FIL 240 & 404 – Trefzger
SPREADSHEET PROBLEM 3
Bond Valuation (Special Feature: IF Statements)

The focus of this problem is computing the theoretical, or intrinsic, value of a bond. This problem also introduces (to those who may not have used it before) the IF statement, a very useful spreadsheet application.

We set up the spreadsheet to deal with a bond whose original maturity was ten years, with interest paid semiannually. We will look directly at remaining periods until maturity of 8, 4, 2, and 1 years, but our objective is to have a versatile tool that lets us easily compare values for periods remaining until maturity ranging from ½ year to 10 years, and for different current required rates of return (yields to maturity). So construct the spreadsheet so if the user wants to change input values, including remaining time until maturity, all the output values change automatically. Cells the computations are based on should contain formulas or cell references and not just typed-in numbers, and see the accompanying file on avoiding the NAME error message. We want this spreadsheet to be a versatile tool for analyzing bonds with remaining maturities of up to 20 semiannual periods.

Assume that the bond has a $1,000 par value and an annual coupon interest rate of 9%. Your assignment is to compute the bond's theoretical value under the following sets of conditions (12 combinations in all):

>   First Sheet: 10.25% effective yield to maturity, for 8, 4, 2, and 1 years remaining
>   Second Sheet: 9.2025% effective yield to maturity, for 8, 4, 2, and 1 years remaining
>   Third Sheet: 8.16 % effective yield to maturity, for 8, 4, 2, and 1 years remaining

Thus, you should plan to have ***THREE EXCEL WORKSHEETS IN THE WORKBOOK YOU UPLOAD TO REGGIE NET*** (or three separate pages if we collect hard copies), one for each indicated effective yield to maturity.

A set of fairly detailed instructions is provided for anyone who would like to use it. You might try to develop a creative solution to the problem on your own, but be sure that you show all of the main computational steps assigned and the related output. On page setup please select landscape orientation to make the output easier for the grader to read. If you submit electronically, please have one workbook with three separate worksheets (pages). If we are asking for hard copy submissions please print your output for each yield to maturity case on one page; using less paper saves money and trees, and makes the grading process easier (less page-flipping).

WHAT YOU SUBMIT SHOULD BE YOUR OWN INDIVIDUALLY-COMPLETED, ORIGINAL WORK. OUR SPREADSHEET ASSIGNMENTS ARE NOT GROUP PROJECTS OR CUT-AND-PASTE EXERCISES.

You should try to develop a creative solution to the problem on your own, but the following set of fairly detailed instructions is provided for anyone who might find them useful. These instructions are for working the above problem with the *Microsoft Excel* spreadsheet software; other spreadsheet packages might not require identical, steps. Again, the procedure described is *a* method for using the computer to solve the problem; it is not *the* only possible method. But make sure that whatever you submit allows for the uses described in the statement of the problem. When a blank spreadsheet page appears on the screen of the computer monitor, you are ready to begin following the instructions.

Remember to "Save" every few minutes. The instructions may be unclear in a few places, despite the instructor's best efforts; ask if questions arise. If you follow directions as specified and nothing seems to happen, try hitting "Enter" before proceeding. You can move the indicator that highlights a cell by hitting one of the keys that shows an arrow pointing up, down, left, right, *etc*. If a cell shows a series of ####### marks, you need to make your column wider by dragging the mouse at the right-hand corner of the top of the column (or just double-click and it should adjust automatically to a width sufficient to show the values).

In cells A1 and A2, type the information that identifies yourself and the type of problem being worked. In cells A4 – A7, type a short narrative description of what we are attempting to do in this problem (you won't necessarily need all 4 lines or all 15 columns).

In cell A9 type, "INPUT VALUES." In cells A10 through A13, respectively, type "Par Value," "Coupon Rate," "Effective Yield to Maturity," and "Yrs. Until Maturity: Case A." Then highlight cell A13 and copy the contents into cells E13, I13, and M13. (You might want to make columns D, H, and L narrow; they just provide separations between the four cases we consider.) Then change the text in cells E/I/M13 to say that they are for cases B, C, and D, respectively. In cell B10, type "1000" and format as currency with two decimal places. In cell B11, type ".09 ." That $1,000 par value and 9% annual coupon interest rate will apply throughout our analysis. In cell B12, type ".1236 ." [We use a 12.36% effective yield to maturity for practice; a sample output page is provided so you can check your work. But if you hand in only the practice problem, and not the three assigned yield cases, you will receive zero points.] In cell B13 type, "8." Then in cells F13, J13, and N13 type "4," "2," and "1," respectively.

In cell A15 type, "WORKING AND OUTPUT VALUES." In cells A16 and A17 TYPE "Periodic Rate" and "Stated Annual Rate (APR)." In cell B16, type "=(1+B12)^.5-1. (This step translates your effective yield to maturity, which is a compounded annual rate or effective annual rate [EAR], into a semiannual periodic rate to use in discounting.) In cell B17, type "=B16*2." (This step translates your semiannual periodic rate into a stated annual rate, or annual percentage rate [APR].) Then format cells B11, B12, B16, and B17 as percentages, each with two decimal places.

In cell A19 type, "Case A," and in cell A20 type "Half-years Remaining." Copy and paste the wording in cells A19 & 20 into cells E19 &20, I19 &20, and M19 &20; then change the text in cells E/I/M19 to say that they are for cases B, C, and D, respectively. In cell B20 type "=B13*2" and then copy/paste the cell B20 contents into cells F20, J20, and N20. B20 should show a value of 16, but the relative cell references should leave values of 8, 4, and 2 showing in F/J/N20 (each should be half of the value in the same column in row 13 above).

In cell A22, type "PV of Par Value to be Received at Maturity." In cells A23 and A24, respectively, type "Par Value" and "=$B$10." The result should be $1,000 showing in cell A24. In cells B23 and C23 type "PV Factor" and "PV of Par." In cell B24, type "=1/(1+$B$16)^B20" (a step that computes the present value of a dollar factor for the number of periods remaining until the bond matures and the par value is received). In cell C24, type "=A24*B24" to compute the PV of the par value (we use the standard $1,000 par throughout our example) that is expected to be received at maturity. In cell A26, type "PV of Expected Interest Payments." In cells A27, B27, and C27, respectively, type "Period," "Cash Flow," and "PV of CF." In cells A28 through A47, type the digits 1 through 20 (or type 1 in cell A28, and then in cell A29 type "=A28+1," to show 2, and then paste the contents of A29 down through cell A47, such that each row in column A shows a value greater by 1 than the row above it.) In cell A49 type, "Bond Value."

Now we are ready to use IF statements, which allow us to assign different values to a cell depending on the circumstances. The format of an IF statement is "=IF(condition, value to assign if condition is true, value to assign otherwise)." For example, let's say that you want cell B50 to show a value of 10 if cell A50's value is less than 100, or to show a value of 20 if cell A50's value is 100 or greater. In cell B50 you would type, "=IF(A50<100,10,20)." Here we will use IF statements simply to keep cells empty, for a less cluttered visual appearance, if there would be no interest payments in the indicated time periods.

In cell B28, type: =IF(A28<=B$20,$B$10*($B$11/2)," "). The value 45 should show. [It may not be necessary, but is probably best to type a blank space between quotation marks; doing so tells the computer to type nothing in the cell, thereby leaving it blank if the bond has matured. And if you leave out the " " the cell will show FALSE instead of being blank the way we want it to be, so make sure you include the " "!!] In cell C28, type: =IF(A28<=B$20,B28*1/(1+$B$16)^A28," ") should show a present value a little less than 45. [*Type the IF formulas in by hand*; if you try to copy them from this PDF file and paste into your spreadsheet you might get error messages, like NAME or FALSE, caused by the quote marks being in a font that Excel does not recognize – needs to look like " " not " ". See the file with the Spreadsheet 3 materials on

the web site that addresses this issue.] The placement of the dollar signs for absolute cell references is extremely important here; leaving a dollar sign off where it is indicated, or putting one in where it should not be, will cause problems when you copy and paste to other cells (an activity that constitutes much of the remaining work in this problem). Format cells B28 and C28 as currency, with two decimal places.

Highlight cells B28 and C28 so you can copy their contents (select Copy from the Edit menu, or hit the C key while holding down the Ctrl key). Then highlight the block of cells B29 through C47 and paste (select Paste from the Edit menu, or hit the V key while holding down the Ctrl key). The result should be to show the value $45.00 in each of cells B28 through B43, the present values of the $45.00 expected interest payments in cells C28 through C43, and blanks in cells B44 – C47 (if the bond will mature in 16 half-years there will be no receipts of interest in half-years 17 – 20). In cell C49, type "=SUM(C24:C47)" to sum the present values of the expected interest payments plus the PV of the expected receipt of the par value at maturity, and format C49 as currency with two decimal places. Now most of the hard work is done; it is mostly "copy and paste" from here on.

Highlight the entire block of cells A22 through C49, and select Copy from the Edit menu (or hit the C key while holding down the Ctrl key). Then select cell E22 and select Paste from the Edit menu (or hit the V key while holding down the Ctrl key). Paste again into cells I22 and M22. The blocks of cells E22 through G49, I22 through K49, and M22 through O49 should all contain exact copies of the contents of cells A22 through C49. However, the cells that are blank and the indicated bond values are different! Case B shown in columns E – G, for example, is based on 4 years = 8 half-years remaining until maturity, rather than the 8 years = 16 half-years illustrated in Case A in columns A – C. (Then cases C and D compute with reference to 2 years = 4 half-years and 1 year = 2 half-years, respectively; notice how case D shows just two expected interest payments, with blanks in all of cells N30 – O47.) If your work is correct you should be able to enter any value from .5 to 10 (in increments of .5) in any of cells B/F/J/N13, and get correct bond values in the corresponding column on row 49, and the appropriate cells showing as blanks (try it to check your work, as your grader will). Once the tedious detail work is done the copying and pasting that delivers an equivalent computational structure is pretty easy.

ALLOWING FOR OUR THREE SEPRATE CASES
If you have done all steps correctly, then the values you have computed should be the same as those shown on the sample output page. All that remains to do are three brief changes (for the effective YTMs you are actually supposed to use), and some interpretation. First go to cell B12 and change the Effective Yield to Maturity to .1025. (The appropriate values should change correctly, and automatically, if you have entered everything, including the IF statements and dollar signs for absolute cell references, correctly. Just to double-check, look to see whether the bond value appearing in cell C49 is $945.81, as it should be if you correctly show 8 years remaining to maturity in cell B13.) Then copy the entire contents of your correctly done worksheet onto two additional pages/worksheets in the Excel workbook. Enter the other two assigned Effective Yield to Maturity values into cell B12 of each of the two copies. Now you should have a workbook with correct bond values for all four cases under each of the three assigned effective yield to maturity values. (You might left-click on each worksheet's tab at the bottom to Rename it, perhaps naming it as the effective yield to maturity used in that sheet, like 10.25%.) You are done with the typing and number crunching; now let's interpret the results.

INTERPRETATION
Recall that the theoretical value of a bond is the present value of the expected cash flows (determined by the specified par value and the coupon interest rate) discounted at the required periodic rate of return (the yield to maturity, or YTM, for a bond with annual payments, or $\sqrt[2]{1 + \text{Eff.YTM}} - 1$ for a bond with semiannual payments). Here the payments are semiannual, so the in the three cases shown we see the following:

- When the effective yield to maturity is 10.25% the semiannual periodic discount rate is $\sqrt[2]{1.1025} - 1 = 5\%$, or viewed in the other direction, if we know that the semiannual periodic rate is 5% the effective yield to maturity (effective annual rate, or EAR) is $(1.05)^2 - 1 = 10.25\%$, and the equivalent stated annual rate (the non-compounded annual percentage rate, or APR) is 2 x 5% = 10%.

- When the effective YTM is 9.2025% the semiannual periodic discount rate is $\sqrt[2]{1.092025} - 1 = 4.5\%$, or viewed in the other direction, if we know that the semiannual periodic rate is 4.5% the effective yield to maturity is $(1.045)^2 - 1 = 9.2025\%$, and the APR is 2 x 4.5% = 9%.

- When the effective yield to maturity is 8.16% the semiannual periodic discount rate is $\sqrt[2]{1.0816} - 1 = 4\%$, or viewed in the other direction, if we know that the semiannual periodic rate is 4% the effective yield to maturity is $(1.04)^2 - 1 = 8.16\%$, and the APR is 2 x 4% = 8%. Then notice two effects:

1) When the semiannual discount rate is equal to half the annual coupon rate (4.5%, corresponding to a 9.2025% effective yield to maturity) the bond's theoretical value is the par value (the idea is that the market's required semiannual return is equal to the rate that the bond delivers in interest every six months). But when the semiannual discount rate is above half the annual coupon rate (here 5%, corresponding to a 10.25% YTM), the bond's theoretical value is below the par value (the market's required semiannual return exceeds the rate that the bond delivers in interest every six months, so the buyer must pay a price less than par to force the unchanging interest payments to represent a higher periodic percentage return). And when the semiannual discount rate is less than half the annual coupon rate (here 4%, compounding to an 8.16% YTM), the bond's theoretical value is above the par value (the market's required semiannual return is less than the rate that the bond delivers in interest every six months, so the buyer is willing to pay a price greater than par that leaves the unchanging interest payments representing a lower percentage return).

2) The longer the time remaining to maturity, the more severely is the semiannual-coupon bond's value affected by the required periodic return's being above/below half the coupon rate. Notice how with 8 years remaining, the bond's value is substantially below or above the $1,000 par value if the semiannual required return is above or below (respectively) half of the coupon rate, whereas with only 1 year remaining the value is only slightly below/above the $1,000 par value if the semiannual required return is above/below half of the coupon rate. But if the required semiannual return is equal to half of the coupon rate, the bond's theoretical value is equal to the $1,000 par value regardless of how many years remain in the bond's life. If the unchanging annual coupon rate is 9% when the world expects a 10.25% EAR return for taking the attendant risk of lending (a "9% bond in a 10% world," as your ancient instructor likes to say), the value is noticeably below par if that disadvantage will persist for 8 years, but only slightly below par if the disadvantage will end when the bond matures in just 1 year. If the unchanging coupon rate is 9% when the world expects only an 8.16% EAR (a "9% bond in an 8% world,"), the value is noticeably above par if that advantage will persist for 8 years, but only slightly higher than par if the advantage will remain in place for only a year. But if the coupon rate is 9% when the world expects exactly a 9.2025% EAR (a "9% bond in a 9% world,"), the bond delivers what the market currently asks for, and its theoretical value is the $1,000 par value, regardless of whether 1 year, 20 years, or 150 years remain until the maturity date.

Upload your finished workbook to the Assignments tab on Reggie Net, unless we are asking for hard copies.

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