Collateralized Debt Obligations

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

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

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

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

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

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

Study Session 16: Fixed Income—Analysis of Risk

Understanding Fixed-Income Risk and Return

Cross-Reference to CFA Institute Assigned Reading #55

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

1. Coupon and principal payments.

2. Interest earned on reinvested coupon payments.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

The estimated price change including the convexity adjustment is:

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

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

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

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

Fundamentals of Credit Analysis

Cross-Reference to CFA Institute Assigned Reading #56

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

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

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

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

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

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

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

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

Credit Ratings

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

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

Figure 2: Credit Rating Categories

(a) Investment grade ratings		(b) Non-investment grade ratings	
Moody's	*Standard &Poor's, Fitch*	*Moody's*	*Standard &Poor's, Fitch*
Aaa	AAA	Ba1	BB+
Aa1	AA+	Ba2	BB
Aa2	AA	Ba3	BB–
Aa3	AA–	B1	B+
A1	A+	B2	B
A2	A	B3	B–
A3	A–	Caa1	CCC+
Baa1	BBB+	Caa2	CCC
Baa2	BBB	Caa3	CCC–
Baa3	BBB–	Ca	CC
		C	C
		C	D

In a holding company structure, a subsidiary's debt covenants may prohibit the transfer of cash or assets to the parent until after the subsidiary's debt is serviced. The parent company's bonds are thus effectively subordinated to the subsidiary's bonds. This is referred to as **structural subordination** and is considered by rating agencies when notching an issue credit rating.

Relying on ratings from credit rating agencies has risks. Credit ratings change over time and ratings mistakes happen. Event risks specific to a company or industry such as natural disasters, acquisitions, and equity buybacks using debt, are difficult to anticipate and therefore not easily captured in credit ratings. Finally, changes in yield spreads and bond prices anticipate ratings changes and reflect expected losses, while ratings are based solely on default risk.

Credit Analysis

One way to represent the key components of credit analysis is by the **four Cs** of credit analysis: **capacity**, **collateral**, **covenants**, and **character**. *Capacity* refers to a corporate borrower's ability repay its debt obligations on time. *Collateral* refers to the value of a borrower's assets. *Covenants* are the terms and conditions the borrowers and lenders have agreed to as part of a bond issue. *Character* refers to management's integrity and its commitment to repay.

Capacity to repay is assessed by examining: (1) industry structure, (2) industry fundamentals, and (3) company fundamentals. Industry structure can be described by Porter's five forces: rivalry among existing competitors, threat of new entrants, threat of substitute products, bargaining power of buyers, and bargaining power of suppliers. Analysis of industry fundamentals focuses on industry cyclicality (more cyclicality indicates greater credit risk) and growth prospects (earnings growth indicates less credit risk). Company fundamentals include competitive position, operating history, management's strategy and execution, and leverage and coverage ratios.

Collateral analysis is more important for less creditworthy companies. The market value of a company's assets can be difficult to observe directly. High depreciation expense relative to capital expenditures may signal that management is not investing sufficiently and the quality of the company's assets may be poor. Some intangible assets that can be sold to generate cash flows, such as patents, are considered high-quality collateral, whereas goodwill is not considered a high-quality, intangible asset.

Bond covenants protect lenders while leaving some operating flexibility to the borrowers to run the company.

Character analysis includes an assessment of management's ability to develop a sound strategy; management's past performance in operating the company without bankruptcies or restructurings; accounting policies and tax strategies that may be hiding problems, such as revenue recognition issues, frequent restatements, and frequently changing auditors; any record of fraud or other legal and regulatory problems; and prior treatment of bondholders, such as benefits to equity holders at the expense of debt holders through debt-financed acquisitions and special dividends.

Financial ratios used in credit analysis

Profit and cash flow metrics commonly used in ratio analysis include earnings before interest, taxes, depreciation, and amortization (EBITDA); funds from operations (FFO), which is net income from continuing operations plus depreciation, amortization, deferred taxes, and noncash items; free cash flow before dividends; and free cash flow after dividends.

Two primary categories of ratios for credit analysis are leverage ratios and coverage ratios. The most common measures of leverage used by credit analysts are the debt-to-capital ratio, the debt-to-EBITDA ratio, the FFO-to-debt ratio, and the FCF after dividends-to-debt ratio. The most commonly used coverage ratios are EBITDA-to-interest and EBIT-to-interest. When calculating ratios, analysts should adjust debt reported on the financial statements by including the firm's obligations,

such as underfunded pension plans (net pension liabilities), and off-balance-sheet liabilities, such as operating leases. In general, higher coverage ratios and lower leverage ratios are associated with higher credit quality. A firm's ratios are compared to benchmark ratios in determining its overall credit rating.

Yield Spreads

A bond's yield spread is primarily affected by five interrelated factors: the credit cycle, economic conditions, financial market performance, broker-dealer capital, and general market demand and supply. Yield spreads on lower-quality issues tend to be more volatile than spreads on higher-quality issues.

High Yield Debt

Reasons for non-investment grade ratings may include high leverage; unproven operating history; low or negative free cash flow; high sensitivity to business cycles; low confidence in management; unclear competitive advantages; large off-balance-sheet liabilities; or an industry in decline.

Special considerations for high yield bonds include their liquidity, projections of earnings and cash flow, debt structure, corporate structure, and covenants.

Sources of liquidity (in order of reliability) include:

1. Balance sheet cash.
2. Working capital.
3. Operating cash flow.
4. Bank credit.
5. Issuing equity.
6. Sales of assets.

To understand difficulties firms may have in meeting their debt payments, analysts should include stress scenarios when forecasting future earnings and cash flows and consider the effects of possible changes in capital expenditures and working capital investment.

High yield issuers' capital structures often include different types of debt with several levels of seniority and hence varying levels of potential loss severity.

Companies for which secured bank debt is a high proportion of the capital structure are said to be *top heavy* and have less capacity to borrow from banks in financially stressful periods. When an issuer has multiple layers of debt with a variety of expected recovery rates, a credit analyst should calculate leverage for each level of the debt structure.

Many high-yield companies use a holding company structure so that structural subordination can lead to lower recovery rates for the parent company's debt.

Important covenants for high yield debt may include a **change of control put** that gives debt holders the right to require the issuer to buy back debt in the event of an acquisition; restricted payments to equity holders; limitations on liens; and **restricted subsidiaries**. Restricted subsidiaries' cash flows and assets are designated to service the debt of the parent holding company. This benefits creditors of holding companies because their debt is pari passu with the debt of restricted subsidiaries, rather than structurally subordinated.

Sovereign and Non-Sovereign Government Debt

Sovereign debt is issued by national governments. Sovereign credit analysis must assess both the government's *ability* to service debt and its *willingness* to do so. Willingness is important because bondholders usually have no legal recourse if a national government refuses to pay its debts.

A basic framework for evaluating and assigning a credit rating to sovereign debt includes five key areas:

1. *Institutional effectiveness*: Successful policymaking, absence of corruption, and commitment to honor debts.

2. *Economic prospects*: Growth trends, demographics, income per capita, and size of government relative to the private economy.

3. *International investment position*: Foreign reserves, external debt, and the status of the country's currency in international markets.

4. *Fiscal flexibility*: Willingness and ability to increase revenue or cut expenditures to ensure debt service, and trends in debt as a percentage of GDP.

5. *Monetary flexibility*: Ability to use monetary policy for domestic economic objectives (this might be lacking with exchange rate targeting or membership in a monetary union) and credibility and effectiveness of monetary policy.

Credit rating agencies assign each national government a **local currency debt rating** and a **foreign currency debt rating.** Foreign currency debt typically has a higher default rate and a lower credit rating because the government must purchase foreign currency in the open market to make payments. In contrast, local currency debt can be repaid by simply printing more currency. Ratings can differ as much as two notches for local currency and foreign currency bonds.

Municipal bonds are issued by state and local governments or their agencies. Municipal bonds usually have lower default rates than corporate bonds with same credit ratings. Most municipal bonds can be classified as general obligation bonds or revenue bonds. **General obligation** (GO) **bonds** are unsecured bonds backed by the full faith and credit (taxing power) of the issuer. **Revenue bonds** finance specific projects. Revenue bonds often have higher credit risk than GO bonds because the project is the sole source of funds to service the debt.

Municipal governments' ability to service their general obligation debt depends ultimately on the local economy. Economic factors to assess include employment, trends in per capita income and per capita debt, tax base, demographics, and ability to attract new jobs. Credit analysts must also observe revenue variability through economic cycles. Relying on tax revenues that are highly variable over an economic cycles indicate higher credit risk. Municipalities may have underfunded long-term obligations such as pension and other post-retirement benefits.

Analysis of revenue bonds requires both analysis of the project and analysis of the financing structure of the project. A key metric for revenue bonds is the **debt service coverage ratio**, which is the ratio of the project's net revenue to the required interest and principal payments on the bonds.