Finance

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FINANCE BASICS: UNDERSTANDING PRESENT VALUE

THE TIME VALUE OF MONEY AND PRESENT VALUE

A dollar today is worth more today than a dollar to be received in the future. Because capital is productive over time, there is an **opportunity cost** to delayed payments. This simple intuition, known as the **time value of money,** is essential for, among other things, valuing stocks and bonds, determining whether to undertake a new corporate venture, and deciding to buy or lease equipment.

Present value refers to the current value of future cash flows. These future cash flows must be adjusted by an appropriate **discount factor** in order to account for the time value of money. The discount factor is related to the **rate of return** demanded by investors for accepting delayed payment on a particular investment. This rate is often referred to as the **discount rate** or **cost of capital.**

$$\text{Discount factor} = \frac{1}{(1+r)^n}$$

where r is the appropriate rate of return and n is the number of periods over which the payment must be discounted, assuming simple discounting.

SIMPLE PRESENT VALUE CALCULATIONS

The present value (PV) of a future cash flow (CF) to be received in n periods assuming a simple discount rate of r is calculated as:

$$PV = CF \times (\text{discount factor}) = \frac{CF}{(1+r)^n}$$

For continuous discounting, $PV = CFe^{-rn}$

Similarly, the **future value (*FV*)** of a current investment (INV) that is expected to return r per period (simple compounding) over n periods is given as:

$$FV = INV(1+r)^n$$

- The **rule of 72** is a "back of the envelope" method for calculating the approximate number of years (x) it will take to double an investment given an expected return of r per year, assuming simple compounding: $x = \frac{72}{r}$

An **annuity** is a series of fixed payments (CF) to be received each period over a specified number of periods (n). The present value of an annuity is given as:

$$PV = \sum_{t=1}^{n} \frac{CF}{(1+r)^t} = CF\left[\frac{1}{r} - \frac{1}{r(1+r)^n}\right]$$

A **perpetuity** is a series of fixed payments to be received each period for an infinite number of periods. The present value of a perpetuity is calculated as: $PV = \frac{CF}{r}$

- For a perpetuity with cash flows growing at a constant rate of g per period after period 1: $PV = \frac{CF_1}{r-g}$, where CF_1 is the cash flow in period 1.

The present value of a series of different cash flows to be received at different times in the future ($t_1, t_2, \ldots, t_n$) is calculated as:

$$PV = \sum_{t=1}^{n} \frac{CF_t}{(1+r)^t} = \frac{CF_1}{1+r} + \frac{CF_2}{(1+r)^2} + \cdots + \frac{CF_n}{(1+r)^n}$$

NET PRESENT VALUE

The **Net Present Value (*NPV*)** of a project is the sum of the present values of all cash flows associated with the project over its life, assuming an appropriate discount rate. This includes any current investment (CF_0) associated with the project.

$$NPV = CF_0 + \sum_{t=1}^{n} \frac{CF_t}{(1+r)^t}$$

The NPV method can be used to determine whether a firm should undertake a project. In general, **positive *NPV*** projects (i.e., those with $NPV > 0$, assuming an appropriate discount rate) will increase shareholder wealth and therefore should be undertaken; **negative *NPV*** projects will decrease shareholder wealth and should be rejected.

The **Internal Rate of Return (*IRR*)** refers to the discount rate at which the NPV of a given project equals zero. Firms often use this value to determine whether to undertake a project: if the IRR exceeds the firm's cost of capital, the project is undertaken; if not, the project is rejected.

ESTIMATING COST OF CAPITAL: THE CAPM

Investors require a higher return for taking on additional risk. While certain risks associated with individual projects or companies can be eliminated through **diversification** (i.e., the creation of a broad portfolio of different projects or companies), there is an underlying **market risk** that cannot be diversified away. In the context of securities, the risk of a diversified portfolio is determined by the market risk of the securities in the portfolio.

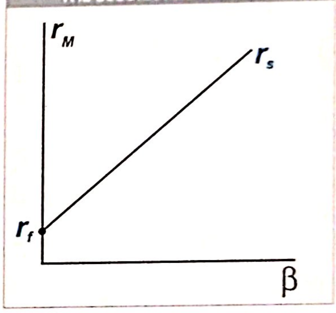
The **Capital Asset Pricing Model (CAPM)** is a commonly used model that relates a security's expected rate of return (r_S), and hence its associated cost of capital, to its contribution to the risk of a portfolio comprising the market as a whole—the theoretical **market portfolio**—using its **beta** (β_S), the risk-free rate (r_f), and the expected return of the overall market (r_M).

$$r_S = r_f + \beta_S(r_M - r_f)$$

– **Beta** is a statistical concept that measures the sensitivity of a security's return to the return of the market as a whole.
– The interest rate on long-term Treasury bonds (e.g., the 10-year Treasury) is typically used for the risk-free rate.
– The difference, $r_M - r_f$, is known as the **market risk premium.** While there is no precise way to measure this value, the market has returned approximately 7–8% above the 10-year Treasury bond on average over the past 70 years.

This model is summarized graphically by the **security market line,** shown below.

THE SECURITY MARKET LINE



DEBT

INTRODUCTION TO DEBT SECURITIES

Companies periodically need funds to invest in projects and to cover working capital shortfalls. Typically, companies raise capital by issuing one of two types of corporate securities: **debt** (referred to as **bonds** or **fixed-income securities**) and **equity** (referred to as **stocks**).

When a company issues debt, it is essentially borrowing money with the promise that it will ultimately repay the amount borrowed—**the principal**—and make regular **interest payments** in the interim.

- The face value of each bond (typically $1,000) is referred to as the **par value.**
- Interest payments are often called **coupon payments.** These payments are typically made annually or semi-annually. Bonds that repay the face value at a specified future time but do not make any intermediate coupon payments are known as **zero-coupon bonds** or **strips.**

If the company fails to make its payments, it **defaults** on its debt and must turn over assets to repay the debtholders.

A company's interest payments are deducted from its taxable (i.e., before-tax) income; this favorable tax status is sometimes referred to as a **tax shield.**

Debt securities are characterized by a number of features:

- **Maturity** refers to the period over which the bond is to be paid back.
- **Seniority** refers to the liquidation preference of the bond in the event of a default. Holders of **subordinated debt** must wait until the firm's more senior creditors have been paid before seeking claims on the company's assets.
- Assets are sometimes pledged as **collateral** against a loan; holders of a collateralized bond will have first claim on these assets in the event of a default. This type of security is also known as **secured debt.** Unsecured long-term loans are known as **debentures.**
- While interest payments are typically fixed at the time of issuance (e.g., 5% annually), some bonds offer a variable rate that can fluctuate based on another rate (e.g., **prime rate** or **LIBOR,** plus 1%). These are referred to as **floating-rate** bonds.

Debt securities are rated by several ratings agencies according to the likelihood of default.

- **Standard & Poor's scale** runs from AAA (least likely default) to C; **Moody's scale** runs from Aaa to C.
- The highest quality bonds are known as **investment grade** (AAA-BBB for S&P, Aaa-Baa for Moody's). Bonds with lower ratings are commonly referred to as junk or **high-yield bonds.**

A **convertible bond** allows holders to exchange the bond for a specified number of shares of common stock in the firm at a prespecified conversion rate.

VALUING DEBT SECURITIES

Bonds are relatively easy to value using simple present value formulas. A bond is essentially a combination of an annuity—the coupon payments—and the discounted value of the face value to be paid back at maturity (the exception here is the floating-rate bond, which can have fluctuating coupon payments). For a nonfloating-rate bond (B) with a given face value (F), periodic coupon payment (C), discount rate (r_B), and total number of periods until maturity (M), the value can be calculated as:

$$V_B = \frac{F}{(1+r_B)^M} + \sum_{t=1}^{M} \frac{C}{(1+r_B)^t}$$

$$= \frac{F}{(1+r_B)^M} + C\left[\frac{1}{r_B} - \frac{1}{r_B(1+r_B)^M}\right]$$

The current price of a bond is often used to determine its **yield to maturity ("yield").** The yield refers the discount rate at which the present value of the bond is equal to its current market price and represents the rate of return required by investors for this type of loan. Note that for corporate securities, the yield is greater than the **risk-free rate** (i.e., the interest rate on risk-free bonds like U.S. Treasury Bonds); this is because all corporate securities carry some degree of default risk.

CONTINUED ON OTHER SIDE

DEBT (continued)

Duration is a measure of a bond's effective maturity. It is defined as the weighted-average of the time until each payment, with weights proportional to the present value of each payment.

For a bond with a given yield to maturity (y), periodic coupon payment (C), total number of periods until maturity (M), face value (F), and current market price (P), **Macauley's Duration** (D) is defined as follows:

$$D = \left[\frac{\left(\frac{1C}{(1+y)^1} + \frac{2C}{(1+y)^2} + \cdots + \frac{M(C+F)}{(1+y)^M} \right)}{P} \right]$$

Modified Duration (MD) is a related measure defined as:

$$MD = -\frac{1}{1+y} \left[\frac{\left(\frac{1C}{(1+y)^1} + \frac{2C}{(1+y)^2} + \cdots + \frac{M(C+F)}{(1+y)^M} \right)}{P} \right]$$

Duration can be a useful measure in understanding the sensitivity of a bond's price to changes in interest rates. The percentage change in a bond's price ($\%\triangle P_B$) with respect to a given absolute change in interest rates ($\triangle IR$) can be estimated using the following:

$$\%\triangle P_B = -\frac{1}{1+y} D(\triangle IR) = -MD(\triangle IR)$$

This estimation method is only accurate for small, identical changes in interest rates at all maturities.

EQUITY

INTRODUCTION TO EQUITY

Equity represents ownership in a corporation. There are two forms of equity: **common stock** and **preferred stock**. The smallest unit of equity is known as a **share**.

Common stockholders (or **shareholders**) exercise control over a company by voting for its **Board of Directors** and, in certain cases, by voting directly on major corporate issues (e.g., **mergers**). These common stockholders are entitled to receive whatever assets or earnings are available from the business once its creditors have been paid.

A company distributes its profits to shareholders through periodic **dividend** payments, typically on a quarterly basis. These dividend payments often grow as a company's earnings grow; however, a company can choose to reduce or even eliminate its dividend payments.

- Whereas interest payments are paid out of before-tax income, dividends are paid out of after-tax income; thus, interest payments are tax-advantaged, relative to dividends.
- Dividend yield $= \frac{\text{dividend per share of common stock}}{\text{price per share}}$
- Payout ratio $= \frac{\text{dividend per share}}{\text{earnings per share}}$

Preferred stock is an equity security with certain features similar to debt:

- Like bonds, preferred stock typically offers a fixed dividend; however, payment on a preferred dividend can be withheld without threat of default. All preferred dividends must be paid before a company can pay a dividend to its common shareholders.
- In the event of liquidation, holders of preferred shares line up behind debtholders but ahead of common shareholders.
- Preferred stock often has a conversion feature that allows shares to be converted into common shares.
- Preferred dividends, like common dividends, are paid out of after-tax income.

VALUING EQUITY SECURITIES

The **dividend discount model** values an equity security based on the future dividends anticipated by holders of that security. These future dividends (Div_1, Div_2, ...), which represent the cash flows associated with share ownership, are estimated and discounted at the appropriate cost of equity capital (r_E) to give the present value of the security (V_S):

$$V_S = \sum_{t=1}^{\infty} \frac{\text{Div}_t}{(1+r_E)^t}$$

If a constant growth rate (g) is assumed for these dividends, this model can be simplified using the familiar formula for a growing perpetuity:

$$V_S = \frac{\text{Div}_1}{r_E - g}$$

Another valuation technique, known as a **Discounted Cash Flow** (**DCF**) analysis, seeks to determine the value of the entire firm (V_F), from which the value of a single share can be deduced. In the most common form of this analysis, the company's future **Free Cash Flows** (**FCF**) are estimated and discounted at a rate that takes into account the capital structure of the firm (i.e., its mix of debt and equity) and the tax benefits associated with interest payments. This rate is known as the after-tax **Weighted Average Cost of Capital** (**WACC**):

$$V_F = \sum_{t=1}^{\infty} \frac{FCF_t}{(1+WACC)^t}$$

The $WACC$ is calculated based on the company's cost of equity (r_E), cost of debt (r_D), market value of outstanding debt (D), market value of equity (E), and marginal tax rate (T):

$$WACC = r_E \frac{E}{D+E} + r_D \left(\frac{D}{D+E} \right) (1-T)$$

- Free cash flows are defined as the cash flows from operating activities that are available for distribution to suppliers of capital.
- In practice, free cash flows are often projected over a relatively short forecast horizon (H), after which they are expected to grow at a modest annual growth rate (g) indefinitely. The present value calculation can then be simplified as:

$$V_F = \frac{FCF(1+g)}{(WACC-g)(1+WACC)^H} + \sum_{t=1}^{H} \frac{FCF_t}{(1+WACC)^t}$$

- Note that the DCF analysis assumes that the firm maintains a constant ratio of debt to equity and has sufficient income each year to realize the tax benefits of interest payments.

DERIVATIVE SECURITIES

DEFINITION

Derivatives are financial instruments whose value is wholly determined by the price of an **underlying asset**, often a financial security. Some of the most commonly used derivatives include **forwards**, **futures**, **call options**, and **put options**.

Unlike debt or equity, derivative instruments are typically used to protect the company from certain risks (e.g., fluctuations in the price of commodity inputs or foreign currency) rather than to finance corporate projects.

FORWARDS AND FUTURES

A **forward contract** is an agreement between two parties to buy/sell an underlying asset (e.g., commodity, stock, stock index, or foreign currency) at a prespecified price on a prespecified date. These agreements are typically privately arranged deals between two financially sophisticated entities (e.g., banks or corporations). Each contract specifies: (1) the amount and quality of the good to be provided; (2) the delivery price; (3) the time of delivery; and (4) the delivery location.

- The party that has agreed to buy the underlying asset is said to have taken a **long position**; the party that has agreed to sell the underlying asset is said to have taken a **short position**.

Futures contracts are conceptually identical to forward contracts, except that they are more standardized agreements that can be traded on regulated exchanges (e.g., Chicago Board of Trade and the Chicago Mercantile Exchange). In addition, these contracts are priced each day, or **marked to market**.

The price of a forward/futures contract ($F_{0,1}$) entered into at time t_0 to purchase a share of a nondividend-paying stock with current price S_0 at future time t_1, assuming a per-period continuously compounded risk-free rate of r_f, is calculated as:

$$F_{0,1} = S_0 e^{r_f(t_1 - t_0)}$$

OPTIONS

A **call option** gives its owner the right—but not the obligation—to buy an asset at a specified price (the **exercise** or **strike price**) on or before a specified date (the **expiration date**).

- **Payoff to holder of call option at expiration** $= S_X - X$ if $S_X > X$, and 0 if $S_X \leq X$; where S_X is the stock price at expiration, and X is the exercise price.
- A call is **in-the-money** if the asset price is greater than the exercise price; it is **out-of-the-money** if the asset price is lower than the exercise price.

A **put option** gives its owner the right—but not the obligation—to sell an asset at a specified price on or before a specified date.

- **Payoff to holder of put option at expiration** $= XS_X$ if $S_X < X$, and 0 if $S_X \geq X$.
- A put is **in-the-money** if the asset price is lower than the exercise price; it is **out-of-the-money** if the asset price is greater than the exercise price.

The holder of either a call or put option is said to have taken a **long position**, the seller of the call or put has taken a **short position**.

The holder of a **European option** can exercise only when the contract expires; the holder of an **American option** can exercise at any time up to and including the expiration date.

One common formula for estimating the value of options is the **Black-Scholes pricing formula**. For European options on nondividend-paying stocks, the inputs to this formula are: the current stock price (S_0), the exercise price of the option (X), the time to expiration (T_X), the continuously compounded per-period risk-free interest rate (r_f), and an estimate of the volatility of the underlying stock (σ). The formula makes use of the cumulative normal distribution (N). Using this formula, the price of a call (C) and a put (P) are:

$$C = S_0 N(d_1) - Xe^{-r_f T_X} N(d_2)$$

$$P = Xe^{-r_f T_X} N(-d_2) - S_0 N(d_1)$$

where

$$d_1 = \frac{\ln\left(\frac{S_0}{Xe^{-r_f T_X}}\right)}{\sigma\sqrt{T_X}} + \frac{\sigma\sqrt{T_X}}{2}$$

and

$$d_2 = d_1 - \sigma\sqrt{T_X}$$

Put-call parity refers to the relationship between the price of a European put and a European call with the same exercise price and expiration date on the same underlying asset.

- Put-call parity for European options on a non-dividend-paying stock, where C = the price of the call; P = price of the put; S_0 = current share price; X = exercise price; r_f = the risk-free interest rate; T_X = time until expiration:

$$C - P = S_0 - Xe^{r_f T_X}$$

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ISBN 978-1-4114-7035-4
50495

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10 9 8 7
Printed in China $4.95 | $5.95 CAN