

*For Age and Want save while you may;
No morning Sun lasts a whole Day.*

Ben Franklin

Holding Period and Annualized Returns

1. What is a holding period return?
2. What is the notation for a 3-year holding period return?
3. What's the formula to compute a 3-year holding period return?
4. What is an annualized rate of return?
5. What is the notation for a 3-year annualized rate of return?
6. What's the formula to compute a 3-year annualized rate of return?
7. You earn the following annual returns: 10%, 20%, 5%, -10%, and -5%
 - (a) What is your holding period return?
 - (b) What is your average annual return (arithmetic)? *[AVERAGE]*
 - (c) What is your average annual return (geometric or CAGR)? *[GEOMEAN]* If your answers seems wildly off, you'll have to look up how to use the function correctly.
 - (d) Which return better represents your true economic return?
 - (e) Now assume that you earn the same returns but in exactly the reverse order, i.e., -5%, -10%,...etc. Do your answers in a, b, and c change?
 - (f) Now assume that you start with \$10,000 in your investment account, and at the end of each year, you add an additional \$10,000 and the account earns the above annual returns.

For example, using the first sequence of returns in (a), after one year you will have \$11,000 (the \$10,000 starting balance plus a return of 10%)+ \$10,000 (the addition to account made at year end) for a total of \$21,000.

Which of the two sequence of returns above gives you a higher balance at the end of 5 years? It probably best to create two tables that show the beginning balances, returns, additions, ending balance, etc. This is a potentially important issue, especially for those on the cusp of retirement.
8. In what way are U.S. treasuries risk-free?
9. In what ways are U.S. treasuries not risk-free?

10. You borrow \$500,000 at 7% per year (APR, not EAR) for 30 years to purchase an apartment (in some city that is not New York).
- (a) What is your monthly payment? *[PMT]*
 - (b) If you make an additional monthly payment of \$250, in how many years will the loan be repaid? *[NPER or N]*
 - (c) Using the original facts, if you want to repay the loan in 15 years instead of 30, how much more do you need to pay each month? *[PMT] and [NPER or N]*
 - (d) Using the original facts, immediately after the 72nd payment, you receive a \$50,000 bonus, which you use to pay down the principal. By how many years and months do you reduce the mortgage? *Note: When you prepay a mortgage, your monthly payment does not change but the interest that accrues each month is less (because the principal is less), and you will make fewer payments. [PV and NPER]*
11. You've found your dream house/apartment/room, and you apply for a \$500,000 mortgage from your local bank after seeing an ad on your Instagram feed for a 7.50%, 30-year mortgage. After you show your W-2 (wage statement) to the loan officer, the bank concludes that you may not be able to afford the monthly payment. They therefore offer you a rate of 7.00% (APR) but you must also pay an upfront fee of 3 "points." A point, in loan parlance, means 1% of the loan amount. Thus, if you borrow \$100,000 and pay 3 points, you must pay \$3,000. Even though you receive only the loan proceeds *less* the points paid, you must repay the *entire* amount using the amortization schedule for that amount.

Points paid are economically equivalent to additional interest on the loan, except the interest is paid upfront. (You should convince yourself that the result is the same whether the bank deducts the points from the loan proceeds or you write a separate check for them.)

- (a) What is your true interest rate (use APR) as a result of paying the 3 points assuming that you pay off the loan over the original 30 year term? *[Rate]*. **Hint:** *The PMT is calculated using the loan amount, but the amount you receive is the loan amount less the points.*
- (b) Suppose that your income qualifies you for either mortgage. In helping you to decide between the two mortgages, one back-of-the-envelope calculation that often appears online, is the breakeven point, that is, how long before you recover the points paid with the lower monthly payment. If you plan to stay in your home for a period exceeding the breakeven point, then the breakeven approach suggests that paying the points is superior. What is the breakeven point for these two mortgages? Using some of the principles we covered this semester,

very, very briefly critique the breakeven methodology. What is other information that could be relevant to the analysis?

- (c) Assume that you choose the 7.00% plus 3 points mortgage and that you pay off the remaining loan balance at the end of three years instead of over 30 years. What is the true interest rate (use APR) that you have paid over the three years?

Hint: Assume you repay the loan after one day. You will have borrowed the net proceeds (after points) but must repay the entire \$500,000 balance and one day's interest. You can see that's indeed a hefty interest rate. If, however, the loan is repaid over 30 years as in (a) above, the extra interest is spread out over the 30 years. Your true interest rate over 3 years is going to fall between the rate in (a) and the rate you pay when you borrow the net proceeds and repay \$500,000 one day later.

There are a couple of ways to tackle this problem. The easiest is to use *IRR*. Input the cash flows—the points, the loan proceeds, the 36 payments, and the loan repayment (the loan balance at the end of the 3 years)—using the correct sign convention, positive for inflows and negative for outflows. *IRR* will give you the correct answer. To solve it with Excel using the *NPER*, *RATE*, *PV*, *PMT*, and *FV* formulas, remember that your *PV* is the net loan proceeds (after points), your *PMT* remains the same, but the *FV* is the amount that you owe to the bank after 36 payments—you must calculate that.

12. Slick Willy offers you an investment that requires a cash outflow of \$10,000 today followed by a cash inflow of \$12,000 in two years. Assume that the investment is risk free, the nominal annual rate of interest is 5%, and the annual inflation rate is 3%.
- (a) What is the NPV in nominal dollars?
- (b) What is the NPV in real dollars?
13. MC Question: The YTM (IRR) on a bond:
- (a) Assumes that interim coupons are invested at the coupon rate.
- (b) Equals the current yield (CY) plus the holding period return.
- (c) Is below the coupon rate when the bond is selling at a discount, and above the coupon rate when the bond is selling at a premium.
- (d) Is the discount rate that if applied to compute the present value of all the payments will result in the price today.
14. You own a five-year bond with a 5% annual coupon that sells at a YTM of 7% and has a face value of \$1,000.

- (a) Is the bond a discount or premium bond?
 - (b) If interest rates remain constant, one year from today, the price of the bond will be (choose the correct answer and very briefly explain):
 - i. Higher
 - ii. Lower
 - iii. The same
 - iv. Par (Face)
 - (c) One goal of our tax system is to *attempt* to match economic and taxable income. If no election is made, a holder of the bond will recognize \$50 of taxable interest income from each coupon payment. Is the taxpayer over or under taxed in terms of economic income?
 - (d) If interest rates increase, what will happen to the price of the bond?
15. Assume that one-year rates are 5% and you purchase a government note with one year remaining term for \$1,000 that will pay a 5% coupon plus the principal (a total of \$1,050) one year from today. Immediately after you purchase the note, interest rates rise to 10%.
- (a) What will be the price of the note now?
 - (b) Have you made or lost money?
 - (c) If you don't sell the note, is your loss *realized* or *unrealized*?
 - (d) Students have sometimes pointed out that you can continue to hold the bill to maturity and you will receive the promised \$1,050. Therefore, if you don't sell, you won't suffer any financial losses. Briefly explain why this is a mistaken view. To show this, you may wish to consider and compare the financial results of a person who purchases the same bill at the new price and holds it to maturity.
16. You just purchased a 5% (assume annual coupons), 30-year government bond, with a face value of \$1,000 and a YTM of 5% . Note, Excel has both Modified Duration (*MDuration*) and Macaulay Duration (*Duration*) functions.
- (a) What is the bond's modified duration? [Use 1/1/22 for the settlement date and 1/1/52 for the maturity date.]
 - (b) If the YTM increases by 100 basis points, what is the percentage change in the bond's price?
 - (c) If the YTM decreases by 100 basis points, what is the percentage change in the bond's price?

- (d) Same as above. What's the percentage change in price predicted by the bond's modified duration?
- (e) Why doesn't the bond's modified duration do a good job of predicting the percentage price change of a 100 bps movement in the YTM?
- (f) If you have an equal amount of liabilities with the same modified duration as the bond, very briefly explain why (e) is a potentially a problem?