Problem 1. Define the following terms and give an example of each:

(a) asset

(b) nominal wealth

(c) physical asset

(d) financial asset

(e) intangible asset

Answer 1.

(a) An asset is anything that has value because it is expected to bring benefits to the owner in the future. Your college degree will be an asset because it will open up a lot of employment opportunities for you.

(b) Nominal wealth is the market value (i.e. the dollar value) of all assets own by an individual. If you own a house worth \$500,000 and a car worth \$20,000, then your nominal wealth is \$520,000.

(c) A physical asset is a *tangible* thing (i.e. actual object that you can see and touch) that has some non-monetary benefits. A house provides shelter.

(d) A financial asset is a tangible thing that provides some monetary benefit. If you own stock in a company, you expect the value of that stock to increase over time which means you become richer.

(e) An intangible asset is a non-physical thing. If you teach yourself how to code, that is an intangible skill because you can't touch skill; but being able to code makes you more employable.

Problem 2. A financial asset that is traded in financial markets is specifically called

(a) a liquid asset

(b) a tradable asset

(c) a security

(d) a bond

(e) none of the above

Answer 2: c. Not all financial assets can be traded in the market, e.g. your checking account. Assets that are called securities and financial markets are also called securities markets.

Problem 3. What is a bond? What is the difference between a discount bond and a coupon bond?

Answer 3. A bond is just a way of borrowing money, essentially an IOU. The entity that wants to borrow money issues a bond (the IOU) for which they receive some money, and later on they have to pay that money back, usually with additional interest.

A discount bond means the money is borrowed and then gets paid back all at once in the future. If I want to borrow \$100 and pay you back in a year with 5% interest, then I issue a one-year \$100 bond with a 5% annual interest rate. You buy the bond by giving me \$100 today; this is the *price* of the bond. One year from now I give you back \$105; this is the *face value* of the bond.

A coupon bond means the money is borrowed and then gets paid back in fixed increments called *coupon payments*. I might issue a one-year \$100 coupon bond with \$10 monthly coupon payments. That means you give me \$100 today, and I pay you back \$10 each month for one year.

Problem 4. The relationship between interest rates and bond prices is

(a) positive

(b) negative

(c) neutral

(d) getting serious but bond prices are afraid of commitment

(e) none of the above

Answer 4. Intuition: when you pay less for the same thing, you benefit more. Discount bonds are denominated in terms of their face value, i.e. what the lender gets back at the maturity date. Consider a bond that has a face value of $F = \$100$. You buy the bond for $P = \$80$ and your confused friend buys the same bond for $P' = \$90$.

So you pay \$80 today, you get \$100 in the future, so your rate of return (i.e the interest rate) is

$$R = \frac{\$100 - \$80}{\$80} = 25\%.$$

Your friend though paid \$90 today to get \$100 in the future, so their rate of return is

$$R' = \frac{\$100 - \$90}{\$90} = 11.11\%.$$

Problem 5. The process through which the rates of return on identical assets are equalized is called

(a) financial market transaction

(b) arbitrage

(c) securities market

(d) investment

(e) none of the above

Answer 5: b. Arbitrage is the fancy name for that old cliche "buy low, sell high." Suppose you have two assets, A and B, that are identical except suddenly the price of A goes up and the price of B goes down. There is now an excess supply of asset A because the price is high; and an excess demand for asset B because the price is low.

People will then buy a lot of asset B at the low price and sell it in another market at the high asset A price, for which they will earn a profit. Since so many people want to buy asset B, its price will be driven up. And since not many people want to buy asset A, its price will be driven down. This process will equalize the two prices so that there is no more profit opportunity. The price at which the two identical assets equalize is sometimes called the *fair value*.

An illustration is shown on the next page; the fair value is the point where supply and demand intersect for each market.

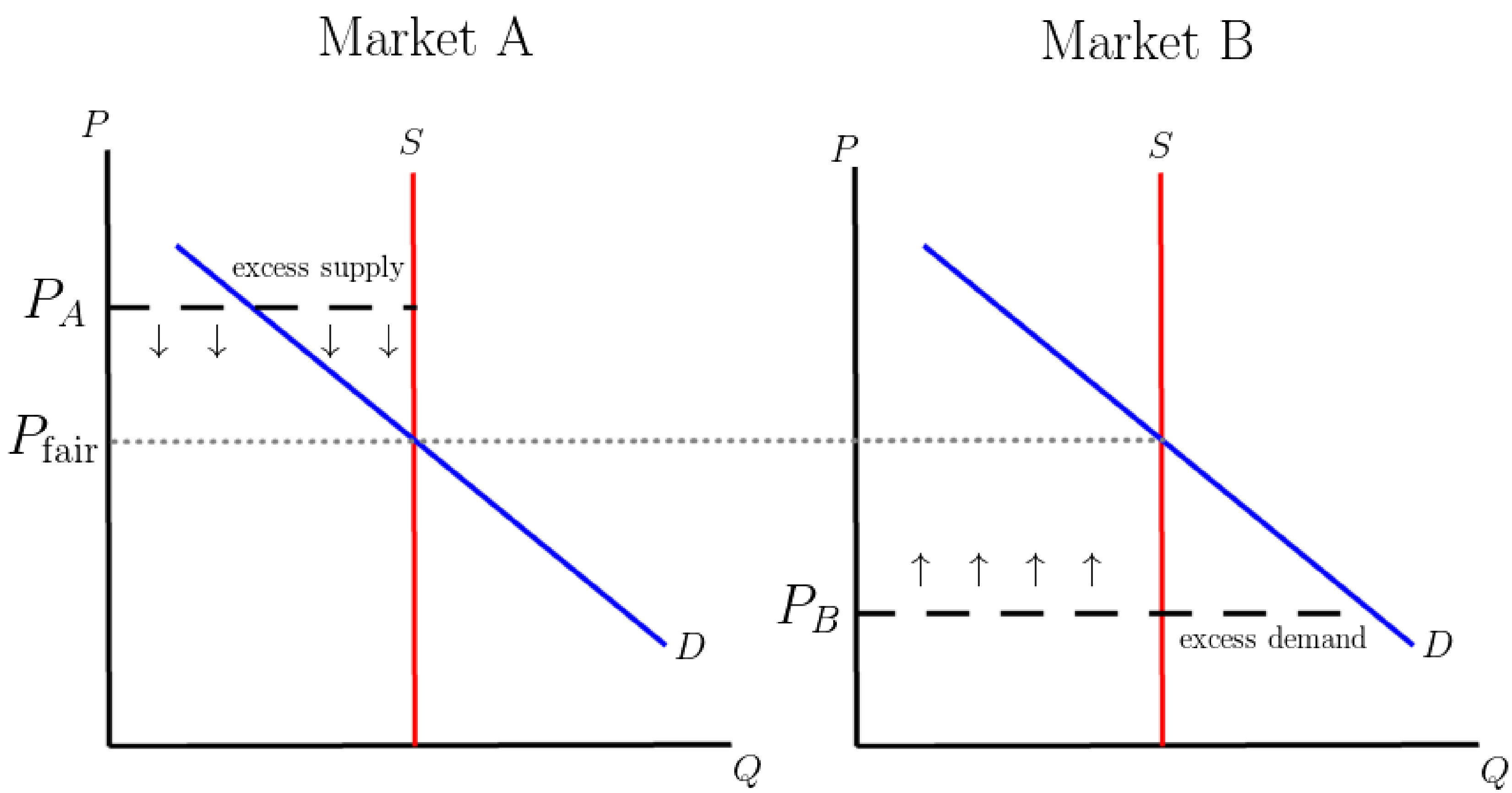


Figure 1: People buy a lot of asset B because it's cheaper, which drives its price up. The assets get sold in market A at a higher price for a profit, which then drives the price of asset A down. The two prices will eventually equalize at the fair price. Note that in the age of the Internet, this process happens *very* quickly because information is so readily available and trading assets is so fast and simple.

Problem 6. Asset A can be converted into cash faster than Asset B without any loss in value. We say that Asset A is

(a) more tradeable

(b) more liquid

(c) more cashable

(d) more fluid

(e) none of the above

Answer 6: b. Liquidity refers to how quickly an asset can be converted into cash. In general, undesirable qualities will increase the interest rate of an asset (because otherwise no one would buy them), all else equal. In other words, undesirable qualities require compensation in the form of a higher rate of return.

- A riskier asset, all else equal, will have a higher interest rate.
- A less liquid asset, all else equal, will have a higher interest rate.
- A heavily-taxed asset, all else equal, will have a higher interest rate.

Problem 7. What is the difference between company-specific and market risk? How can you minimize each type of risk?

Answer 7. Company-specific risk is the risk you face from investing in a specific company, go figure. If you buy stock in only Tesla and Tesla stock falls in value because Elon Musk smokes pot on a podcast, then the value of your portfolio will go down. You can minimize the company-specific risk by **diversifying** your portfolio, that is, buying stocks from different companies in uncorrelated sectors of the economy. The idea is that if Tesla stock value suffers, that doesn't somehow mean Dunkin' Donuts are making dubious decisions, so Dunkin' Donuts stock could still be performing well. The good performance of the Dunkin' Donuts stock then mitigates some of the losses of the poorly-performing Tesla stock.

Market risk, on the other hand, cannot be diversified away from. If the entire market is doing poorly during a recession, then that means both Dunkin' Donuts and Tesla are probably doing poorly.

Problem 8. Chris buys stock of Chevron for \$50. After a few weeks, he collects dividends of \$2 and sells it for \$52. Find Chris's rate of return from this investment.

Answer 8. The future payout \$52 + \$2 = \$54. Since the stock was purchased for \$50, this means the return is \$4. And therefore the rate of return is

$$\frac{\text{Future Payout} - \text{Asset Price}}{\text{Asset Price}} = \frac{\$54 - \$50}{\$50} = 8\%.$$

This is classified as a capital gain because the rate of return is positive.

Present and Future Value

- The **future value** tells you what the value of a present variable will be in the future given the growth rate g_x:

$$(\text{present value of } x) \times (1 + g_x) = \text{future value of } x.$$

  Suppose you can invest \$100 today at annual interest rate 10%. Then the future value (one year from now) of your present \$100 is $\$100 \times (1.10) = \$110$.

- The **present value** goes in the opposite direction: it tells you what the value of a future variable is in today's terms, given the growth rate:

$$\text{present value of } x = \frac{\text{future value of } x}{1 + g_x}.$$

  This process is called **discounting** and $1/(1 + g_x)$ is the **discount factor**.

  Suppose you will receive \$110 in one year, and the interest rate over that period is 10%. Then the present value of that future \$110 is $\$110/1.10 = \$100$. It's like asking, "how much do I have to invest today, given that the interest rate is 10%, so that I get back \$110 in the future?"

Arbitrage ensures that price equals present value.

Problem 9. A bond has a future value of \$140,000 and an interest rate of 12%. What is the price of this bond?

Answer 9. Use the formula:

$$P(1.12) = \$140,000 \implies P = \frac{\$140,000}{1.12} = \$125,000.$$

Problem 10. A bond has a future value of \$136,800 and a price today of \$120,000. What is the interest rate on this bond?

Answer 10. Use the formula, again:

$$\$120,000(1+R) = \$136,800 \implies R = \frac{\$136,800}{\$120,000} - 1 \implies R = 14\%.$$

Problem 11. A one-year corporate bond pays out \$10,000 next year and is selling for \$8,000 today in the bond market. A one-year US treasury discount bond pays \$1,325 next year and is selling for \$1,250 today. Find the risk premium on the corporate bond.

Answer 11. Remember that risk is an undesirable quality, and accordingly those who issue risky bonds have to offer compensation in the form of a higher rate of return. We call this compensation the risk premium, RP. We can then write $R_{\text{risky}} = R_{\text{safe}} + RP$.

A corporate bond is risky, whereas a US Treasury bond is about as safe as it gets (the US has never defaulted). So we conclude that the safe interest rate

$$\$1,250(1 + R_{\text{safe}}) = \$1,325 \quad \Longrightarrow \quad R_{\text{safe}} = \frac{\$1,325}{\$1,250} - 1 = 6\%.$$

The risky corporate bond has an interest rate of

$$\$8,000(1 + R_{\text{risky}}) = \$10,000 \quad \Longrightarrow \quad R_{\text{risky}} = \frac{\$10,000}{\$8,000} - 1 = 25\%.$$

Therefore the extra compensation offered by the corporate bond for its riskiness is

$$RP = 25\% - 6\% = 19\%.$$

Problem 12. A low-risk bond has a future value of \$140,000 and a price today of \$125,000. What is the future value of a high-risk bond with a risk premium of 5% and a price of \$100,000?

Answer 12. First let's find the risk-free interest rate using

$$\$125,000(1 + R_{\text{safe}}) = \$140,000 \implies R_{\text{safe}} = \frac{\$140,000}{\$125,000} - 1 = 12\%.$$

We are told that the risk premium is 5%, so it must be the case that the high-risk bond has an interest rate of $R_{\text{risky}} = 12\% + 5\% = 17\%$. We conclude that the future value of the high-risk bond is

$$\$100,000 \times (1.17) = \$117,000.$$

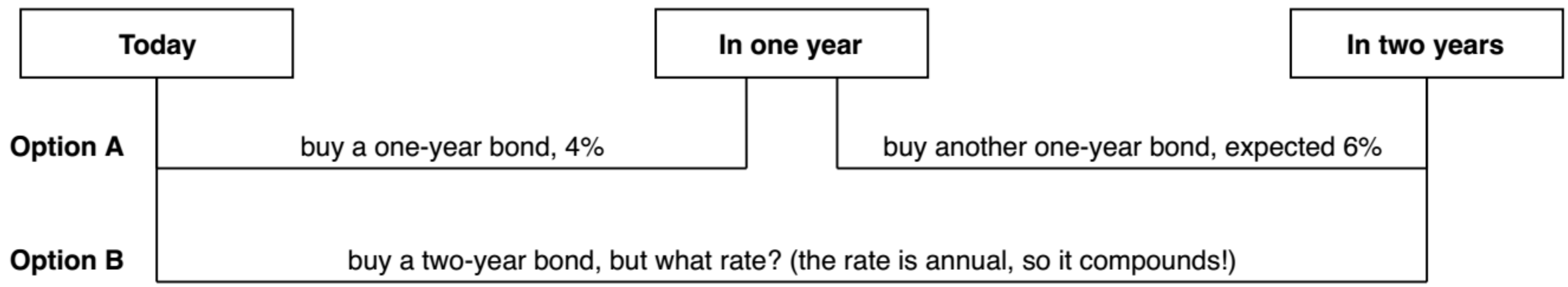
Problem 13. You buy a three-year coupon bond. Each coupon payment is \$100, and in the third year you also receive your final payment of \$842.38. The interest rate on this coupon bond is 5%. Find the price of the coupon bond.

Answer 13. The coupon bond means in one year you receive \$100; in two years you receive \$100; in the third and final year you receive another \$100 and \$842.38 on top of that. To find the price, calculate the present value of each payment and the sum it all up. To find the present value of something two years in the future, you square the discount factor; to find the present value of something t years in the future, you take the discount factor to a power of t.

Years from now	Future Value Payout	Present Value
1	100	$\frac{100}{1.05}$
2	100	$\frac{100}{1.05^2}$
3	942.38	$\frac{942.38}{1.05^3}$

The present values sum to \$1,000.

Problem 14. Suppose you are looking at one-year bonds and two-year bonds. You can buy a one-year bond today that will give rate of return 4%. If you buy another one-year bond next year, then you expect it to give rate of return 6%. What is the rate of return on today's two-year bond?



Answer 14. The **expectations hypothesis (EH)** says that the yield on a long-maturity bond is the average of the expected yields on shorter-maturity bonds. In other words, you should expect to do no better by purchasing a sequence of one-year bonds than from just buying the two-year bond.

To illustrate. If you purchased the sequence of one-year bonds, you would expect to get back

$$(1+0.04)(1+0.06) = 1+0.04+0.06+(0.04\times 0.06)$$

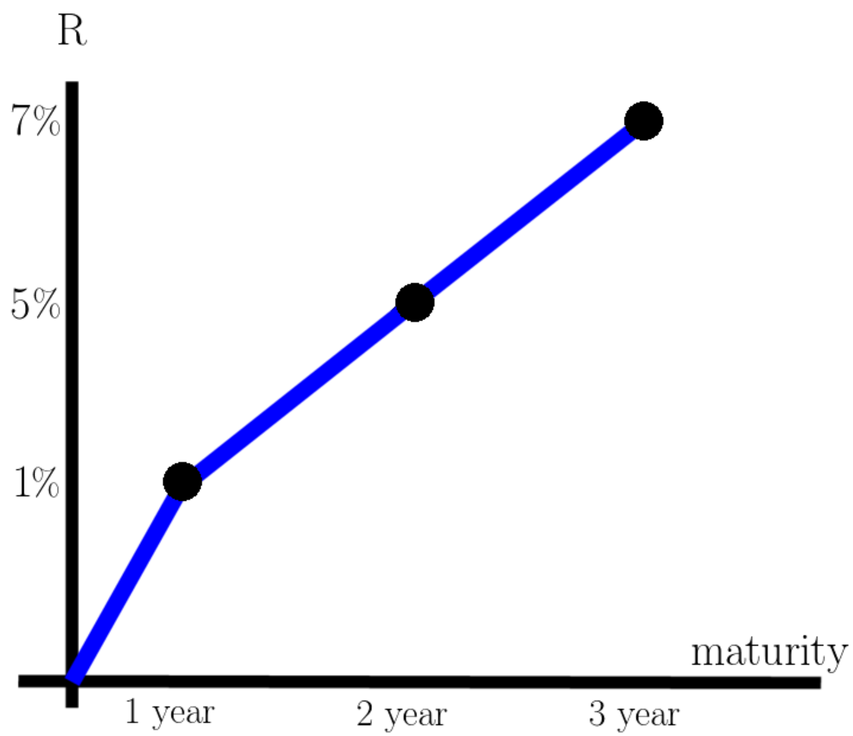
times your initial investment. The product 0.04×0.06 is really small, so let's just get rid of it. So you'll expect to get back approximately 1.10 times your initial investment, a rate of return equaling 10%.

If instead you just buy the two-year bond, then its annual return R_2 must satisfy

$$(1+R_2)^2 = 1.10 \quad \Longrightarrow \quad R_2 \approx 5\% = \frac{4\%+6\%}{2}.$$

So yeah, now you can forget about all of that approximation stuff in your calculations: today's two year rate is the average of today's one-year rate (4%) and next year's expected one year-rate (6%). An analogous result holds for today's three-year rate up to the 30-year rate, the longest offered.

Problem 15. Consider the extremely amateurish-looking yield curve below that I drew in MS Paint, which shows today's annual rates of return on one, two, and three-year bonds.



Find the expected one-year rate of return to be offered a year from now; and the expected one-year rate of return to be offered two years from now.

Answer 15. The EH says the interest rate for a two-year bond purchased today (5%) must be the average of today's one-year rate (1%) and the expected one-year rate of a bond purchased next year (x). That is,

$$5\% = \frac{1\% + x}{2} \implies x = 9\%.$$

Using the same logic, the interest rate for a three-year bond purchased today (7%) must be the average of today's one-year rate (1%), the expected one-year rate of a bond purchased next year (9%), and the expected one-year rate of a bond purchased in two years (x). That is,

$$7\% = \frac{1\% + 9\% + x}{3} \implies x = 11\%.$$

Alternatively, the interest rate for a three-year bond purchased today (7%) must be the average of today's two-year rate (5% twice since it's a two-year bond) and the expected one-year rate of a bond purchased in two years (x). That is,

$$7\% = \frac{5\% + 5\% + x}{3} \implies x = 11\%.$$