

HOMEWORK 1

DUE DATE: Tuesday April 15, 2025 by 11:59pm.

Please submit a PDF with your answers on Canvas. This Homework considers data problems you may have to solve in your workplace.

1. Calculate the present value of a \$1,000 zero-coupon bond with 5 years to maturity if the required annual interest rate is 6%.
2. You are willing to pay \$15,625 now to purchase a perpetuity which will pay you and your heirs \$1,250 each year, forever, starting at the end of this year. If your required rate of return does not change, what is the yield to maturity?
3. What is the price of a perpetuity that pays a coupon of \$50 per year and a yield to maturity of 2.5%? If the yield to maturity doubles, what will happen to its price?
4. Calculate the duration of a \$1000 10-year coupon bond with semiannual coupons paid at 6% per year if the interest rate 10%.
5. Suppose you are a manager of a financial institution. You hold 50% of a portfolio in the bond described in the previous question and the rest in a 10-year zero coupon bond. What is the duration of the portfolio?
6. A pension fund manager is holding a 10-year 10% coupon bond in the portfolio and the interest rate is 10%. What loss would the fund be exposed to if the interest rate rises to 11% next month? This manager has the option to switch to a 10-year 20% coupon bond. Would the manager switch to this bond in terms of the interest-rate risk?
7. Consider a \$1,000 10-year bond that pays a 2.5% annual coupon.
 - (a) Compute the current price and the duration (using excel) of this bond, given that the interest rate is 2.5%.

- (b) Suppose that the interest rate jumps to 3%. What is the percent price change in the bond? Use the approximate formula based on Duration that we learned in class for the remainder of this problem (b)-(f);
- (c) What is the new price level of the bond?
- (d) Suppose that the interest rate is 2.5% at $t+1$ and $t+2$, but will jump at $t+3$ to 3% and stay at 3% forever. If you are the only person that knows this information, what will be the bond price at $t+1$, at $t+2$ and at $t+3$?
- (e) Refer to question (d). If you can invest only in either this bond or in cash (that offers zero interest), would you keep or sell the bond at $t+1$? At $t+2$?
- (f) Refer to question (d), but suppose that everyone in the market knows at time $t+1$ that the interest rate will jump at $t+3$ to 3%. What will be the bond price at $t+1$, at $t+2$ and at $t+3$?
8. Consider a \$1,000-par junk bond paying a 12% annual coupon. The issuing company has 20% chance of defaulting this year; in which case, the bond would not pay anything. If the company survives the first year, paying the annual coupon payment, it then has a 25% chance of defaulting in the second year. If the company defaults in the second year, neither the final coupon payment nor par value of the bond will be paid. What price must investors pay for this bond to expect a 10% yield to maturity?
9. On 4/4/2025 we observe a \$105.041 asking price for a 10-year US Treasury Bill maturing on 2/15/2035, with an annual 4.625 coupon.
- a) Determine the asking yield to maturity
- b) Determine the current yield

Tip: to simplify the problem assume that the observation date is 2/15/2025. To obtain credit, your answer must include your computations.

10. Consider weekly data on closing prices of the SP500 index from 1/1/1960 to 4/4/2025. The data is in the attached Excel file.

- a. Generate a series of weekly rates of return. Then Compute the mean and the standard deviation of the weekly rates of return over the entire sample period, as well as the 95% and 99% confidence intervals. How many standard deviations away from the mean is the rate of return of the week ending on 4/4/2025?
- b. Plot a histogram of the weekly rates of return, with 100 bins of equal size.
- c. Compute the arithmetic annual rate of return of the SP500 price. This is the so called *annual percentage rate (APR)*:

$$APR = n * r(\text{weekly})$$

where n is the number of weeks in a year (number of compounding periods in a year) and $r(\text{weekly})$ is the average weekly rate of return over the sample.¹

- d. Compute the geometric annual rate of return of the SP500 index. This is the so called *effective annual rate (EAR)*:

$$1 + EAR = [1 + r(T)]^{1/T}, \text{ where}$$

T = number of years in the sample & $1 + r(T) = P(4/4/2025) / P(1^{\text{st}} \text{ week in sample})$.

- e. Compute the *continuously compounded annual rate of return (CCR)* of the SP500 index. It can be obtained with the formula:

$$CCR = \ln(1 + EAR).$$

¹ In financial returns, a year is generally considered to have 52 weeks, though some years may include 53 weeks depending on the accounting method used.

- **52 Weeks:** Most years in this system consist of 52 weeks (364 days). This is achieved by dividing the year into four quarters, each with 13 weeks (grouped as 4 weeks, 4 weeks, and 5 weeks per month) for consistent financial reporting.
- **53 Weeks:** Because a calendar year has 365 days (or 366 in leap years), the extra days accumulate over time. Approximately every five to six years, an additional week is added to account for these extra days, resulting in a fiscal year with 53 weeks

- f. Suppose that rates of return over the next 30 years will have the same statistical properties as those over 1960-2025. Using continuous compounding and your result in (e) write a simple formula for the *total return* over the next 30 years.

11. Read these WSJ articles and answer the following questions

Banks Don't Pay Tariffs, but Tariffs Will Cost Them

Bankers don't import or export sneakers or cars. But that doesn't mean they are immune to tariffs. In less than three lines, explain Why.

Trump's Team Is Getting the Bond Rally It Wanted. But for the Wrong Reasons.

Why did the 10-year Treasury Yield fall? Why does the article say, "for the wrong reasons"? What would the good reasons be?