$$\frac{S_{1.0}}{2} = 1.0368^{1/2} - 1 = 0.0182$$

$$S_{1.0} = 0.0182 \times 2 = 0.0364 = 3.64\%$$

$$\begin{aligned} \left(1 + \frac{S_{1.5}}{2}\right)^3 &= \left(1 + \frac{S_{0.5}}{2}\right) \left(1 + \frac{6m6m}{2}\right) \left(1 + \frac{12m6m}{2}\right) \\ &= \left(1 + \frac{0.035}{2}\right) \left(1 + \frac{0.038}{2}\right) \left(1 + \frac{0.040}{2}\right) = 1.0576 \end{aligned}$$

$$\frac{S_{1.5}}{2} = 1.0576^{1/3} - 1 = 0.0188$$

$$S_{1.5} = 0.0188 \times 2 = 0.0376 = 3.76\%$$

$$\begin{aligned} \left(1 + \frac{S_{2.0}}{2}\right)^4 &= \left(1 + \frac{S_{0.5}}{2}\right) \left(1 + \frac{6m6m}{2}\right) \left(1 + \frac{12m6m}{2}\right) \left(1 + \frac{18m6m}{2}\right) \\ &= \left(1 + \frac{0.035}{2}\right) \left(1 + \frac{0.038}{2}\right) \left(1 + \frac{0.040}{2}\right) \left(1 + \frac{0.044}{2}\right) = 1.0809 \end{aligned}$$

$$\frac{S_{2.0}}{2} = 1.0809^{1/4} - 1 = 0.0196$$

$$S_{2.0} = 0.0196 \times 2 = 0.0392 = 3.92\%$$

$$B. \quad \frac{2}{1 + \frac{0.035}{2}} + \frac{2}{\left(1 + \frac{0.0364}{2}\right)^2} + \frac{102}{\left(1 + \frac{0.0376}{2}\right)^3} = 100.35$$

INTRODUCTION TO ASSET-BACKED SECURITIES

Study Session 15

EXAM FOCUS

In this topic review we introduce asset-backed securities, describing their benefits, legal structure, and characteristics. Our primary focus is residential mortgage-backed securities (RMBS). Candidates should understand the characteristics of mortgage pass-through securities and how and why collateralized mortgage obligations are created from them. Be prepared to compare and contrast agency RMBS, non-agency RMBS, and commercial MBS. Finally, candidates should know why collateralized debt obligations are created and how they differ from the other securitized debt securities covered.

LOS 54.a: Explain benefits of securitization for economies and financial markets.

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 securities supported by 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 and (2) an increase in the liquidity of the underlying financial assets.

Consider a bank that makes mortgage loans to home buyers and retains and services these loans (i.e., collects the mortgage payments and performs the necessary recordkeeping functions). To gain exposure to a bank's mortgage loans, investors traditionally could only choose among investing in bank deposits, bank debt securities, or the common equity of banks.

Compared to this traditional structure, with the bank serving the function of financial intermediary between borrowers and lenders, securitization can provide the following benefits:

- Securitization reduces intermediation costs, which results in lower funding costs for borrowers and higher risk-adjusted returns for lenders (investors).
- With securitization, the investors' legal claim to the mortgages or other loans is stronger than it is with only a general claim against the bank's overall assets.
- When a bank securitizes its loans, the securities are actively traded, which increases the liquidity of the bank's assets compared to holding the loans.
- By securitizing loans, banks are able to lend more than if they could only fund loans with bank assets. When a loan portfolio is securitized, the bank receives the proceeds, which can then be used to make more loans.

- Securitization has led to financial innovation that allows investors to invest in securities that better match their preferred risk, maturity, and return characteristics. As an example, an investor with a long investment horizon can invest in a portfolio of long-term mortgage loans rather than in only bank bonds, deposits, or equities. The investor can gain exposure to long-term mortgages without having the specialized resources and expertise necessary to provide loan origination and loan servicing functions.
- Securitization provides diversification and risk reduction compared to purchasing individual loans (whole loans).

LOS 54.b: Describe securitization, including the parties involved in the process and the roles they play.

We can illustrate the basic structure of a *securitization transaction* with this simplified, fictitious example of Fred Motor Company.

Fred Motor Company sells most of its cars on retail sales installment contracts (i.e., auto loans). The customers buy the automobiles, and Fred loans the customers the money for the purchase (i.e., Fred *originates* the loans) with the autos as collateral and receives principal and interest payments on the loans until they mature. The loans have maturities of 48 to 60 months at various interest rates. Fred is also the *servicer* of the loans (i.e., it collects principal and interest payments, sends out delinquency notices, and repossesses and disposes of the autos if the customers do not make timely payments).

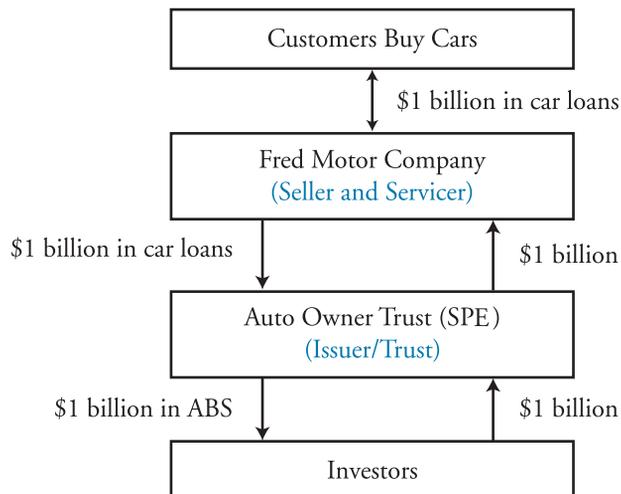
Fred has 50,000 auto loans totaling \$1 billion that it would like to remove from its balance sheet and use the proceeds to make more auto loans. It accomplishes this by selling the loan portfolio to a **special purpose entity** (SPE) called Auto Loan Trust for \$1 billion (Fred is called the *seller*). The SPE, which is set up for the specific purpose of buying these auto loans and selling asset-backed securities (ABS), is referred to as the *trust* or the *issuer*. The SPE then sells ABS to investors. The loan portfolio is the collateral supporting the ABS because the cash flows from the loans are the source of the funds to make the promised payments to investors. An SPE is sometimes also called a special purpose vehicle (SPV). The SPE is a separate legal entity from Fred.

Let's review the parties to this transaction and their functions:

- The seller (Fred) originates the auto loans and sells the portfolio of loans to Auto Loan Trust, the SPE.
- The issuer/trust (Auto Loan Trust) is the SPE that buys the loans from the seller and issues ABS to investors.
- The servicer (Fred) services the loans.
- In this case, the seller and the servicer are the same entity (Fred Motor Company), but that is not always the case.

The structure of this securitization transaction is illustrated in Figure 1.

Figure 1: Structure of Fred Motor Company Asset Securitization



Subsequent to the initial transaction, the principal and interest payments on the original loans are allocated to pay servicing fees to the servicer and principal and interest payments to the owners of the ABS. Often there are several classes of ABS issued by the trust, each with different priority claims to the cash flows from the underlying loans and different specifications of the payments to be received if the cash flows from the loans are not sufficient to pay all the promised ABS cash flows. This flow of funds structure is called a **waterfall structure** because each class of ABS (**tranche**) is paid sequentially, to the extent possible, from the cash flows from the underlying loan portfolio.

ABS are most commonly backed by automobile loans, credit card receivables, home equity loans, manufactured housing loans, student loans, Small Business Administration (SBA) loans, corporate loans, corporate bonds, emerging market bonds, and structured financial products. When the loans owned by the trust (SPE) are mortgages, we refer to the securities issued by the trust as **mortgage-backed securities (MBS)**.

Note that the SPE is a separate legal entity from Fred and the buyers of the ABS have no claim on other assets of Fred, only on the loans sold to the SPE. If Fred had issued corporate bonds to raise the funds to make more auto loans, the bondholders would be subject to the financial risks of Fred. With the ABS structure, a decline in the financial position of Fred, its ability to make cash payments, or its bond rating do not affect the value of the claims of ABS owners to the cash flows from the trust collateral (loan portfolio) because it has been sold by Fred, which is now simply the servicer (not the owner) of the loans. The credit rating of the ABS securities may be higher than the credit rating of bonds issued by Fred, in which case the cost to fund the loans using the ABS structure is lower than if Fred funded additional loans by issuing corporate bonds.

LOS 54.c: Describe typical structures of securitizations, including credit tranching and time tranching.

Securitizations may involve a single class of ABS so the cash flows to the securities are the same for all security holders. They can also be structured with multiple classes of securities, each with a different claim to the cash flows of the underlying assets. The different classes are often referred to as **tranches**. With this structure, a particular risk of the ABS securities is redistributed across the tranches. Some bear more of the risk and others bear less of the risk. The total risk is unchanged, simply reapportioned.

With **credit tranching**, the ABS tranches will have different exposures to the risk of default of the assets underlying the ABS. With this structure, also called a **senior/subordinated structure**, the subordinated tranches absorb credit losses as they occur (up to their principal values). The level of protection for the senior tranche increases with the proportion of subordinated bonds in the structure.

Let's look at an example to illustrate how a senior/subordinated structure redistributes the credit risk compared to a single-class structure. Consider an ABS with the following bond classes:

Senior Tranche	\$300,000,000
Subordinated Tranche A	\$80,000,000
Subordinated Tranche B	<u>\$30,000,000</u>
Total	\$410,000,000

Tranche B is first to absorb any losses (and is termed the *first-loss tranche*) until they exceed \$30 million in principal. Any losses from default of the underlying assets greater than \$30 million, and up to \$110 million, will be absorbed by Subordinated Tranche A. The Senior Tranche is protected from any credit losses of \$110 million or less and therefore will have the highest credit rating and offer the lowest yield of the three bond classes. This structure is also called a **waterfall** structure because in liquidation, each subordinated tranche would receive only the "overflow" from the more senior tranche(s) if they are repaid their principal value in full.

With **time tranching**, the first (sequential) tranche receives all principal repayments from the underlying assets up to the principal value of the tranche. The second tranche would then receive all principal repayments from the underlying assets until the principal value of this tranche is paid off. There may be other tranches with sequential claims to remaining principal repayments. Both credit tranching and time tranching are often included in the same structure. More detail about time tranching and the related planned amortization/support tranche structure is included later in this review when we discuss the structures of mortgage-backed securities.

LOS 54.d: Describe types and characteristics of residential mortgage loans that are typically securitized.

A **residential mortgage loan** is a loan for which the collateral that underlies the loan is residential real estate. If the borrower defaults on the loan, the lender has a legal claim to the collateral property. One key characteristic of a mortgage loan is its **loan-to-value ratio** (LTV), the percentage of the value of the collateral real estate that is loaned to the borrower. The lower the LTV, the higher the borrower's equity in the property.

For a lender, loans with lower LTVs are less risky because the borrower has more to lose in the event of default (so is less likely to default). Also, if the property value is high compared to the loan amount, the lender is more likely to recover the amount loaned if the borrower defaults and the lender repossesses and sells the property. In the United States, mortgages with higher LTV ratios, made to borrowers with good credit, are termed *prime loans*. Mortgages to borrowers of lower credit quality, or that have a lower-priority claim to the collateral in event of default, are termed *subprime loans*.

Typical mortgage terms and structures differ across regions and countries. The key characteristics of mortgage loans include their maturity, the determination of interest charges, how the loan principal is amortized, the terms under which prepayments of loan principal are allowed, and the rights of the lender in the event of default by the borrower. We address each of the characteristics in more detail.

Maturity

The term of a mortgage loan is the time until the final loan payment is made. In the United States, mortgage loans typically have terms from 15 to 30 years. Terms are longer, 20 to 40 years, in many European countries and as long as 50 years in others. In Japan, mortgage loans may have terms of 100 years.

Interest Rate

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

An **adjustable-rate mortgage** (ARM), also called a **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 such as Libor or the one-year U.S. Treasury bill rate, although several other reference rates are used.

A mortgage loan may have an interest rate that is fixed for some initial period, but 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.

Amortization of Principal

With a **fully amortizing** loan, each payment includes both an interest payment and a repayment of some of the loan principal so there is no loan principal remaining after the last regular mortgage payment. When payments are fixed for the life of the loan, payments in the beginning of the loan term have a large interest component and a small principal repayment component, and payments at the end of the loan terms have a small interest component and large principal repayment component.

A loan is said to be **partially amortizing** when loan payments include some repayment of principal, but there is a lump sum of principal that remains to be paid at the end of the loan period which is called a *balloon payment*. With an **interest-only mortgage**, there is no principal repayment for either an initial period or the life of the loan. If no principal is paid for the life of the loan it is an *interest-only lifetime* mortgage and the balloon payment is the original loan principal amount. Other interest-only mortgages specify that payments are interest-only over some initial period, with partial or full amortization of principal after that.

Prepayment Provisions

A partial or full repayment of principal in excess of the scheduled principal repayments required by the mortgage is referred to as a **prepayment**. If a homeowner sells her home during the mortgage term (a common occurrence), repaying the remaining principal is required and is one type of prepayment. A homeowner who *refinances* her mortgage prepays the remaining principal amount using the proceeds of a new, lower interest rate loan. Some homeowners prepay by paying more than their scheduled payments in order to reduce the principal outstanding, reduce their interest charges, and eventually pay off their loans prior to maturity.

Some loans have no penalty for prepayment of principal while others have a **prepayment penalty**. A prepayment penalty is an additional payment that must be made if principal is prepaid during an initial period after loan origination or, for some mortgages, prepaid anytime during the life of the mortgage. A prepayment penalty benefits the lender by providing compensation when the loan is paid off early because market interest rates have decreased since the mortgage loan was made (i.e., loans are refinanced at a lower interest rate).

Foreclosure

Some mortgage loans are **non-recourse loans**, which means the lender has no claim against the assets of the borrower except for the collateral property itself. When this is the case, if home values fall so the outstanding loan principal is greater than the home value, borrowers sometimes voluntarily return the property to the lender in what is called a *strategic default*.

Other mortgage loans are **recourse loans** under which the lender has a claim against the borrower for the amount by which the sale of a repossessed collateral property falls short of the principal outstanding on the loan. Understandably, borrowers are more likely to default on non-recourse loans than on recourse loans. In Europe, most residential mortgages are recourse loans. In the United States, they are recourse loans in some states and non-recourse in others.

LOS 54.e: Describe types and characteristics of residential mortgage-backed securities, including mortgage pass-through securities and collateralized mortgage obligations, and explain the cash flows and risks for each type.

LOS 54.f: Define prepayment risk and describe the prepayment risk of mortgage-backed securities.

Residential mortgage-backed securities (RMBS) in the United States are termed **agency RMBS** or **non-agency RMBS**, depending on the issuer of the securities. Agency RMBS are issued by the Government National Mortgage Association (GNMA or Ginnie Mae), the Federal National Mortgage Association (Fannie Mae), and the Federal Home Loan Mortgage Corporation (Freddie Mac). Ginnie Mae securities are guaranteed by the GNMA and are considered to be backed by the full faith and credit of the U.S. government. Fannie Mae and Freddie Mac also guarantee the MBS they issue but are *government-sponsored enterprises* (GSE). While they are not considered to be backed by the full faith and credit of the U.S. government, these securities are considered to have very high credit quality.

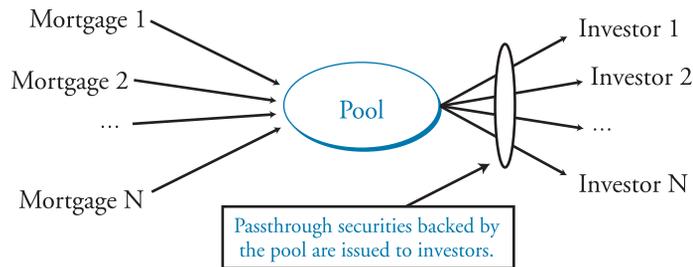
Agency RMBS are **mortgage pass-through securities**. Each mortgage pass-through security represents a claim on the cash flows from a pool of mortgages. Any number of mortgages may be used to form the pool, and any mortgage included in the pool is referred to as a **securitized mortgage**. The mortgages in the pool typically have different maturities and different mortgage rates. The **weighted average maturity** (WAM) of the pool is equal to the weighted average of the final maturities of all the mortgages in the pool, weighted by each mortgage's outstanding principal balance as a proportion of the total outstanding principal value of all the mortgages in the pool. The **weighted average coupon** (WAC) of the pool is the weighted average of the interest rates of all the mortgages in the pool. The investment characteristics of mortgage pass-through securities are a function of their cash flow features and the strength of the guarantee provided.

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

Investors in mortgage pass-through securities receive the monthly cash flows generated by the underlying pool of mortgages, less any servicing and guarantee/insurance fees.

The fees account for the fact that **pass-through rates** (i.e., the coupon rate on the MBS, also called its *net interest* or *net coupon*) are less than the mortgage rate of the underlying mortgages in the pool.

Figure 2: Mortgage Pass-through Cash Flow



The timing of the cash flows to pass-through security holders does not exactly coincide with the cash flows generated by the pool. This is due to the delay between the time the mortgage service provider receives the mortgage payments and the time the cash flows are *passed through* to the security holders.

Prepayment Risk

An important characteristic of pass-through securities is their **prepayment risk**. Because the mortgage loans used as collateral for agency MBS have no prepayment penalty, the MBS themselves have significant prepayment risk. Recall that prepayments are principal repayments in excess of the scheduled principal repayments for amortizing loans. The risk that prepayments will be slower than expected is called *extension risk* and the risk that prepayments will be more rapid than expected is called *contraction risk*.

Prepayments cause the timing and amount of cash flows from mortgage loans and MBS to be uncertain; rapid prepayment reduces the amount of principal outstanding on the loans supporting the MBS so the total interest paid over the life of the MBS is reduced. Because of this, it is necessary to make specific assumptions about prepayment rates in order to value mortgage pass-through securities. The single monthly mortality rate (SMM) is the percentage by which prepayments reduce the month-end principal balance, compared to what it would have been with only scheduled principal payments (with no prepayments). The **conditional prepayment rate (CPR)** is an annualized measure of prepayments. Prepayment rates depend on the weighted average coupon rate of the loan pool, current interest rates, and prior prepayments of principal.

The Public Securities Association (PSA) *prepayment benchmark* assumes that the monthly prepayment rate for a mortgage pool increases as it ages (becomes *seasoned*). The PSA benchmark is expressed as a monthly series of CPRs. If the prepayment rate (CPR) of an MBS is expected to be the same as the PSA standard benchmark CPR, we say the PSA is 100 (100% of the benchmark CPR). A pool of mortgages may have prepayment rates that are faster or slower than PSA 100, depending on the current level of interest rates and the coupon rate of the issue. 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.

Based on an assumption about the prepayment rate for an MBS, we can calculate its weighted average life, or simply average life, which is the expected number of years until all the loan principal is repaid. Because of prepayments, the average life of an MBS will be less than its weighted average maturity. During periods of falling interest rates, the refinancing of mortgage loans will accelerate prepayments and reduce the average life of an MBS. A high PSA, such as 400, will reduce the average life of an MBS to only 4.5 years, compared to an average life of about 11 years for an MBS with a PSA of 100.

Collateralized Mortgage Obligations

Collateralized mortgage obligations (CMO) are securities that are collateralized by RMBS. Each CMO has multiple bond classes (CMO tranches) that have different exposures to prepayment risk. The total prepayment risk of the underlying RMBS is not changed; the prepayment risk is simply reapportioned among the various CMO tranches.

Institutional investors have different tolerances for prepayment risk. Some are primarily concerned with extension risk while others may want to minimize exposure to contraction risk. By partitioning and distributing the cash flows generated by RMBS into different risk packages to better match investor preferences, CMOs increase the potential market for securitized mortgages and perhaps reduce funding costs as a result.

CMOs are securities backed by mortgage pass-through securities (i.e., they are securities secured by other securities). Interest and principal payments from the mortgage pass-through securities are allocated in a specific way to different bond classes called tranches, so that each tranche has a different claim against the cash flows of the mortgage pass-throughs. Each CMO tranche has a different mixture of contraction and extension risk. Hence, CMO securities can be more closely matched to the unique asset/liability needs of institutional investors and investment managers.

The primary CMO structures include sequential-pay tranches, planned amortization class tranches (PACs), support tranches, and floating-rate tranches.

Sequential Pay CMO

One way to reapportion the prepayment risk inherent in the underlying pass-through MBS is to separate the cash flows into tranches that are retired sequentially (i.e., create a **sequential pay CMO**). As an example of this structure, we consider a simple CMO with two tranches. Both tranches receive interest payments at a specified coupon rate, but all principal payments (both scheduled payments and prepayments) are paid to Tranche 1 (the *short tranche*) until its principal is paid off. Principal payments then flow to Tranche 2 until its principal is paid off.

Contraction and extension risk still exist with this structure, but they have been redistributed to some extent between the two tranches. The short tranche, which

matures first, offers investors relatively more protection against extension risk. The other tranche provides relatively more protection against contraction risk. Let's expand this example with some specific numbers to illustrate how sequential pay structures work.

Consider the simplified CMO structure presented in Figure 3. Payments to the two sequential-pay tranches are made first to Tranche A and then to Tranche B.

Figure 3: Sequential Pay CMO Structure

<i>CMO Structure</i>		
<i>Tranche</i>	<i>Outstanding Par Value</i>	<i>Coupon Rate</i>
A	\$200,000,000	8.50%
B	50,000,000	8.50%

Payments from the underlying collateral (which has a pass-through coupon rate of 8.5%) for the first five months, as well as months 183 through 187, are shown in Figure 4. These payments include scheduled payments plus estimated prepayments based on an assumed prepayment rate. (Note that some totals do not match due to rounding.)

Figure 4: CMO Projected Cash Flows

<i>Month</i>	<i>Beginning Principal Balance</i>	<i>Principal Payment</i>	<i>Interest</i>	<i>Total Cash Flow = Principal Plus Interest</i>
1	\$250,000,000	\$391,128	\$1,770,833	\$2,161,961
2	249,608,872	454,790	1,768,063	2,222,853
3	249,154,082	518,304	1,764,841	2,283,145
4	248,635,778	581,620	1,761,170	2,342,790
5	248,054,157	644,690	1,757,050	2,401,741
183	\$51,491,678	\$545,153	\$364,733	\$909,886
184	50,946,525	540,831	360,871	901,702
185	50,405,694	536,542	357,040	893,582
186	49,869,152	532,287	353,240	885,526
187	49,336,866	528,065	349,469	877,534



Professor's Note: This example is provided as an illustration of how cash flows are allocated to sequential tranches. The LOS does not require you to do the calculations that underlie the numbers in Figure 4. The important point here is how the cash flows are allocated to each tranche.

Example: Calculating principal payments on a sequential pay tranche

Calculate the principal payments, ending principal balance, and interest payments to each tranche for the first month using the data in Figure 4.

Answer:

Tranche A receives the entire principal payment as well as its share of the interest.
Tranche B only receives interest.

$$\text{Tranche A principal payment} = \$391,128$$

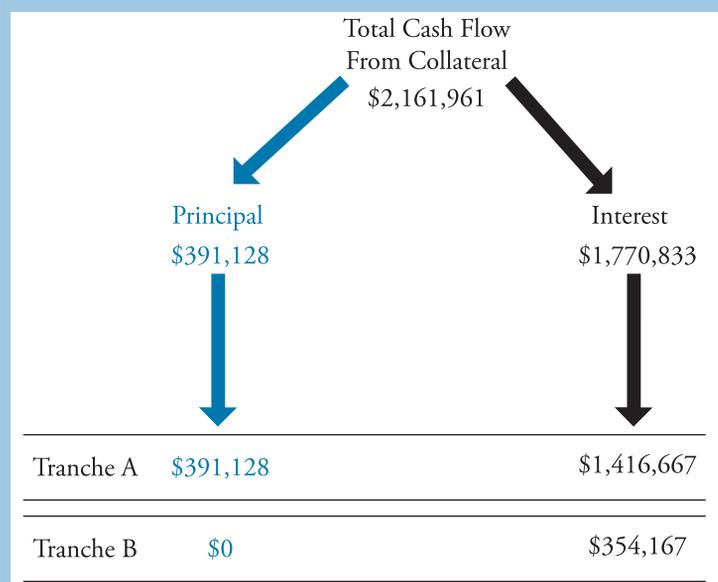
$$\text{Tranche A ending principal balance} = \$200,000,000 - \$391,128 = \$199,608,872$$

$$\text{Tranche A interest} = \$200,000,000 \times \frac{0.085}{12} = \$1,416,667$$

$$\text{Tranche B principal payment} = \$0$$

$$\text{Tranche B ending principal balance} = \$50,000,000 - \$0 = \$50,000,000$$

$$\text{Tranche B interest} = \$50,000,000 \times \frac{0.085}{12} = \$354,167$$

Cash Flow to Sequential Pay Tranches: Month 1

Example: Calculating principal payments – Part 2

Calculate the principal payments, ending principal balance, and interest payments to each tranche in the 185th month, assuming the principal balance of Tranche A is now \$405,694.

Answer:

From Figure 4 we see that the total month 185 principal payment is \$536,542 and the total interest payment is \$357,040. Tranche A receives principal payments sufficient to pay off its balance as well as its share of the interest. Tranche B receives the remaining principal as well as its interest.

$$\text{Tranche A principal payment} = \$405,694$$

$$\text{Tranche A ending principal balance} = \$405,694 - \$405,694 = \$0$$

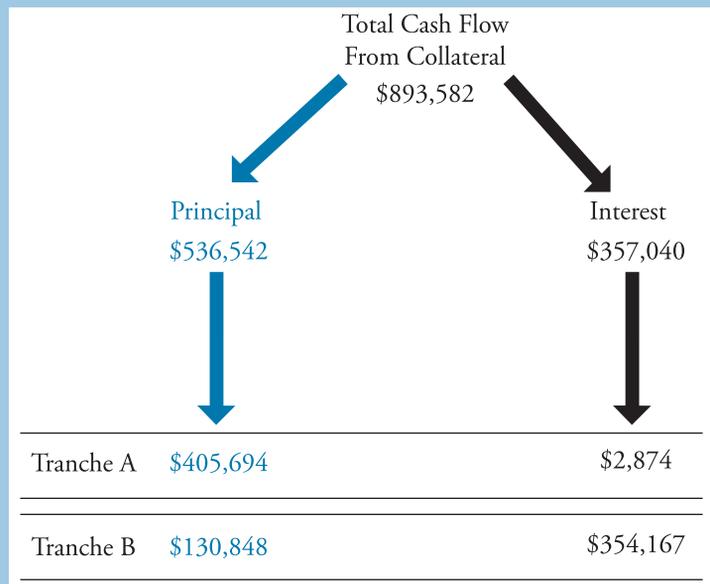
$$\text{Tranche A interest} = \$405,694 \times \frac{0.085}{12} = \$2,874$$

$$\text{Tranche B principal payment} = \$536,542 - \$405,694 = \$130,848$$

$$\text{Tranche B ending principal balance} = \$50,000,000 - \$130,848 = \$49,869,152$$

$$\text{Tranche B interest} = \$50,000,000 \times \frac{0.085}{12} = \$354,167$$

Cash Flow to Sequential Pay Tranche: Month 185



Planned Amortization Class (PAC) CMO

Another CMO structure has one or more **planned amortization class (PAC)** tranches and **support tranches**. A PAC tranche is structured to make predictable payments, regardless of actual prepayments to the underlying MBS. The PAC tranches have both reduced contraction risk and reduced extension risk compared to the underlying MBS.

Reducing the prepayment risk of the PAC tranches is achieved by increasing the prepayment risk of the CMO's support tranches. If principal repayments are more rapid than expected, the support tranche receives the principal repayments in excess of those specifically allocated to the PAC tranches. Conversely, if the actual principal repayments are slower than expected, principal repayments to the support tranche are curtailed so the scheduled PAC payments can be made. The larger the support tranche(s) relative to the PAC tranches, the smaller the probability that the cash flows to the PAC tranches will differ from their scheduled payments.

For a given CMO structure there are limits to how fast or slow actual prepayment experience can be before the support tranches can no longer either provide or absorb prepayments in the amounts required to keep the PAC payments to their scheduled amounts. The upper and lower bounds on the actual prepayment rates for which the support tranches are sufficient to either provide or absorb actual prepayments in order to keep the PAC principal repayments on schedule are called the **initial PAC collar**.

A PAC may have an initial collar given as 100 – 300 PSA. This means the PAC will make its scheduled payments to investors unless actual prepayment experience is outside these bounds (i.e., above 300 PSA or below 100 PSA). If the prepayment rate is outside of these bounds so payments to a PAC tranche are either sooner or later than promised, the PAC tranche is referred to as a **broken PAC**.

Support tranches have both more contraction risk and more extension risk than the underlying MBS and have a higher promised interest rate than the PAC tranche.

As an example, Figure 5 shows the average life for a hypothetical structure that includes a PAC I tranche and a support tranche at various PSA speeds, assuming the PSA speed stays at that level for the entire life of the PAC tranche.

Figure 5: Average Life Variability of PAC I Tranche vs. Support Tranche

<i>PSA Speed</i>	<i>PAC I Tranche</i>		<i>Support Tranche</i>
0	13.2		24.0
50	8.8		21.2
100	6.5	↑	17.1
150	6.5		13.3
200	6.5	Initial Collar	10.4
250	6.5		5.2
300	6.5	↓	2.9
350	5.9		2.4
400	5.4		1.8
450	4.6		1.5
500	4.2		1.2

Figure 5 illustrates that the PAC I tranche has less prepayment risk than the support tranche because the variability of its average life is significantly lower.

- When prepayment speeds fall and prepayments decrease, the support tranche average life is significantly longer than the average life of the PAC I tranche. Thus, the support tranche has significantly more extension risk.
- When prepayment speeds rise and prepayments increase, the support tranche average life is much shorter than that of the PAC I tranche. Thus, the support tranche also has significantly more contraction risk.
- Within the initial PAC collar of 100 to 300 PSA, the average life of the PAC I tranche is constant at 6.5 years.

Non-Agency RMBS

RMBS not issued by GNMA, Fannie Mae, or Freddie Mac are referred to as **non-agency RMBS**. They are not guaranteed by the government, so credit risk is an important consideration. The credit quality of a non-agency MBS depends on the credit quality of the borrowers as well as the characteristics of the loans, such as their LTV ratios. To be investment grade, most non-agency RMBS include some sort of **credit enhancement**. The level of credit enhancement is directly proportional to the credit rating desired by the issuer. Rating agencies determine the exact amount of credit enhancement necessary for an issue to hold a specific rating.

Credit tranching (subordination) is often used to enhance the credit quality of senior RMBS securities. A **shifting interest mechanism** is a method for addressing a decrease in the level of credit protection provided by junior tranches as prepayments or defaults occur in a senior/subordinated structure. If prepayments or credit losses decrease the credit enhancement of the senior securities, the shifting interest mechanism suspends payments to the subordinated securities for a period of time until the credit quality of the senior securities is restored.

LOS 54.g: Describe characteristics and risks of commercial mortgage-backed securities.

Commercial mortgage-backed securities (CMBS) are backed by income-producing real estate, typically in the form of:

- Apartments (multi-family).
- Warehouses (industrial use property).
- Shopping centers.
- Office buildings.
- Health care facilities.
- Senior housing.
- Hotel/resort properties.

An important difference between residential and commercial MBS is the obligations of the borrowers of the underlying loans. Residential MBS loans are repaid by homeowners; commercial MBS loans are repaid by real estate investors who, in turn, rely on tenants and customers to provide the cash flow to repay the mortgage loan. CMBS mortgages

are structured as **nonrecourse loans**, meaning the lender can *only* look to the collateral as a means to repay a delinquent loan if the cash flows from the property are insufficient. In contrast, a residential mortgage lender with recourse can go back to the borrower personally in an attempt to collect any excess of the loan amount above the net proceeds from foreclosing on and selling the property.

For these reasons, the analysis of CMBS securities focuses on the credit risk of the property and not the credit risk of the borrower. The analysis of CMBS structures focuses on two key ratios to assess credit risk.

1. **Debt-to-service-coverage ratio (DSC)** is a basic cash flow coverage ratio of the amount of cash flow from a commercial property available to make debt service payments compared to the required debt service cost.

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

Net operating income (NOI) is calculated after the deduction for real estate taxes but before any relevant income taxes. This ratio, which is typically between one and two, indicates greater protection to the lender when it is higher. Debt service coverage ratios below one indicate that the borrower is not generating sufficient cash flow to make the debt payments and is likely to default. Remember: *the higher the better* for this ratio from the perspective of the lender and the MBS investor.

2. **Loan-to-value ratio** compares the loan amount on the property to its current fair market or appraisal value.

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

The lower this ratio, the more protection the mortgage lender has in making the loan. Loan-to-value ratios determine the amount of collateral available, above the loan amount, to provide a cushion to the lender should the property be foreclosed on and sold. Remember: *the lower the better* for this ratio from the perspective of the lender and the MBS investor.

The basic **CMBS structure** is created to meet the risk and return needs of the CMBS investor. As with residential MBS securities, rating organizations such as S&P and Moody's assess the credit risk of each CMBS issue and determine the appropriate credit rating. Each CMBS is segregated into tranches. Losses due to default are first absorbed by the tranche with the lowest priority. Sometimes this most-junior tranche is not rated and is then referred to as the equity tranche, residual tranche, or first-loss tranche.

As with any fixed-rate security, call protection is valuable to the bondholder. In the case of MBS, call protection is equivalent to prepayment protection (i.e., restrictions on the early return of principal through prepayments). CMBS provide call protection in two ways: loan-level call protection provided by the terms of the individual mortgages and call protection provided by the CMBS structure.

There are several means of creating **loan-level call protection**:

- *Prepayment lockout.* For a specific period of time (typically two to five years), the borrower is prohibited from prepaying the mortgage loan.
- *Defeasance.* Should the borrower insist on making principal payments on the mortgage loan, the mortgage loan can be defeased. This is accomplished by using the prepaid principal to purchase a portfolio of government securities that is sufficient to make the remaining required payments on the CMBS. Given the high credit quality of government securities, defeased loans increase the credit quality of a CMBS loan pool.
- *Prepayment penalty points.* A penalty fee expressed in points may be charged to borrowers who prepay mortgage principal. Each point is 1% of the principal amount prepaid.
- *Yield maintenance charges.* The borrower is charged the amount of interest lost by the lender should the loan be prepaid. This *make whole* charge is designed to make lenders indifferent to prepayment, as cash flows are equivalent (at current market rates) whether the loan is prepaid or not.

With all loan call protection programs, any prepayment penalties received are distributed to the CMBS investors in a manner determined by the structure of the CMBS issue.

To create **CMBS-level call protection**, CMBS loan pools are segregated into tranches with a specific sequence of repayment. Those tranches with a higher priority will have a higher credit rating than lower priority tranches because loan defaults will first affect the lower tranches. A wide variety of features can be used to provide call protection to the more senior tranches of the CMBS.

Commercial mortgages are typically amortized over a period longer than the loan term; for example, payments for a 20-year commercial mortgage may be determined based on a 30-year amortization schedule. At the end of the loan term, the loan will still have principal outstanding that needs to be paid; this amount is called a **balloon payment**. If the borrower is unable to arrange refinancing to make this payment, the borrower is in default. This possibility is called balloon risk. The lender will be forced to extend the term of the loan during a workout period, during which time the borrower will be charged a higher interest rate. Because balloon risk entails extending the term of the loan, it is also referred to as extension risk for CMBS.

LOS 54.h: Describe types and characteristics of non-mortgage asset-backed securities, including the cash flows and risks of each type.

In addition to those backed by mortgages, there are ABS that are backed by various types of financial assets including small business loans, accounts receivable, credit card receivables, automobile loans, home equity loans, and manufactured housing loans. Each of these types of ABS has different risk characteristics and their structures vary to some extent as well. Here we explain the characteristics of two types, ABS backed by automobile loans and ABS backed by credit card receivables. These two have an important difference in that automobile loans are fully amortizing while credit card receivables are non-amortizing.

Auto Loan ABS

Auto loan-backed securities are backed by loans for automobiles. Auto loans have maturities from 36 to 72 months. Issuers include the financial subsidiaries of auto manufacturers, commercial banks, credit unions, finance companies, and other small financial institutions.

The cash flow components of auto loan-backed securities include interest payments, scheduled principal payments, and prepayments. Auto loans prepay if the cars are sold, traded in, or repossessed. Prepayments also occur if the car is stolen or wrecked and the loan is paid off from insurance proceeds. Finally, the borrower may simply use excess cash to reduce or pay off the loan balance.

Automobile loan ABS all have some sort of credit enhancement to make them attractive to institutional investors. Many have a senior-subordinated structure, with a junior tranche that absorbs credit risk. One or more internal credit enhancement methods, a reserve account, an excess interest spread, or overcollateralization, is also often present in these structures. Just as with mortgages, prime loans refer to those made to borrowers with higher credit ratings and sub-prime loans refers to those made to borrowers with low credit ratings.

Credit Card ABS

Credit card receivable-backed securities are ABS backed by pools of credit card debt owed to banks, retailers, travel and entertainment companies, and other credit card issuers.

The cash flow to a pool of credit card receivables includes finance charges, annual fees, and principal repayments. Credit cards have periodic payment schedules, but because their balances are revolving (i.e., non-amortizing), the principal amount is maintained for a period of time. Interest on credit card ABS is paid periodically, but no principal is paid to the ABS holders during the **lockout period**, which may last from 18 months to 10 years after the ABS are created.

If the underlying credit card holders make principal payments during the lockout period, these payments are used to purchase additional credit card receivables, keeping the overall value of the receivables pool relatively constant. Once the lockout period ends, principal payments are passed through to security holders. Credit card ABS typically have an early (rapid) amortization provision that provides for earlier amortization of principal when it is necessary to preserve the credit quality of the securities.

Interest rates on credit card ABS are sometimes fixed but often they are floating. Interest payments may be monthly, quarterly, or for longer periods.

LOS 54.i: Describe collateralized debt obligations, including their cash flows and risks.

A **collateralized debt obligation** (CDO) is a structured security issued by an SPE for which the collateral is a pool of debt obligations. When the collateral securities are corporate and emerging market debt, they are called *collateralized bond obligations* (CBO). *Collateralized loan obligations* (CLO) are supported by a portfolio of leveraged bank loans. Unlike the ABS we have discussed, CDOs do not rely on interest payments from the collateral pool. CDOs have a **collateral manager** who buys and sells securities in the collateral pool in order to generate the cash to make the promised payments to investors.

Structured finance CDOs are those where the collateral is ABS, RMBS, other CDOs, and CMBS.

Synthetic CDOs are those where the collateral is a portfolio of credit default swaps on structured securities.



Professor's Note: Credit default swaps are derivative securities that decrease (increase) in value as the credit quality of their reference securities increases (decreases).

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. In creating a CDO, the structure must be able to offer an attractive return on the subordinated tranche, after accounting for the required yields on the senior and mezzanine bond classes.

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. To the extent the collateral manager meets his goal of earning returns in excess of borrowing costs (the promised return to CDO investors), these excess returns are paid to the CDO manager and the equity tranche.

The CDO structure typically is to issue a floating-rate senior tranche that is 70–80% of the total and a smaller mezzanine tranche that pays a fixed rate of interest. If the securities in the collateral pool pay a fixed rate of interest, the collateral manager may enter into an interest rate swap that pays a floating rate of interest in exchange for a fixed rate of interest in order to make the collateral yield more closely match the funding costs in an environment of changing interest rates. The term *arbitrage CDO* is used for CDOs structured to earn returns from the spread between funding costs and portfolio returns.

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 CDOs senior and mezzanine bonds.

KEY CONCEPTS

LOS 54.a

The primary benefits of the securitization of financial assets are:

- Reduce the funding costs for firms selling the financial assets to the securitizing entity.
- Increase the liquidity of the underlying financial assets.

LOS 54.b

Parties to a securitization are a seller of financial assets, a special purpose entity (SPE), and a servicer.

- The seller is the firm that is raising funds through the securitization.
- An SPE is an entity independent of the seller. The SPE buys financial assets from the seller and issues asset-backed securities (ABS) supported by these financial assets.
- The servicer carries out collections and other responsibilities related to the financial assets. The servicer may be the same entity as the seller but does not have to be.

The SPE may issue a single class of ABS or multiple classes with different priorities of claims to cash flows from the pool of financial assets.

LOS 54.c

Asset-backed securities (ABS) can be a single class of securities or multiple classes with differing claims to the cash flows from the underlying assets. Time tranching refers to classes that receive the principal payments from underlying securities sequentially as each prior tranche is repaid in full. With credit tranching, any credit losses are first absorbed by the tranche with the lowest priority, and after that by any other subordinated tranches, in order. Some structures have both time tranching and credit tranching.

LOS 54.d

Characteristics of residential mortgage loans include:

- Maturity.
- Interest rate: fixed-rate, adjustable-rate, or convertible.
- Amortization: full, partial, or interest-only.
- Prepayment penalties.
- Foreclosure provisions: recourse or non-recourse.

The loan-to-value (LTV) ratio indicates the percentage of the value of the real estate collateral that is loaned. Lower LTVs indicate less credit risk.

LOS 54.e

Agency residential mortgage-backed securities (RMBS) are guaranteed and issued by GNMA, Fannie Mae, or Freddie Mac. Mortgages that back agency RMBS must be conforming loans that meet certain minimum credit quality standards. Non-agency RMBS are issued by private companies and may be backed by non-conforming mortgages.

Key characteristics of RMBS include:

- Pass-through rate, the coupon rate on the RMBS.
- Weighted average maturity (WAM) and weighted average coupon (WAC) of the underlying pool of mortgages.
- Conditional prepayment rate (CPR), which may be compared to the Public Securities Administration (PSA) benchmark for expected prepayment rates.

Non-agency RMBS typically include credit enhancement. External credit enhancement is a third-party guarantee. Internal credit enhancement includes reserve funds (cash or excess spread), overcollateralization, and senior/subordinated structures.

Collateralized mortgage obligations (CMOs) are collateralized by pools of residential MBS. CMOs are structured with tranches that have different exposures to prepayment risks.

In a sequential-pay CMO, all scheduled principal payments and prepayments are paid to each tranche in sequence until that tranche is paid off. The first tranche to be paid principal has the most contraction risk and the last tranche to be paid principal has the most extension risk.

A planned amortization class (PAC) CMO has PAC tranches that receive predictable cash flows as long as the prepayment rate remains within a predetermined range, and support tranches that have more contraction risk and more extension risk than the PAC tranches.

LOS 54.f

Prepayment risk refers to uncertainty about the timing of the principal cash flows from an ABS. Contraction risk is the risk that loan principal will be repaid more rapidly than expected, typically when interest rates have decreased. Extension risk is the risk that loan principal will be repaid more slowly than expected, typically when interest rates have increased.

LOS 54.g

Commercial mortgage-backed securities (CMBS) are backed by mortgages on income-producing real estate properties. Because commercial mortgages are non-recourse loans, analysis of CMBS focuses on credit risk of the properties. CMBS are structured in tranches with credit losses absorbed by the lowest priority tranches in sequence.

Call (prepayment) protection in CMBS includes loan-level call protection such as prepayment lockout periods, defeasance, prepayment penalty points, and yield maintenance charges, and CMBS-level call protection provided by the lower-priority tranches.

LOS 54.h

Asset-backed securities may be backed by financial assets other than mortgages. Two examples are auto loan ABS and credit card 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 from the borrower's excess cash.

Credit card ABS are backed by credit card receivables, which are revolving debt (non-amortizing). Credit card ABS typically have a lockout period during which only interest is paid to investors and principal payments on the receivables are used to purchase additional receivables.

LOS 54.i

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 CLOs.
- Synthetic CDOs backed by credit default swaps on structured securities.

CONCEPT CHECKERS

1. Economic benefits of securitization *least likely* include:
 - A. reducing excessive lending by banks.
 - B. reducing funding costs for firms that securitize assets.
 - C. increasing the liquidity of the underlying financial assets.
2. In a securitization, the issuer of asset-backed securities is *best* described as the:
 - A. SPE.
 - B. seller.
 - C. servicer.
3. A mortgage that has a balloon payment equal to the original loan principal is a(n):
 - A. convertible mortgage.
 - B. fully amortizing mortgage.
 - C. interest-only lifetime mortgage.
4. Residential mortgages that may be included in agency RMBS are *least likely* required to have:
 - A. a minimum loan-to-value ratio.
 - B. insurance on the mortgaged property.
 - C. a minimum percentage down payment.
5. The primary motivation for issuing collateralized mortgage obligations (CMOs) is to reduce:
 - A. extension risk.
 - B. funding costs.
 - C. contraction risk.
6. For investors in commercial mortgage-backed securities, balloon risk in commercial mortgages results in:
 - A. call risk.
 - B. extension risk.
 - C. contraction risk.
7. During the lockout period of a credit card ABS:
 - A. no new receivables are added to the pool.
 - B. investors do not receive interest payments.
 - C. investors do not receive principal payments.
8. A debt security that is collateralized by a pool of the sovereign debt of several developing countries is *most likely* a:
 - A. CMBS.
 - B. CDO.
 - C. CMO.

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ANSWERS – CONCEPT CHECKERS

1. A Banks that securitize loans they hold as assets receive cash with which they can make additional loans. The primary benefits of securitization to the economy include reducing firms' funding costs and increasing the liquidity of the financial assets that are securitized.
2. A ABS are issued by a special purpose entity (SPE), which is an entity created for that specific purpose. In a securitization, the firm that is securitizing financial assets is described as the seller because it sells the assets to the SPE. The servicer is the entity that deals with collections on the securitized assets.
3. C An interest-only lifetime mortgage includes no repayment of principal in its monthly payments so the balloon payment at maturity is equal to the original loan principal. A fully amortizing mortgage has no balloon payment at maturity. A convertible mortgage gives the borrower an option to change the loan from fixed-rate to adjustable-rate or from adjustable-rate to fixed-rate.
4. A Conforming loans that may be securitized in agency RMBS have a *maximum* loan-to-value ratio, along with other requirements such as minimum percentage down payments and insurance on the mortgaged property.
5. B Issuing CMOs may allow the issuer to raise funds at a lower cost by creating tranches that appeal to investors with different preferences for extension risk and contraction risk. CMOs do not reduce these risks compared to their pool of collateral; they only distribute the risks among the various CMO tranches.
6. B Balloon risk is the possibility that a commercial mortgage borrower will not be able to refinance the principal that is due at the maturity date of the mortgage. This results in a default that is typically resolved by extending the term of the loan during a workout period. Thus, balloon risk is a source of extension risk for CMBS investors.
7. C During the lockout period on a credit card receivables backed ABS, no principal payments are made to investors.
8. B A collateralized debt obligation or CDO is backed by an underlying pool of debt securities, which may include emerging markets debt. Both collateralized mortgage obligations and commercial mortgage-backed securities are backed by mortgages only.