Understanding Bonds, Stocks, and Derivatives Basics

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July 8, 2021

Almost all investor portfolios today contain stocks, bonds, or both. While today stocks tend to get more prominence, historically bonds tended to dominate. Many of today's portfolios also contain other types of assets such as real estate, commodities, or more sophisticated investments such as hedge funds, which in turn may contain securities whose prices are derived from stock and bond prices—and hence know as derivatives. This note provides a basic understanding of what bonds and stocks are, why they have value, and why their prices change. We'll also provide an overview of derivatives.

As a starting point, let's first consider how a farmer's market works. Consumers and farmers meet at a common location, exchanging money for fruits and vegetables. Capital markets, or the markets for bonds and stocks, work in a similar manner. Investors are like consumers, wanting to exchange their cash—which they might not need right now—for something else. Companies or firms are like farmers, who need cash now in order to grow their businesses. But instead of exchanging cash for fruits and vegetables, they exchange cash for promises, like IOUs or "contracts" that specify their obligations. Those contracts—depending on the nature of the IOU—are known as either bonds or stocks, and are also known collectively as financial instruments or financial securities. The original bond or stock investor acquires the IOU directly from the company in a primary exchange. Subsequently, that investor can trade these securities in secondary markets such as on stock exchanges—effectively selling the IOU to someone else. Let's take a deeper dive into understanding bonds and stocks and what gives them value.

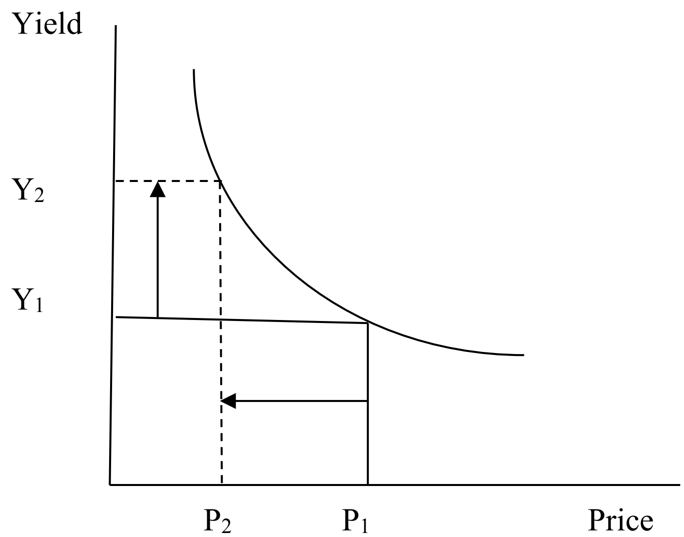
Bonds

A bond investor or bondholder is actually a lender of money to the firm. The amount lent to the firm, say $1,000, is the initial price of the bond. The bond "contract" stipulates that the $1,000 must be repaid—to whoever is holding the contract—at a specified date in the future, say 5 years from now. The contract also indicates what annual interest payments will be made to the bondholder, say 4 percent. That percentage of the value of the bond is known as the coupon rate, and the interest payments are also known as coupons. So for this particular bond, the investor or lender receives \$40 each year. The typical bond pays interest twice a year, so the bondholder receives \$20 coupons every 6 months for the next 5 years, and the \$1,000 principal is repaid to the bondholder in 5 years as well.

The price of the bond represents what is known as the present value (*PV*) of expected future payments to the lender or bondholder. The present value concept reflects that a dollar today is worth more than a dollar tomorrow because we could take today's dollar and invest it, say by earning 3 percent: investing \$1,000 today gives me an expected amount of \$1,030 in one year—or in mathematical terms, \$1,000 x 1.03 = \$1,030. The length of maturity or time to maturity is represented by the number of periods (n). So a bond that matures in 5 years would have 10 six-month periods.

Bondholders receive two types of payments: an expected lump sum of money, as well as an annuity stream. The lump sum or single amount is the principal that is lent to the firm and expected to be repaid by the firm in the future—\$1,000—also known as the face value or future vale (*FV*) of the bond. The interest or coupon payments represent the annuity or payments (*PMT*) stream. There's one more element to bond pricing that reflects the time value of money the discount rate (r) used to calculate the present value (or worth) of the coupon payments and the principal amount, and hence the bond price. In this example the discount rate is that anticipated investment rate of 3 percent. In other words, we can discount the anticipated amount in one year of \$1,030—by dividing by 1.03—to arrive back at the present value of \$1,000. The discount rate for bonds is also known as the yield to maturity, or YTM. Yield to maturity for a particular bond is like an interest rate or the anticipated rate of return if the bond is bought today and held until maturity.

Yield to maturity and bond prices are connected in the same way that two children on a teeter-totter are connected: As the yield to maturity rises, the price of the bond goes down, and vice versa, as shown in the figure below. For instance, say that because of the questionable upcoming launch of a new product you perceived an increase in the riskiness of the firm, hence you require a higher expected return or yield for buying a bond from that firm—or in other words, you aren't willing to pay as much for a particular bond. In this case, the yield to maturity (or expected return) increases and simultaneously the price of the bond will go down.

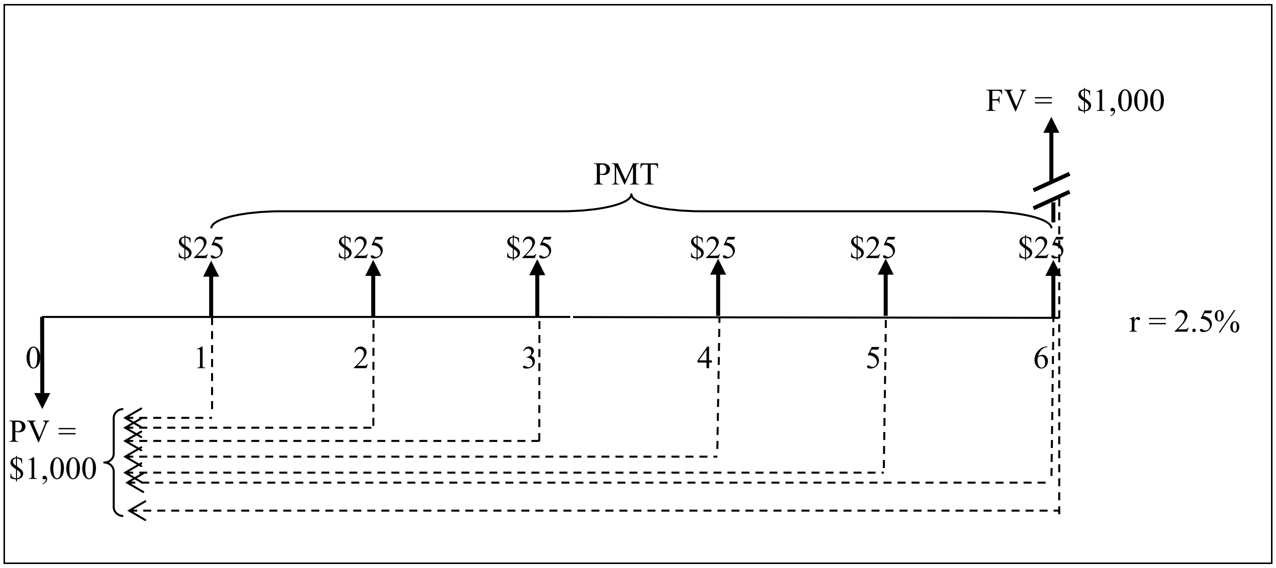


To better understand bond pricing dynamics, let's consider two examples. First, suppose Walmart needs capital and decides to issue three-year bonds. Each bond has a face value of $1,000, the amount to be repaid to Walmart bond investors or lenders in three-year period. Recall coupons are paid on a semi-annual basis. Suppose the coupon rate is set at 5 percent, reflecting current economic conditions such as expected inflation, as well as the perceived riskiness of Walmart bonds. This coupon rate indicates the total annual payments to bond investors as a percent of the face value—in other words, $50 in coupon payments are made each year, so each semiannual payment (PMT) is $25.

The price of the bond is initially the same as the $1,000 face value. In other words, at that point in time only, the coupon rate is equal to the yield to maturity (also the discount rate). Since the coupon rate is 5 percent, the initial *semi-annual* yield to maturity (r or YTM) is simply the coupon rate divided by two (the number of six-month periods in a year), or 2.5 percent. As we see in the figure below, the present value (PV) of the cash flow streams associated with the Walmart bond is equal the face value of the bond, or the $1,000 originally lent to Walmart by each bond investor. The present value of the annuity stream—receiving six payments of $25 every six months, discounted at the semi-annual rate of 2.5 percent—is $137.70.[1] The present value of the

[1] The mathematics behind this is $\frac{\$25}{(1.025)^1}+\frac{\$25}{(1.025)^2}+\frac{\$25}{(1.025)^3}+\frac{\$25}{(1.025)^4}+\frac{\$25}{(1.025)^5}+\frac{\$25}{(1.025)^6}$.

$1,000 in six periods of six months (i.e., in three years), again discounted at the semi-annual rate of 2.5 percent, is $862.30.[2] The total of the two present values is $1,000.



Now let's see what happens if the yield on Walmart's bond increases from 5 percent to 6 percent—perhaps because Walmart is perceived to be a riskier company, or perhaps because inflation was expected to increase. If you were holding Walmart's bond that had a 5 percent coupon, you would see that its price went down. With a higher semi-annual yield of 3 percent (instead of 2.5 percent), the present value of the annuity stream—receiving six payments of $25 every six months, discounted at the semi-annual rate of 3 percent—is $135.43 (down from $137.70). The present value of the $1,000 in six periods of six months (i.e., in three years), again discounted at the semi-annual rate of 3 percent, is $837.48 (down from $862.30). The total of the two present values is $972.91.

There's another way to look at this. If Walmart were to issue a new bond today, that new three-year bond with a $1,000 face value issued at par (or equal to the face value) would now need to pay semi-annual interest or coupons of $30 (instead of the $25 coupons on the old bond). This new bond would have a yield of 6 percent, the same as the coupon rate. So you could either pay $972.91 for the old bond with 5 percent coupons, or pay $1,000 for the new bond with 6 percent

[2] The mathematics behind this amount is $\frac{\$1{,}000}{(1.025)^6}$.

coupons, but either way the yield is the same: 6 percent. So we see that when yields increase, bond prices decrease.

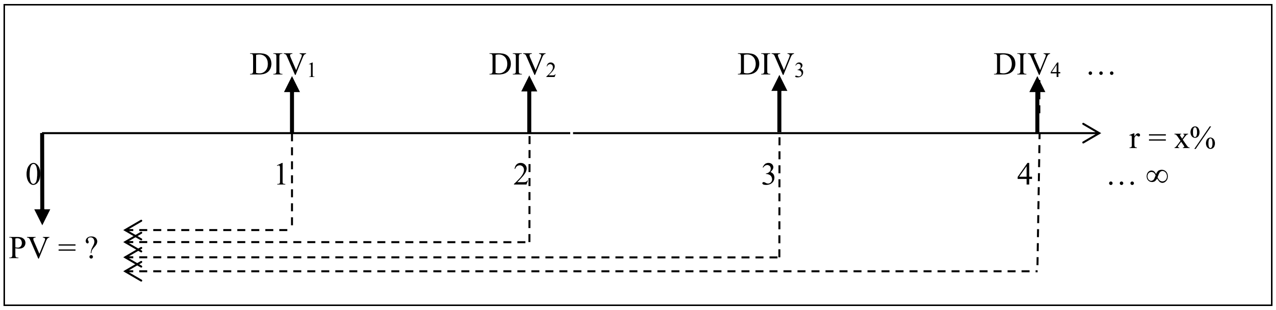
Stocks

An equity holder or shareholder is an investor who obtains a stake or share in the ownership of the firm in exchange for a cash investment. Unlike bondholders who lend money in exchange for interest or coupon payments, shareholders share in the profits of the company after bondholders have received their interest payments. For example, if Walmart had a quarterly profit of $2 billion and you owned 1 percent of Walmart's shares, then you would be entitled to $20 million in profits. Based on these quarterly profits, Walmart's board of directors may choose to pay a certain percentage in dividends, while reinvesting the remaining profits into the business. If you are a shareholder, you still share in the profits either way—by receiving cash dividends directly, or by reinvesting some of those profits in order to grow the business and therefore provide increased dividends in the future.

One way to think about the price we would be willing to pay for Walmart's stock is to consider what the worth is to you today to own an infinite expected stream of dividend payments from Walmart. This approach is known as the "dividend discount model" approach because it discounts the anticipated dividends to the present. Let's see what factors affect the stock price based on this model.

First, you must anticipate the expected future stream of dividends, perhaps by looking at the current dividend the company is paying and incorporating an expected growth in that dividend. Second, you must estimate the present value of that stream of dividends based on discounting the anticipated cash flows at an appropriate discount rate (like we did with bonds). This discount rate should reflect the riskiness of the anticipated cash flows, or dividends, and should therefore represent your expected or required return for investing in such a stock, say 10 percent. (A model known as the Capital Asset Pricing Model or CAPM is one way of estimating that expected or required return.)

Once we know the anticipated stream of dividends (for simplicity, assume one dividend payment per year) and have determined an appropriate discount rate, we can determine the appropriate value or share price, by estimating the present value, as indicated in the figure below.[3]



The challenge with this approach—while great in theory—is that in practice we would need to calculate the present value of each anticipated dividend forever (which would technically take us forever as well). Fortunately, there is a solution that makes our calculations a lot easier. If we're willing to assume that Walmart's dividends will grow at a constant rate *g*—say 5 percent each year—then we can rely on a formula known as a growing perpetuity. Simply stated, the present value is equal to next year's anticipated dividend divided by the difference between the discount rate and the anticipated growth in dividends. In other words:

$$PV = \frac{DIV_1}{(r - g)}$$

where

PV	=	the current value or price of the stock
r	=	the expected or required return by the stock investor
DIV_1	=	the anticipated dividend (next year)
g	=	the expected constant growth rate of dividends

So suppose Walmart's dividend next year, DIV_1, is expected to be \$2.00, and the expected perpetual growth in those dividends, *g,* is expected to be 5 percent (or 0.05). Suppose Walmart stock investors expected a return, *r,* of 7 percent (or 0.07). In this case, the stock price should be

[3] In mathematical terms this is $\frac{DIV_1}{(1+r)^1} + \frac{DIV_2}{(1+r)^2} + \frac{DIV_3}{(1+r)^3} + \frac{DIV_4}{(1+r)^4} + \cdots \infty$.

$2.00/(0.07 – 0.05) = $2.00/(0.02) = $100.00, which is what we should be willing to pay for a share.[4]

The dividend discount model provides some powerful insights explaining why stock prices fluctuate. What it boils down to is that the price of a stock depends on two—and only two—simple factors: the anticipated growth rate of dividends and the perceived riskiness of the dividend stream. An easy way to remember these factors is as follows: Growth is good, and risk is rotten! Notice that in the case of Walmart's stock, if we now anticipate an increase in the growth of dividends of 5.5 percent instead of 5 percent (*Growth is good!*), then the value of Walmart's common stock will be $2.00/(0.07 – 0.055) = $133.33. Alternatively, if Walmart's expected or required return is 7.5 percent because we now perceive Walmart to be riskier (*Risk is rotten!*) and thus demand a better return to compensate us for the risk, then the value of Walmart's stock drops to $2.00/(0.075 – 0.05) = $80.00. As we can see, there is a trade-off between anticipated growth and riskiness.

Derivatives

Derivatives are another form of a contract. Generally their prices are derived from the price of some kind of underlying asset and provide an agreement between the buyer and seller to exchange funds at some point in the future based on the price of the underlying security at that time.[5] Derivative contracts can be arranged privately, between any two parties, or sometimes can be bought or sold on organized exchanges, like the Chicago Board Options Exchange (CBOE). Derivatives can be used for hedging purposes, in order to control the risk profile in your investment portfolio. Derivatives can also be used for pure speculative purposes—betting, say, on the rise or fall of the price of a stock.

For example, well-known call options on stocks give the buyer the right (but not the obligation) to buy the underlying stock at some pre-determined price on or before a particular date—say buying Walmart's stock anytime in the next three months at a price of $110, compared with today's price, say of $100. Researchers had great difficulty determining a formula by which to model the price of call options until a major breakthrough in 1973. But essentially the price of a call option depends on: the price of the underlying security—Walmart's current stock price, say

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[4] Note that this formula only works if r is greater than g. But this is a reasonable assumption because your overall expected stock return should be greater than the anticipated growth in dividends.

[5] More broadly, derivatives can be based on almost anything, such as upcoming weather.

$100; the price at which the buyer and seller agree to a future transaction—the strike or exercise price, say $100; the time to maturity of the contract—say three months; the prevailing risk-free rate—because time value of money matters since the contract won't be settled until three months from now; and the underlying volatility of the stock price—how much Walmart's stock is expected to fluctuate over the next three months.

A put option is like the mirror image of a call option: it gives the buyer the right (but not the obligation) to *sell* the underlying stock at some pre-determined price on or before a particular date. While the buyer of a call option is betting that the underlying stock price will go up, the buyer of a put option is betting that the underlying stock price will go down.

A forward contract is an agreement between two parties to buy and sell a particular asset at a particular price, at an agreed upon date. For example, suppose the current dollar-Euro exchange rate is 1.13 dollars buys one Euro, such a forward contract might specify exchanging $117 for €100 in one year. Future contracts are similar to forward contracts, with the main difference that they are traded on organized exchanges.

There are all kinds of other derivatives such as asset-backed securities, mortgage-backed securities, and collateralized debt obligations. An asset-backed security is a contract or financial instrument that has a payment or income stream attached to the income from an underlying pool of assets, such as loans, leases, or receivables. If the underlying assets are mortgages, they the contract is known as a mortgage-backed security. A collateralized debt obligation is also a type of asset backed security but contains multiple tranches that define the order of payment received from the underlying assets—the lower the priority, the riskier the investment.