**Learning Objective: Understand pricing of bonds, finding the YTM of bond. Compute duration and convexity of bonds. Understand and prove an investment is immunized.**

This homework will be completed in Excel. This homework has finance and excel learning objectives.

**Instructions for completion:**

Please use the Excel File named “Bond\_Examples\_Student\_Version (Template for HW 3)” to complete this assignment. This is the same file posted in Week 5 Excel files that you use to “follow along” with the videos.

This assignment involves completing the “work” that is done in the videos for Week 5. Following along the videos, complete the work.

Work is required in the following worksheets:

-Price the bond basics

-Variable timeline

-Finding\_YTM

-Duration\_Convexity

-Immunize Part 1

-Immunize Part 2

When you complete your assignment, please save your file as follows:

HW\_3\_YOURLASTNAME

So, for me, it would be: HW\_3\_Garner.xlsm

SAVE AS A MACRO ENABLED FILE. This helps with grading. The file extension should be: .xlsm

Complete the Information sheet with your last name and your GT ID!

**All work must be done individually. Do not share your files with other students.**

**Continued on next page**

**Instructions for Writing Formulas:**

**Any cell which is “filled” with a GRAY color must have a formula.**

**Please write the formulas as shown in the week 5 videos!**

1. **Price the bond basics worksheet**

**Learning objective:** Understand that a bond is simply the PV of an N-period annuity and a lump sum at N.

In this worksheet, you should obtain the price of a bond. You will calculate the price “by hand” and by using Excel’s PV function. An “input box” appears in Cells A4 through B7. Of course you may change the inputs to check your formulas but please return the inputs to their original values before submission of your file.

In Cells D13 through D22, write a formula (in each cell) which computes the present value of each payment (the payments of the bond appear in Column B). Do not use the PV function here, but rather write a formula that computes each PV by hand using the PV formula: PV = FV/(1+r)t. Use the timeline (in Column A) as your exponents in the PV calculation. In D12, sum the PVs in D13 through D22.

In E22, compute the present value of the par value which appears in C22. Note E22 is not gray, but we still need a formula here! Compute the present value “by hand” not with the Excel PV function. Refer to values in the input box where necessary. In E12, sum E13 through E22.

Total D12 + E12 in F12.

In H13, use the PV function in Excel and compute the PV of the annuity portion of a bond. Reference values in the input box. In I13, use the PV function in Excel and compute the PV of just the par value (the lump sum piece). In J13, use the PV function in Excel to compute the PV of the bond (the annuity and lump sum pieces). Total H13 and I13 in I14. Place a minus sign in front of your PV formulas in order to obtain a positive “price.”

**Please write formulas as shown in the videos.**

1. **Variable timeline worksheet**

**Learning objective:** Creating a flexible model which populates only if the time period is relevant.

In A11 through A94 use the IfError function and an if statement to populate the timeline based on the term of the bond. Please refer to videos for any clarification.

In B11 through B94 write an if statement to generate the cash flows from the bond, based on whether or not that period (in column A) is within the term of the bond. Note: the cash flows from the bond include the coupon payment and the par value. Write your formula such that the cell only shows the coupon payment (this would be for periods 1 through N-1) and shows the coupon AND par for period N (end of bond’s term). Please write as shown in the videos.

In C11 through C94 write an if statement to generate the present value of the bond’s cash flow if there is a cash flow in column B. Otherwise, there should be a blank (“ “). Please write as shown in videos.

In D10 write a sum formula for C11 through C94. In G11, using the PV function, write a formula to compute the price of the bond. Refer to numbers in the input box. G11’s value should match the value in D10.

Note: in all formulas, use applicable values in the input box.**Please write formulas as shown in the videos.**

1. **Finding\_YTM Worksheet**

**Learning Objectives**: Be able to find a bond’s YTM and understand the relation of bond pricing with YTM and coupons. That is a bond is priced at par if YTM = Coupon. Bond is priced at discount if YTM > Coupon and bond is priced at a premium if YTM < Coupon. This spreadsheet also has a variable timeline, so further understanding of this concept is part of the learning objectives.

In A11 through C94 replicate the formulas from the Variable timeline worksheet. In E10, sum C11 through C94. Once E10 is populated with a formula, replace the hardcoded value in B8 with a formula which is simply =E10. That is, reference E10 in B8.

In I10, using the rate function and numbers in the input box, compute ½ of the bond’s YTM. In I11, compute the YTM by multiplying I10 by 2. Keep track of inflows and outflows of the bond. Treat prices (PV) as outflows and Coupon payments and par as inflows. The value obtained in I11 should match the Yield in the input box (B6).

In L10 write an if statement formula that returns either “Priced at Par”, “Premium” or “Discount” based on the relation between I11 and B5.

In L11 write a formula that reads either “YTM = Coupon”, “YTM < Coupon” or “YTM > Coupon” based on the price of the bond (B8) relative to $1,000.

**Please write formulas as shown in the videos.**

1. **Duration\_Convexity**

**Learning Objectives:** Understanding that duration and convexity are concepts which allow us to predict price changes in bonds. Together, they estimate very closely what would happen to a bond’s price upon an interest rate change. The excel learning objective is to build a simple model which computes both duration and convexity.

In B1 write a formula using the PV function and the inputs in the input box to compute a bond’s price. The bond is a semi-annual paying bond so adjust your formula appropriately. In C18 through I29 write formulas to ultimately compute a bond’s price, its duration and its convexity. Please write the formulas as they are in the videos.

Total E18 through E29 in E31 (bond’s price). Total F18 through F29 in F31 (Bond’s time weighted PV). Divide F31 by E31 in F32. Take ½ of F32 in F33.

Cell G31 can either be a sum of column G in that section, or you can leave blank.  Either way!

Total I18 through I29 in I31. Divide I31 by E31 in I32. Then divide I32 by 4 in I33.

In B8, pull Macaulay Duration from F33.

In B9, write a formula for Modified duration, which is Macaulay duration (in B8) divided by (1 + periodic rate), which is (1 + YTM/2).

In B10, pull Convexity from I33.

In F4, compute the dollar amount of price change predicted by duration.

$ amount of price ∆ from duration = -Modified duration x Original Price x Yield ∆

In G4, compute the % of price change (dollar amount divided by original price)

In F5, compute the dollar amount of price change predicted by convexity.

$ amount of price ∆ from convexity = 0.5 x Convexity x (Yield ∆)2 x Original price

In G5, compute the % of price change (dollar amount divided by original price)

Total F4 and F5 in F6.

In F8, use the PV function and the rate that would result from the change (in this case, the new YTM would be 6% so the semi-annual rate is now 3%) and compute the new price.

Then in F9, add the original price in B1 and the total predicted price change from F6.

Compare these in F10 (Simply subtract F9 from F8). Note: the video says Subtract F8 from F9, so either is okay!

**Please write formulas as shown in the videos.**

1. **Immunize Part 1 and Immunize Part 2 Worksheets**

**Learning objectives:** Bond immunization is a tool that allows portfolio managers to minimize the interest rate risk of an investment by adjusting the portfolio’s duration such that it matches the investment horizon. The work you will do in both of these spreadsheets helps you understand these concepts. Some new Excel functions are here: The Price function, the Duration function, and SumProduct.

**Immunize Part 1** involves computing duration of a liability of a bank (a CD) using the original yield (Rows 20 through 36) and then computing duration using a change in the Yield (Rows 38 – 55). Please write formulas in all gray cells in this spreadsheet.

One mismatch in the video; duration calculated in Cell B13 should be 8.7175 not 76.2957. To achieve this, the denominator should be B7, not B10 as shown at 8:24/32:04 in the video.

Also, the formula in Cell B13 should be as follows:

=B12/(1+(B6+F1)/B7)

The entire quantity of (B6 and F1) need to be divided by B7, the frequency!

**Please write formulas as shown in the videos.**

**Immunize Part 2** involves showing how a bank can immunize itself against harm that would result if yields change. So they will invest in a portfolio of bonds which have a duration equal to the duration of the CD. It will be critical to watch the videos to fill in this spreadsheet!

First find a set of bonds whose weighted average duration match that of the CD. That is done in rows 5 through 14.

In Column G, please use the price function to get the bond’s price (a little different from the PV function). In Column H, use the Duration function!

Originally, set your weights in Column I to 0.2 each. Use the sumproduct function to obtain a weighted average duration and place in Cell H13.

Use Excel’s Solver to find the weights that will result in a duration equal to your liability duration. **Follow along the video to find the constraints you need for Solver**.

Now assume yields change. This work will be done in Rows 18 through 33.

Assume a yield change of 0.25% and prove that your CD is hedged: Compare the price of your CD and the value of your bonds. When interest rates change, the price of our liability changes, but so does the asset’s price. They change by almost the same amount because we matched our bond’s duration to that of the CD.

**Please write formulas as shown in the videos.**

**END OF INSTRUCTIONS**