

Student Preparation Manual for FTS Interactive Market Cases

Introduction

In this manual, we show you how to prepare for a series of FTS Interactive Markets trading cases. We describe the concepts you should think about and review and how to exploit the Excel link of the FTS Trader to build a support system in Excel. This combination helps develop your conceptual understanding as well as *your analytical and model building skills*.

Cases covered in this Manual

We will cover the following basic cases in this manual. Some additional cases (such as XR1 have specific support spreadsheets that you can download from within the FTS Trader's Help menu). Once you have mastered the basic cases, you should be able to create your own analytic support system for the more advanced cases without too much difficulty.

Fixed Income Cases

- [B01](#) An introduction to the time value of money --- zero and coupon bond markets in a constant interest rate world.
- [B02](#) Zero and coupon bond markets open in a non constant interest rate world. Time value of money, and introduction to cash matching
- [B03](#) Zero, coupon and forward markets open in the B02 world. Time value of money (future value, present value), introduction to arbitrage free pricing and yield curves.
- [B04](#) More advanced fixed income case covering duration and the bond immunization theorem.

Equity Cases

- [RE1](#) Introduces the dividend model and the concept of efficient stock markets (strong, semi-strong and weak form efficiency).
- [RE2](#) Introduction to the concepts of arbitrage and informational efficiency
- [RE3](#) Opens a put and call option market in a RE1 type of market. Considers option trading strategies and market efficiency.
- [CA1](#) Introduction to valuation of risky assets with risk averse traders

- [CA3](#) Same as CA1 but with risk loving traders

Option Cases: Binomial Option Pricing World

- [OP1](#): Introduction to the one period binomial option pricing model.
- [OP2](#): Two-period version of OP1 with American options.
- [OP3](#): Three-period version of OP1 designed around a delta hedging problem.

Case specific support for other cases:

1. For cases XR1, XR2, ST1, ST2, GC1, and GC2, there are Excel spreadsheets for the trading support, available at this link: [FTS Trader Support Spreadsheets](#)

Special Instructor Notes:

This manual is also useful to instructors, since it tells them what students need to know in order to prepare for the cases. The focus here is on introductory cases on stocks, bonds, and options that are used in introductory finance and investments courses. More advanced cases are covered in our instructors guide (available with moderator access or by request from ftsweb@gmail.com). With each case, we have included some instructors teaching notes, including simple variations on the cases that you can run quite easily and that help reinforce the learning.

The trading cases are all in Excel spreadsheets. Prior to running the case, you can make some simple adjustments:

- In a case with information (such as RE1), press the F9 key to get a new set of realizations and information
- In every case, you can specify price bounds so that all bids and asks must be within that bound. This can help alleviate mistakes. Price bounds are specified in **row 16**, starting in column D for the first security, as follows:

Price Bounds	12,13/14,15/16,17
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In this example for a 3-period case, in period 1, the minimum bid is 12 and the maximum ask is 13. In period 2, the minimum bid is 14, while in period 3, the minimum bid is 16. So the / character separates periods, the comma separates bids and asks

- You can change the interest rate in the spreadsheet or on the main screen.

Student Preparation Notes: Case B01

In [case B01](#), there are two bonds that trade over three periods. The cash payouts (or “cash flows”) from the bonds in each period are shown in this table:

	Payout at end of	Payout at end of	Payout at end of
	Period 1	Period 2	Period 3
Cp Bond	20	20	120
Zero Cp	0	0	100

Here, “CP Bond” is a coupon bond, and “Zero CP” is a zero coupon bond.

The objective of the case is to understand the time value of money; to understand the cash flows from coupon and zero coupon bonds; to apply the discounting formula to value such bonds. If you are not familiar with these concepts, look at <http://bondtutor.com/btchp1/topic3/topic3.htm>. This is a link to the chapter on coupon bonds in the Bond Tutor online textbook. You may also want to read the section on [time value of money](#).

When the case starts, you have an initial position in cash and/or the bonds. This is simply a starting position, to get things going. For example, you may start with 1000 in cash, 15 of the CP Bond, and none of the Zero Cp bond.

Cash and the Interest Rate

The interest rate on cash is 25%. What this means is the following.

Suppose you start with 1000 in cash and do absolutely no trading.

At the end of the first period, you will earn 25% interest, so your cash balance will be:

$$1000 + 1000 \cdot 0.25 = 1000 \cdot 1.25 = 1250$$

At the end of the second period, you will earn 25% on this, so your cash balance will be:

$$1250 + 1250 \cdot 0.25 = 1250 \cdot 1.25 = 1562.5$$

At the end of the second period, you will earn 25% on this, so your cash balance will be:

$$1562.5 + 1562.5 \cdot 0.25 = 1562.5 \cdot 1.25 = 1953.125$$

Notice the compounding: in period 2, you receive interest on the interest you earned in the first period.

You can verify that

$$1562.5 = 1000 \cdot (1.25)^2 \text{ and}$$

$$1953.125 = 1000 \cdot (1.25)^3$$

In terms of the time value of money, we would say:

1000 at the beginning of period 1 is worth

- 1250 at the end of period 1
- 1562.5 at the end of period 2
- 1953.125 at the end of period 3

This is the notion of future value: what is money now worth in the future.

The reverse of this is present value: what is money in the future worth today, and in our case:

- 1952.125 at the end of period 3 is worth 1562.5 at the end of period 2
- 1562.5 at the end of period 2 is worth 1250 at the end of period 1
- 1250 at the end of period 1 is worth 1000 at the beginning of period 1
- 1953.125 at the end of period 3 is worth 1000 at the beginning of period 1

The Zero Coupon Bond

So what does this have to do with the bonds? Suppose you buy 1 Zero Cp at the beginning of period 1 for price P_1 . What happens is that you give up the interest you could otherwise have earned on the amount P_1 . How much do you give up? We know how to calculate it; if you had simply held on to P_1 , you would have:

$FV = P_1 * (1.25)^3$ at the end of period 3, where FV is the future value of P_1 .

The amount you give up is known as the “opportunity cost.” In return for this, you get the cash flow or payout from the bond, and according to the table at the beginning, this is 100 at the end of period 3.

So you will have paid too much if $FV < 100$. You will have made a good deal if $FV > 100$ because what you gave up was less than what you received.

You make no gain or loss if $FV=100$.

Now, think about what you might happen when you trade and $FV < 100$ or $FV > 100$. In either case, somebody is getting a good deal. This tells you what P_1 should really be.

The calculations so far were for the case when you bought the bond in period 1. What if you bought it in period 2 for price P_2 ? In this case, you would only have given up two interest payments instead of 3. By following the same steps, you should be able to deduce P_2 . Finally, if you bought Zero Cp in period 3 at price P_3 , you can determine what P_3 should be.

The Coupon Bond

The analysis for Cp Bnd is similar, except that you have to take into account the fact that there are additional cash flows, i.e. the coupon payments. So let's go through the argument for the case where you bought the bond in period 1 for price p_1 . We are using lower case letter to denote the prices of the coupon bond. What would you give up and what would you receive?

You would give up a total of $FV = p_1 * (1.25)^3$ as before. What would you get?

- At the end of period 1, you would get 20 in cash. This 20 would get 25% interest at the end of period 2, and would be worth $20*(1.25) = 25$. This amount would in turn get additional interest at the end of period 3, and so would be worth $25*(1.25) = 31.25$ at the end.
- At the end of period 2, you would get another 20, and at the end of period 3, this would be worth $20*(1.25) = 25$.
- At the end of period 3, you would get 120.

So the total you would receive from the bond at the end of period 3 is
 $FV=31.25+25+120=176.25$

So a good deal would be the case where $p_1 \cdot (1.25)^3 < 176.25$ (you are giving up less than you are receiving) and a bad deal would be the case where $p_1 \cdot (1.25)^3 > 176.25$ (you are giving up more than you are receiving).

This lets you deduce p_1 . Now, you can apply the same reasoning to determine p_2 and p_3 .

Preparing for the case

To prepare for the case, you should create a table as follows:

	1	2	3
Coupon Bond	p_1	p_2	p_3
Zero Coupon Bond	P_1	P_2	P_3

You would enter the prices you have calculated in place of p_1 etc. This can be created in Excel. *You can bring the spreadsheet with you to the trading session and use it to guide your trading.* In the discussion of case B02, we will show you how to link the spreadsheet to the FTS Interactive Trader and generate buy and sell signals.

To help you check the calculations, we give you some examples with different rates so you can test that you understand the calculations. Suppose the interest rate was 18% instead of 25%. Then, the price of the zero coupon bond in period 1 should be 104.3485. If the interest rate is 30%, the price of the zero coupon bond in period 1 should be 81.8388 and that of the zero coupon bond should be 45.516.

The trading

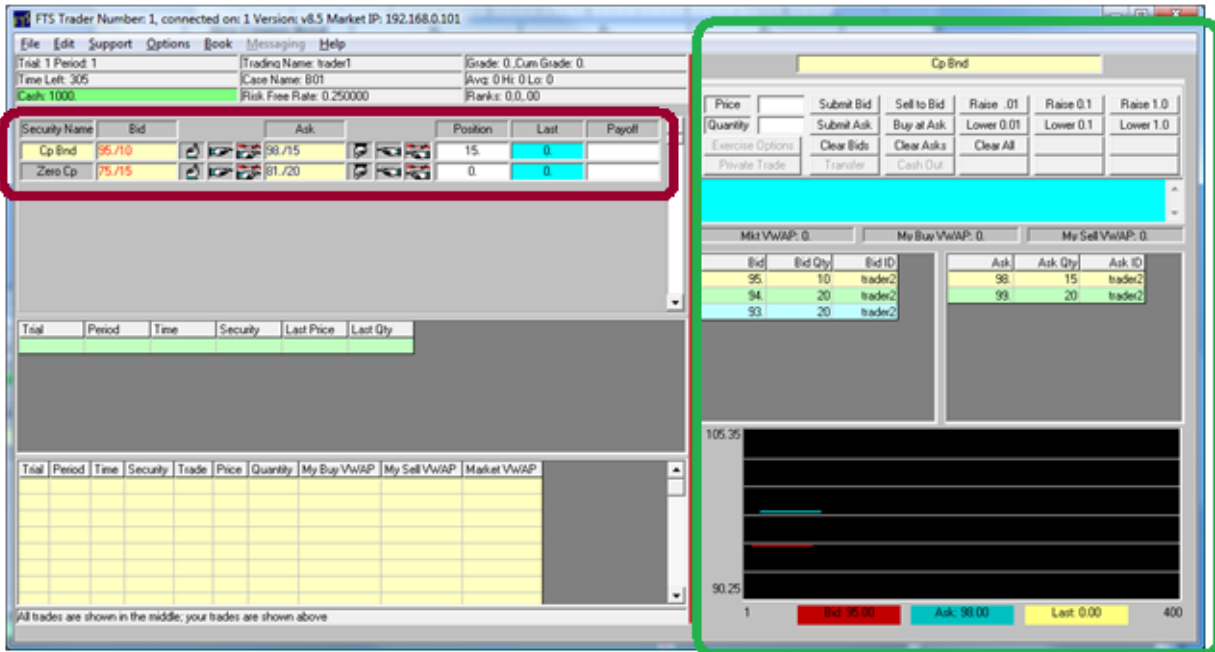
The final piece is the trading. *When the market first opens, there are no prices: someone has to make an offer to buy or sell.* An offer to buy is called a “bid,” and consists of a price and a quantity. An offer to sell is called an “ask,” and also consists of a price and a quantity. A trade takes place when someone submits a bid or ask and someone else hits (or accepts) that bid or ask.

Here is a summary of what happens as a function of who does what:

You submit a bid	Someone hits your bid: they sell to your bid	You buy, they sell
Someone else submit a bid	You hit their bid: you sell to their bid	They buy, you sell
You submit an ask	Someone hits your ask: they buy at your ask	You sell, they buy
Someone else submits an ask	You hit their ask: you buy at their ask	They sell, you buy

The Trading Screen

On the trading screen you can see the highest bid price and the lowest ask price for every security. This is shown in the area outlined in Red in this picture:



If you click on the name of a security in the red circled area, then details about that security are shown in the area outlined in green. In the picture, you can see Cp Bnd at the top of the green circled area with a light yellow background. Just below this, you can enter a price and quantity and submit a bid or ask. You can also hit someone's bid or ask by clicking the buy/sell buttons.

If there is information about the security, it is shown in the blue area. Below that, you see the order book: the bids and asks that have been submitted and also who has submitted them.

At the bottom of the green area is a chart, and shows you the bids, asks, and the last price at which a trade took place, all in real time.

The bottom left of the screen has two grids. The top one shows you every trade that takes place, the bottom one has your trades.

Back to trading

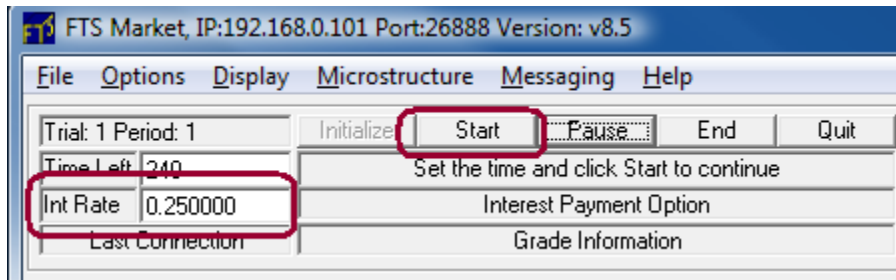
If you think the coupon bond is worth p_1 in period 1, and the current bid and ask are b_1 and a_1 respectively. What would you do (if anything) if:

- $b_1 < p_1 < a_1$?
- $p_1 < b_1 < a_1$?
- $b_1 < a_1 < p_1$?

Note that we usually expect $b_1 \leq a_1$ so we have only listed these three cases.

Instructors notes:

1. We have conducted the analysis mostly in terms of future value. Equivalently, you could have students analyze the bonds completely in terms of present value as a homework exercise.
2. By the changing the interest rate from 25% to something else (larger and smaller), you can reinforce the concepts. It is easy to change the interest rate in the case: all you do is enter the rate in the market screen prior to clicking start (you have to enter the same rate every period):



For these variations, students should prepare a spreadsheet where the bond values are calculated as a function of the interest rate. You can then announce the interest rate, give them a few seconds to re-calculate the prices, and then let them trade. For this case, it is better to keep the interest rate the same for all three periods. Varying interest rates will come in case B02.

Student Preparation Notes: Case B02

[Case B02](#) is an extension of case B01 with two basic changes:

- There are four bonds
- The interest rate is not constant over time

The bonds, their cash flows, and the interest rate are given in the following table:

	Payout at end of Year 1	Payout at end of Year 2	Payout at end of Year 3
Cp Bnd	10	10	110
Zero 1	100		
Zero 2		100	
Zero 3			100
Money Market	4% APR	10% APR	16% APR

A note on the terminology: in the last row, we refer to “money market” and “APR.” The money market is where corporations and individuals borrow and lend for the short term. Since the FTS cash account pays interest, and in most cases you can borrow money, it can be thought of as a money market account. APR is short for “Annual Percentage Rate.” We use this terminology just to get you to think about interest rates and compounding frequency. In practice, interest rates are quoted in different ways. For example, a mortgage interest rate may be 5%, except that the interest is applied daily. Another quote may be 5.01% but interest is applied monthly. The second rate seems higher, but you would actually pay less interest with that quote (you should verify this). The APR is the simple-interest equivalent of the quoted interest rate, and makes the rates comparable. In the FTS Interactive markets, interest can be paid with different compounding frequencies. In this case, it is simple interest, applied to the end of period cash balance.

Background material: If you need to, you can [review bonds and zero coupon bonds](#) and also material on the [time value of money](#) at the Bond Tutor online text.

Instructor’s note: you can run the case with both simple interest and with interest paid during the period. You can also change the interest rates at the beginning of any period, and announce it by sending a public message to all traders.

Returning to the case itself, look at the cash flows from the bonds. Using the analysis in case B01, you should be able to figure out the price of the bonds given the path of interest rates. Again, think about what you would give up if you bought a bond.

For example, consider the coupon bond. If you paid p_1 for it in period 1, you would give up:

$$p_1 * (1.04)^3$$

You would receive:

$10 \cdot (1.10) \cdot (1.16)$ from the cash flow at the end of period 1

$10 \cdot (1.16)$ from the cash flow at the end of period 2

110 from the cash flow at the end of period 3

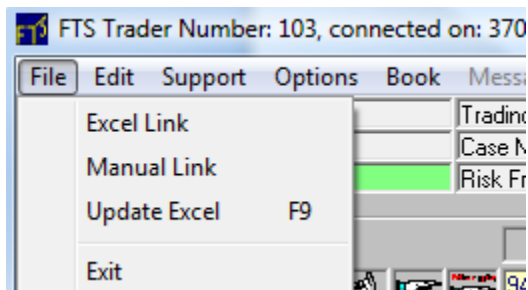
From this, you can deduce what p_1 should be. After you have calculated these for all the bonds, you can create a table of your calculated price of each bond in each period, and use it as trading support:

	1	2	3
Cp Bnd			
Zero 1			
Zero 2			
Zero 3			

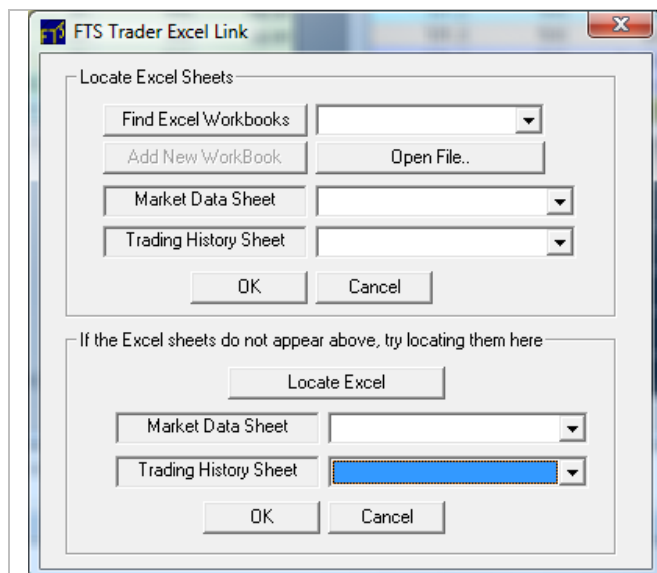
We now show you how to set up a real-time Excel support system to help you detect when prices deviate from what you have calculated in your table and also when they do not satisfy the arbitrage condition in period 1.

Preparing for the case: the Excel Link

You can create a real-time link to Excel from the File menu of the FTS Trader:



Select "Excel Link" to bring up:



- If you have already created a workbook and opened it in Excel, click on “Find Excel Workbooks,” select the sheet where you want the real time market data link and the sheet where you want to store your trading history.
- If it cannot find the workbook, you can create a new workbook or open an existing workbook that is saved on your computer.
- Once the sheets have been selected, click “OK.”

Once you click OK, you should see the following in the sheet where you have linked the market data:

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	
1		Security	Bid	Bid Qty	Ask	Ask Qty	Units	Payoff	Last	Last Qty	VWAP	Futures	My Buy	My Sell	Margin	Margin	Margin	Last	Tot	
2		Cp Bnd	99.5	6,730	103	3,520	100		103	80	91.9831	Obligation	VWAP	VWAP	Cash	Qty	Loan	Info	Volume	
3		Zero 1					500													29755
4		Zero 2	90.91	9,745	94	60	500		90.91	100	90.1572									40580
5		Zero 3	78.3	10	89.9	100	400		80	35	99.1787									27050
6		Cash	61400																	
7																				
8		Time	Total	Trial	Period	RiskFree														
9		Left	Time																	
10		12	240	1	2	0.1														
11																				
12																				
13																				
14																				
15																				
16																				

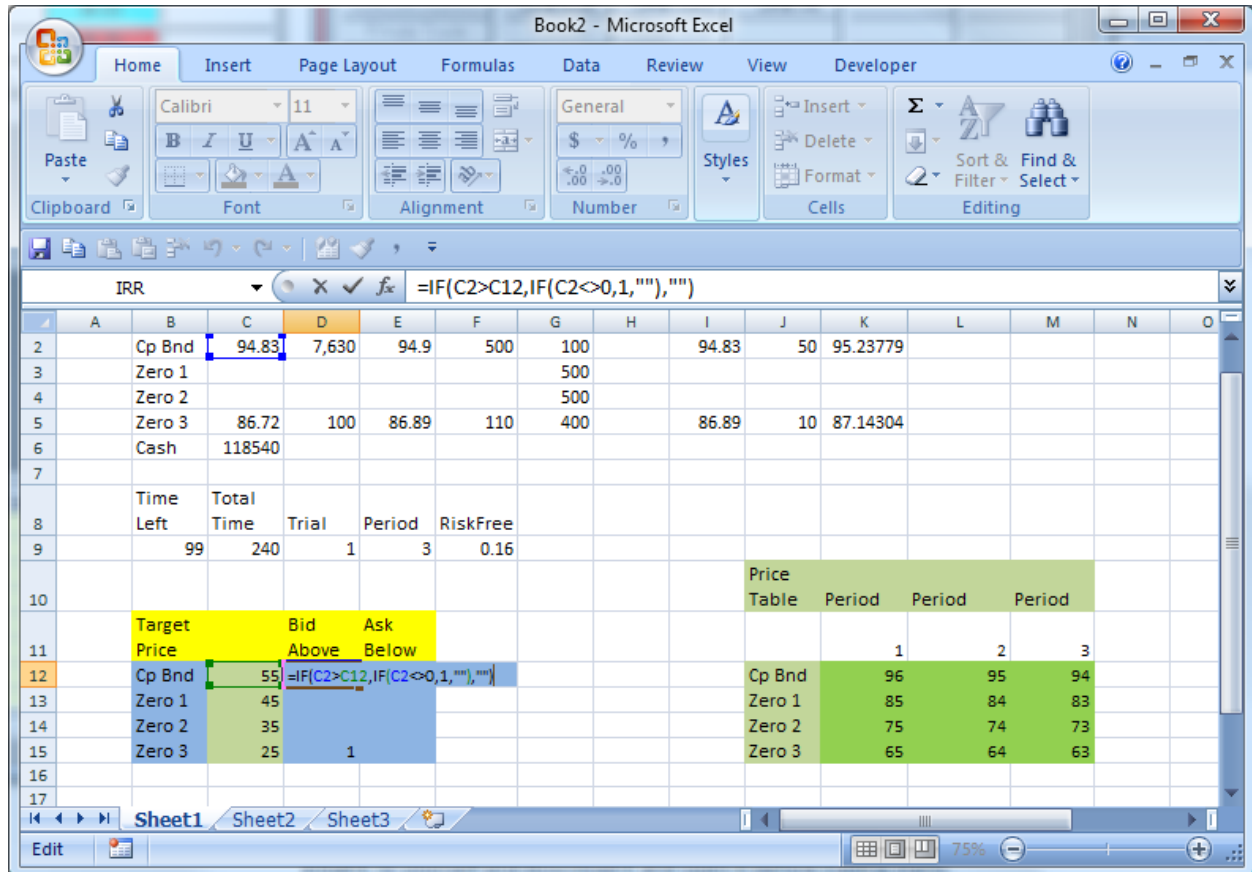
In this example, the current bid for the coupon bond is for 50 bonds at 80.2 each. Some other bids and asks are also shown.

Notes

- *This is a real-time link*, so the spreadsheet is updated every time anything changes in the market.

- If you have created your own workbook, you should not put anything in the top part of the spreadsheet; it will get over-written with the market data. Typically, you will create your own workbook prior to trading and bring it with you for the trading session
 - If you are using a lab computer and cannot store your spreadsheet in advance, you can email it to yourself and download it and open it before trading starts.

Here is an example of how to generate buy and sell signals if the prices in the market differ from what you have calculated:



In our example, we are in Trial 3. In the green table on the right-bottom of the sheet are our calculated prices, i.e. the table you make up using the analysis based on the cash flows of the bonds and the interest rates.

Based on the period, you can copy the column of calculated values into the green area in Column C. This is the simplest solution; you can also use a formula to make the copying automatic, or write a macro to achieve the same result.

Now, look at the formula we have shown:

`=IF(C2>C12,IF(C2<>0,1,\"\"),\"\"')`

It says that if C2 (the current bid on the coupon bond) is greater than C12 (your calculated price), and C2 is non-zero (i.e. is an actual bid), then put in a 1 in the cell; otherwise, make the cell blank.

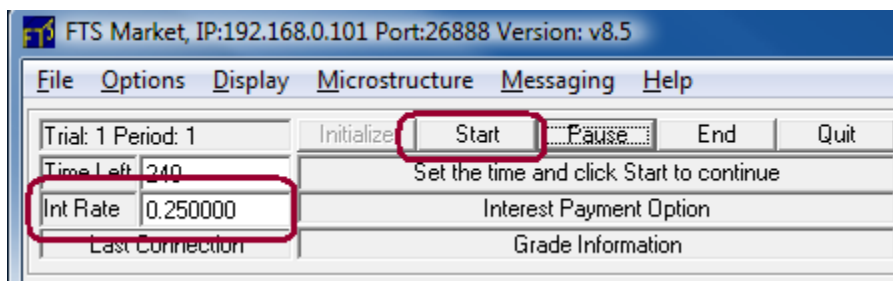
The logic behind this formula is simply that if the bid is higher than your calculated price, you want to sell at that price. So a 1 in the cell tells you that there is a selling opportunity, a blank means there is none.

Note: we will not do this, but you can also use conditional formatting in Excel to make the cells change colors to give you visual cues on buying and selling.

Beyond the analysis of present and future values of cash flows, there is an additional feature in this case that you can exploit. Look carefully at the cash flows of the bonds. Suppose you bought 1 of Zero 1, 1 of Zero 2, and 11 of Zero3. What would be the cash flows from this portfolio? How do these cash flows compare to buying 10 of the Coupon Bond? If you calculate the values, you will see that the portfolio of zero coupon bonds has exactly the same cash flows as 10 coupon bonds. This means that there is an arbitrage relationship between the prices: the portfolio of the zero coupons should cost the same as 10 coupon bonds. There are similar relationships in periods 2 and 3. You can use the Excel link to detect when this is violated.

Instructors notes:

1. We have conducted the analysis mostly in terms of future value; you could have students analyze the bonds completely in terms of present value as a homework exercise.
2. By changing the interest rates, you can reinforce the concepts. It is easy to change the interest rate in the case: all you do is enter the rate in the market screen prior to clicking start (you have to enter the same rate every period):



For these variations, students should prepare a spreadsheet where the bond values are calculated as a function of the interest rates. You can then announce the interest rate, give them a few seconds to re-calculate the prices, and then let them trade.

3. You could illustrate what happens with rising rates, falling rates, and a U-shaped path of rates.
4. An interesting variation is to announce a range of future interest rates and so introduce uncertainty. For example, before the start of a trial, you could announce that the period 3 rate will be either 8% or 12%, equally likely. You can then see the impact of the uncertainty on bond prices in period 1. In this case, the yield curve implied by bond prices is endogenous, and you can discuss the role of expectations in determining the yield curve.
5. You may want to distribute the TradeData Sheet to the class and have them check if the arbitrage relation was violated. A simple way is to have them only check the last traded prices, though ideally you want them to check it at the bid-ask level.

Student Preparation Notes: Case B03

[Case B03](#) is an extension of case B02 with one addition: there are forward contracts on the zero coupon bonds. The cash flows of the bonds and interest rates are as before:

	Payout at end of Year 1	Payout at end of Year 2	Payout at end of Year 3
Cp Bond	10	10	110
Zero 1	100	0	0
Zero 2	0	100	0
Zero 3	0	0	100
Interest Rate	4%	10%	16%

There are also 2 forward contracts:

- FwdZero2 is a forward contract on Zero 2
 - You trade it only in period 1.
 - If you buy one unit of FwdZero2 at in period 1 at price F , then
 - At the time you buy it, no money changes hands
 - At the end of period 1, you pay F and receive one unit of Zero 2
 - F is called a forward price because in the trade, you agreed, in period 1, to pay money in the future in return for Zero 2.
- FwdZero3 is a forward contract on Zero 3
 - You can trade it in period 1 and in period 2
 - If you buy one unit of FwdZero3 in period 1 or period 2 at price F , no money changes hands
 - At the end of period 2, you pay F and receive one unit of Zero 3.
 - Again, F is called a forward price.

Preparing for the case

From the notes for Case B02, you already know how to analyze the bonds in this case. So we focus here on the forward contracts. You can review forward contracts [in Bond Tutor](#).

Analyzing FwdZero2

Again, we focus on cash flows. Suppose you buy 1 unit of FwdZero2 in period 1 at price F . What do you give up and what do you receive?

- No cash changes hands at the time of the trade, so nothing happens in period 1
- At the end of period 1, you pay out F from cash and receive 1 unit of Zero 2.

- At the end of period 2, what you paid is worth $F*(1+0.1)$ since you will have given up 10% interest on the amount F that you paid out at the end of period 1. Recall that the interest rate in period 2 is 10%.
- At the end of period 2, Zero 2 will pay 100.
- Therefore, at the end of period 2, you will have paid out $F*(1.1)$ and received 100.
- So now you know what F should be.
- *Question:* how does it compare to the price of Zero 2 in period 1 that you worked out earlier?

Analyzing FwdZero3

Suppose you buy 1 unit of FwdZero3 in period 1 at price F . What do you give up and what do you receive?

- No cash changes hands at the time of the trade, so nothing happens in period 1
- Nothing happens during period 2.
- At the end of period 2, you pay out F from cash and receive 1 unit of Zero 3.
- At the end of period 3, what you paid is worth $F*(1+0.16)$ since you will have given up 16% interest on the amount F that you paid out at the end of period 2. Recall that the interest rate in period 3 is 16%.
- At the end of period 3, Zero 3 will pay 100.
- Therefore, at the end of period 3, you will have paid out $F*(1.16)$ and received 100.
- So now you know what F should be.
- *Question:* what if you bought one unit of FwdZero3 in period 2? Would the price be different from what you just calculated?

Excel Link

Again, you can use the Excel link to create an analytical support system for yourself. Here is an example, where we generate buy and sell signals for FwdZero2 in Excel, using the analysis given above. You should create the same signals for FwdZero3.

	A	B	C	D	E	F	G
1		Security	Bid	Bid Qty	Ask	Ask Qty	Units
2		Cp Bnd	99	100	101	100	100
3		Zero 1	85	50	87	50	500
4		Zero 2	72	50	75	50	500
5		Zero 3					400
6		FwdZero2	80	50	81	50	0
7		FwdZero3					0
8		Cash	10000				
9							
10		Time Left	Total Time	Trial	Period	RiskFree	
11		222	400	1	1	0.04	
12							
13							
14		FwdZero2	Bid	If I sold, I would get	In return, I would give up	Good deal: Yes or No	
15			=C6	=C15*1.1	100	=IF(D15>E15,"Yes","No")	
16							
17			Ask	If I bought, I would give up	In return, I would get	Good deal: Yes or No	
18			=E6	=C18*1.1	100	=IF(D18<E18,"Yes","No")	
19							
20							
21							
22							
23							
24							

At the top is the market data from the Excel link of the FTS Trader; if you don't know how to link to Excel, look at the notes for case B02. The cells with boxes around them have formulas in them; we will show you the results of the formula below.

The Bid

The formula in cell C15 is “=C6” so this simply copies the current bid into that cell. Recall that if you hit someone else's bid, you would sell to them at their bid price. If someone hit your bid, then you would buy at your bid price.

The spreadsheet analyzes what happens if you hit someone else's bid, i.e. sell the forward contract. Suppose the bid is F. In cell D15, we use our analysis: we know that at the end of period 1, we would receive F and give up Zero 2. At the end of period 2, Zero 2 will pay 100, so we would have given up 100 in return for $F*1.1$. Cell F15 compares the two: if what we get is greater than what we give up, it is a good deal. Otherwise, it is not.

The Ask

This is in the green area; first, we simply copy the current ask into cell C18. Someone else's ask is the price at which they would sell, i.e. at which you would buy. If you bought the forward contract at price F, then at the end of period 1, you would pay F and receive Zero 2. At the end of period 2, what you gave up would be $F*1.1$ and you would get 100 from Zero 2. Cell F18 tells you whether this is a good deal or not.

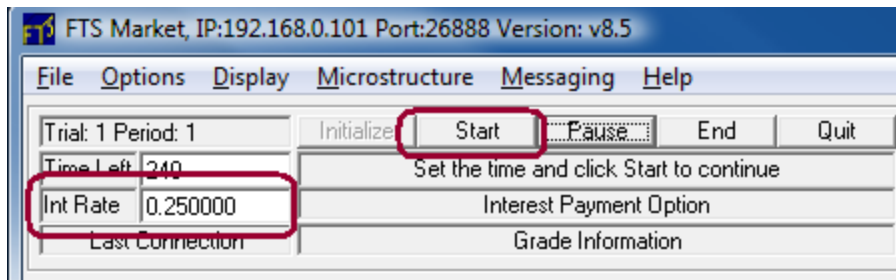
The spreadsheet with the values in the cells looks like this:

	A	B	C	D	E	F	G	H	I	J	VW
1		Security	Bid	Bid Qty	Ask	Ask Qty	Units	Payoff	Last	Last Qty	
2		Cp Bnd	99	100	101	100	100				
3		Zero 1	85	50	87	50	500				
4		Zero 2	72	50	75	50	500				
5		Zero 3					400				
6		FwdZero2	80	50	81	50	0				
7		FwdZero3					0				
8		Cash	10000								
9											
10		Time Left	Total Time	Trial	Period	RiskFree					
11		222	400	1	1	0.04					
12											
13											
14		FwdZero2	Bid	If I sold, I would get	In return, I would give up	Good deal: Yes or No					
15			80	88	100	No					
16											
17			Ask	If I bought, I would	In return, I would get	Good deal: Yes or No					
18			81	89.1	100	Yes					
19											
20											

Now, you can extend this to the forward contract on Zero 3, and also create a similar system to determine the maximum amount you would be winning to bid and the minimum amount you would be willing to ask for the forwards (and, for that matter, for the bonds).

Instructors notes:

1. We have conducted the analysis mostly in terms of future value; you could have students analyze the bonds completely in terms of present value as a homework exercise.
2. By the changing the interest rates, you can reinforce the concepts. It is easy to change the interest rate in the case: all you do is enter the rate in the market screen prior to clicking start (you have to enter the same rate every period):



For these variations, students should prepare a spreadsheet where the bond values and forward prices are calculated as a function of the interest rates. You can then announce the interest rate, give them a few seconds to re-calculate the prices, and then let them trade.

3. You could illustrate what happens with rising rates, falling rates, and a U-shaped path of rates.
4. As in case B02, you could make future interest rates uncertain. In this case, you can now discuss the role of the forward contracts in hedging interest rate risk.

Student Preparation Notes: Case B04

[Case B04](#) teaches you how to use the concepts of duration to manage interest rate risk. If you need to review these concepts, you can find them in [Bond Tutor](#).

In this case as in others, understanding the concepts and being able to build a trading support system can be invaluable. But this case has another twist to it: while you may be able to calculate what you want to do from the theory, others in the market may not allow you to trade at prices you have calculated, which can throw off your calculations. So you will need a plan B.

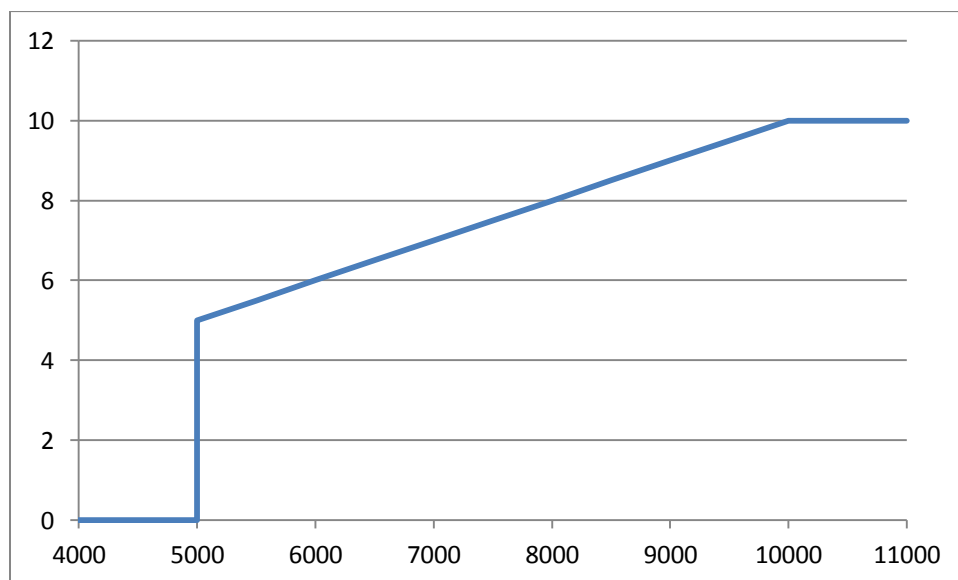
We start with the case description and the theory. We then show you how to build a support system in Excel. Finally, we show you how to use bond analytics to manage the interest rate risk.

In case B04, there are 4 securities, with the following cash flows:

	Payout at end of Period 1	Payout at end of Period 2	Payout at end of Period 3	Payout at end of Period 4
Sec 1	0	160	200	250
Sec 2	30	100	47	0
2YrZero	0	100	0	0
3YrZero	0	0	100	0

You only trade in period 1; at the end of period 1, every security is “marked to market” at its theoretical value given the interest rate prevailing at that time.

Trading Objective: Your goal is to not let your portfolio value drop below 5000 at the end of period 1. If it is below 5000, your grade cash is zero. At 5000, your grade cash is 5. At 10000 or above, your grade cash is 10. Between 5000 and 10000, it increases linearly, as shown in this graph:



The theoretical values at the end of period 1

Consider Sec 1 at the end of period 1. It pays zero immediately, 160 after one more period, then 200 and 250. So if the interest rate for discounting future cash flows is r , the theoretical value of Sec 1 is:

$$V_1(r) = \frac{160}{(1+r)} + \frac{200}{(1+r)^2} + \frac{250}{(1+r)^3}$$

Similarly,

$$V_2(r) = 30 + \frac{100}{(1+r)} + \frac{47}{(1+r)^2}$$

$$V_3(r) = \frac{100}{(1+r)}$$

$$V_4(r) = \frac{100}{(1+r)^2}$$

The interest rate r can be: 5%, 15%, 25%, 35%, or 45%, each of which is equally likely. So the future values of the four securities are uncertain. The interest rate in period 1 is 25%. So that you can check your numbers, if $r=5\%$, you should be able to calculate:

$$V_1(0.05) = 549.75 \approx 550$$

$$V_2(0.05) = 167.87 \approx 168$$

$$V_3(0.05) = 95.24 \approx 95$$

$$V_4(0.05) = 90.703 \approx 91$$

Your starting position

When you trade, you will start with one of two possible positions:

- Position Type 1: 3200 in cash, -29 of Sec 2, and 84 of 2YrZero
- Position Type 2: 5300 in cash, -14 of Sec 1, and 51 of 3YrZero 4

Think of the negative position as a liability you have and the positive position as an asset you have. Your position can change across trials, so you should be prepared for both types of positions.

Trading Restrictions

The next feature is that you cannot trade Sec 1 or Sec 2. In other words, your negative position in these securities is locked in; you can only trade the zero coupon bonds.

Outcomes with no trade

Suppose you are position type 1 and you do no trading. What happens?

At the end of the period, your cash becomes $3200 \times (1.25)$ since the interest rate is 25%. Your short position in Sec 2 is worth $-29 \times V_2(r)$ if the interest rate at the end of period 1 is r . Your long position is worth $84 \times V_4(r)$, so your portfolio value will be

$$3200 \times 1.25 - 29 \times V_2(r) + 84 \times V_4(r)$$

If $r=5\%$, it will be worth 6750.86. If $r=45\%$, it will be worth 4476.97. So if interest rates rise, your value will drop below 5000.

Similarly, consider position type 2 with no trading. The end of period 1 value is:

$$5300 \times 1.25 - 14 \times V_1(r) + 51 \times V_3(r)$$

If $r=5\%$, it is worth 3785.69 and if $r=45\%$, it is worth 6117.60. So this position fares worse if interest rates fall.

Note: once you work out all the values, you will see that each position type has a 40% chance of ending below 5000 if they don't trade.

Your Excel support system

Using the Excel link, you can easily check what happens to your position at the end of period 1 in each interest rate scenario. For example, you could make the following:

Security	Bid	Bid Qty	Ask	Ask Qty	Units
Sec 1					-14
Sec 2					0
2 Yr Zero					51
3 Yr Zero					0
Cash	5300				
Time Left	Total Time	Trial	Period	RiskFree	
239	240	1	1	0.25	
r	0.05	0.15	0.25	0.35	0.45
V1	=160/(1+C11)+200/(1+C11)^2+250/(1+C11)^3				
V2	=30+100/(1+C11)+47/(1+C11)^2				
V3	=100/(1+C11)				
V4	=100/(1+C11)^2				

Position Value	=C6*(1+\$F\$9)+SUMPRODUCT(\$G\$2:\$G\$5,C12:C15)				
----------------	--	--	--	--	--

We have filled in the first column of the green and blue cells and shown you the formulas in each cell; you would have to fill in the rest. The position value in the blue cell is linked to your cash and your position (units). So as you trade, and your cash changes and your holdings of the securities change, you can see what happens to the position value.

Notes:

- You could make a column chart of the position values minus 5000. This would tell you right away the interest rate scenarios in which you would have positive or negative grade cash
- You can also use this to test what happens if you trade. For example, suppose you buy 1 of the 3 Yr Zero at price 75. Then the cash would drop to $5300 - 75 = 5225$ and the position (units) in the 3 year zero would be 1. Just type these in to the spreadsheet and see what happens. This will help you understand what you should do. Remember that you cannot trade the liability.

Plan B and enhancing your support system

Since interest rates are uncertain, there is no obvious theoretical value for the zero coupon bonds in period 1. If we use expected values, then we expect the future interest rate to be 25%, and we could calculate bond values based on that. But no one may be willing to trade at that price. So you have to adapt your strategy to what is going on in the market. So you can add another tool to your support system: you can calculate what would happen if you bought 1 more of something at the current price: does that move your portfolio values in the right direction? What if you sold 1 more at the current ask? These directional signals will tell you how a hypothetical trade will change the outcomes.

Advanced Analysis

There is another way to approach the problem, which is to use the concept of duration to decide on your position. You can review [Macaulay's Duration](#) in the Bond Tutor online text.

We will do following:

- Calculate the duration of Sec 1 by hand
- Show you how to do this in Excel in two ways:
 - Using cell formulas
 - Writing a Visual Basic for Applications (VBA) macro
- Show you how to use this information to trade

The duration of Sec 1

Let V_1 be the value of security 1 in period 1. We will calculate this at the initial interest rate of 25%:

$$V_1 = 0 + \frac{160}{(1+0.25)^2} + \frac{200}{(1+r)^3} + \frac{250}{(1+r)^4} = 307.2$$

Let D_1 be the duration of security 1:

$$D_1 = \frac{1 * 0}{V_1} + \frac{2 * 160}{V_1(1 + 0.25)^2} + \frac{3 * 200}{V_1(1 + r)^3} + \frac{4 * 250}{V_1(1 + r)^4} = 3$$

Calculating the duration in Excel

The formulas in Excel are:

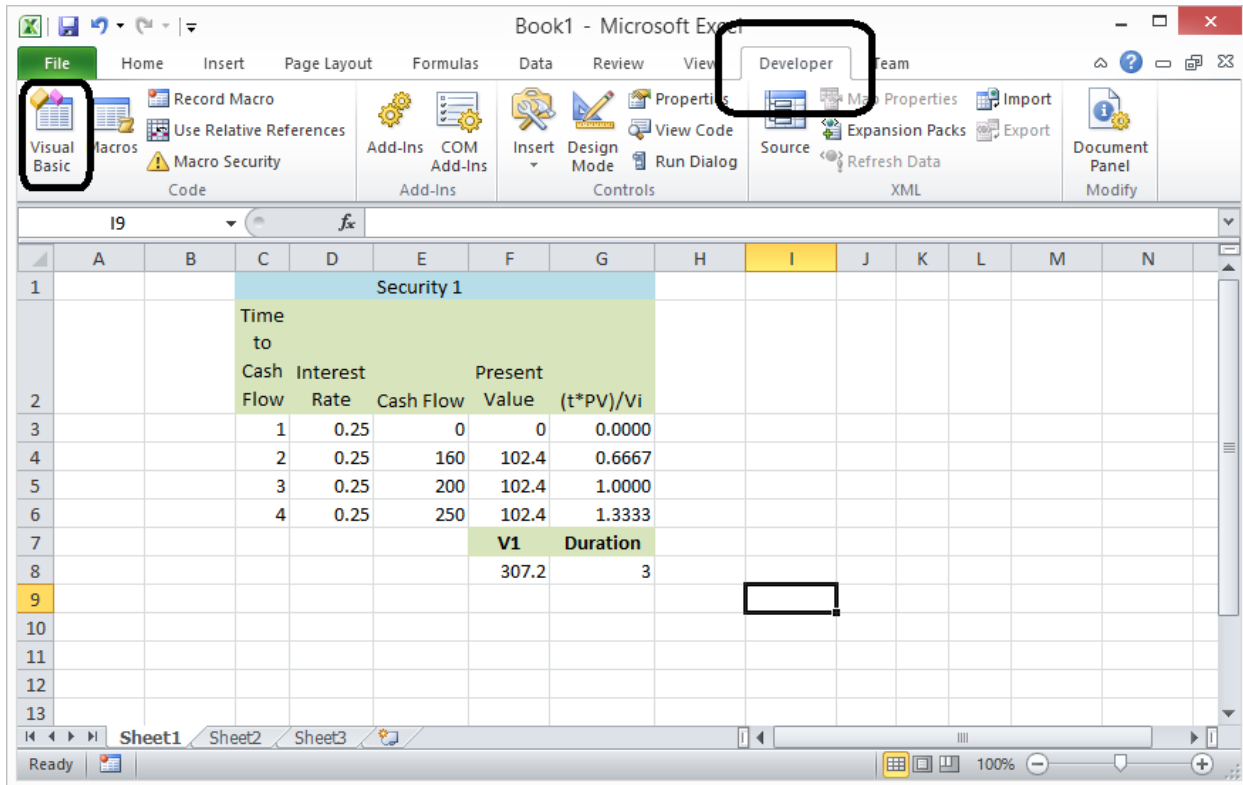
Security 1				
Time to Cash Flow	Interest Rate	Cash Flow	Present Value	(t*PV)/Vi
1	0.25	0	=E3/(1+D3)^C3	=C3*F3
2	0.25	160	=E4/(1+D4)^C4	=C4*F4/\$F\$8
3	0.25	200	=E5/(1+D5)^C5	=C5*F5/\$F\$8
4	0.25	250	=E6/(1+D6)^C6	=C6*F6/\$F\$8
			V1	Duration
			=SUM(F3:F6)	=SUM(G3:G6)

The calculated values are:

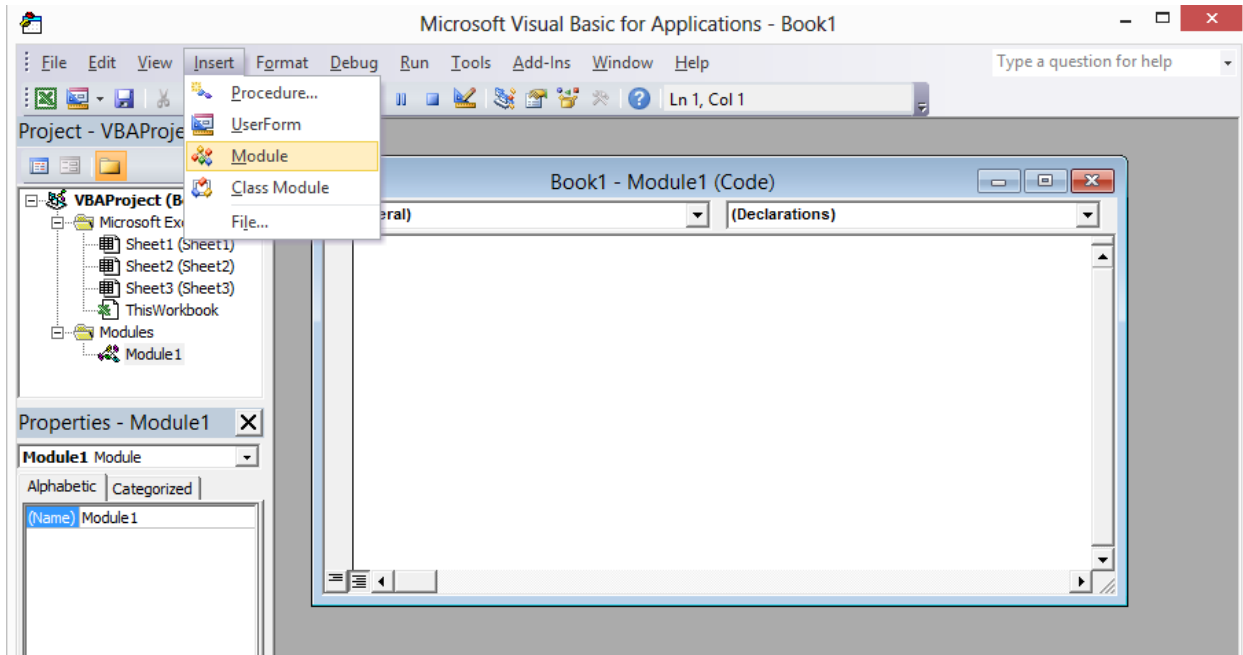
Security 1				
Time to Cash Flow	Interest Rate	Cash Flow	Present Value	(t*PV)/Vi
1	0.25	0	0	0.0000
2	0.25	160	102.4	0.6667
3	0.25	200	102.4	1.0000
4	0.25	250	102.4	1.3333
			V1	Duration
			307.2	3

Calculating the duration in a VBA macro

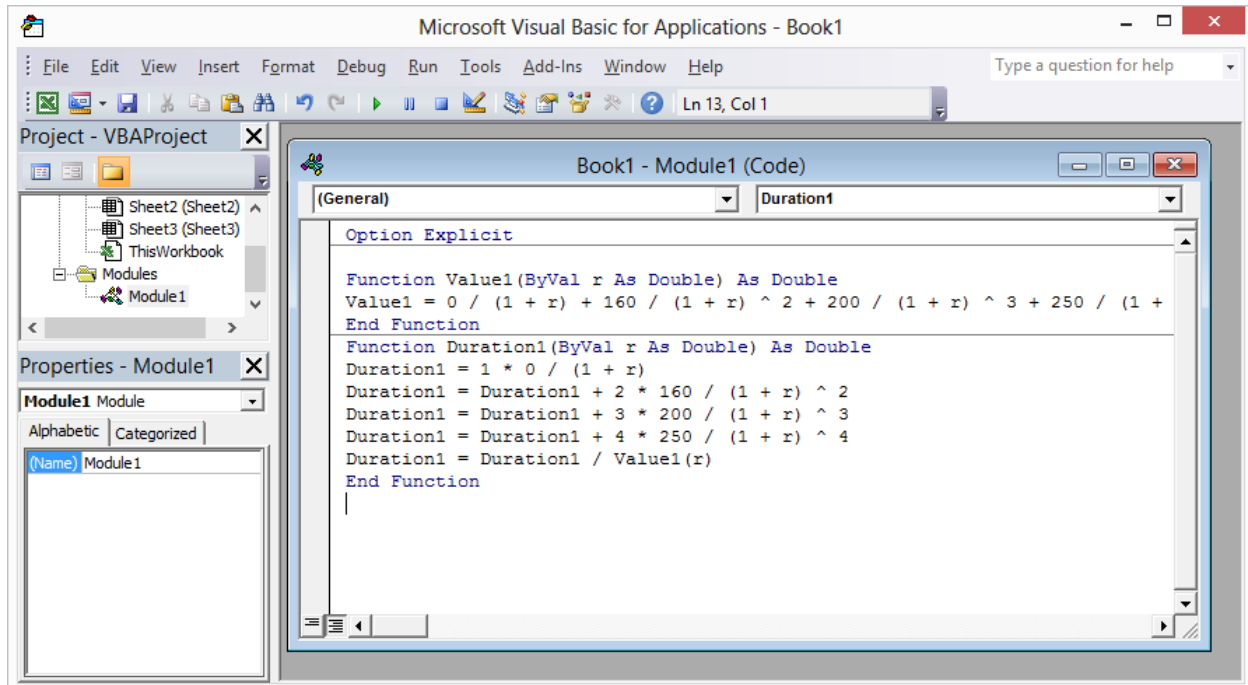
You access VBA through the Developer Tab of Excel. If you cannot see the Developer tab, you will have to enable it from the Excel Options. Exactly how you do this depends on the version of Excel, and you can easily find the answer online by searching for "Excel show developer tab."



Click on the Visual Basic button, and insert a module:



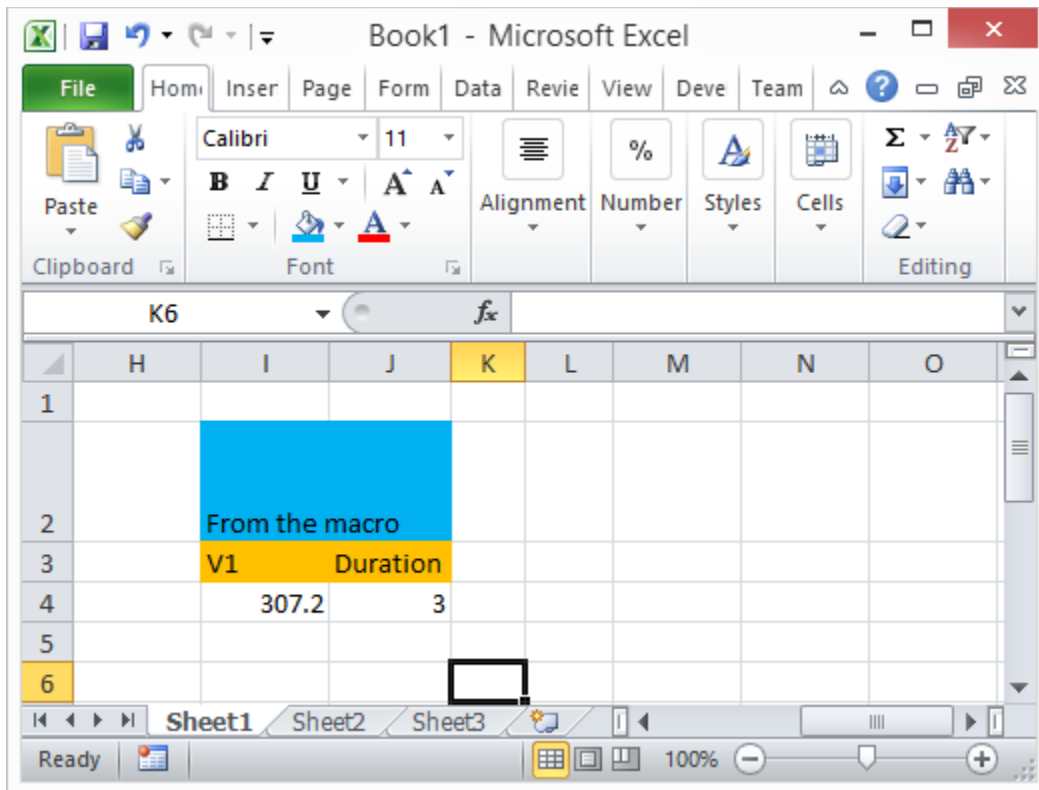
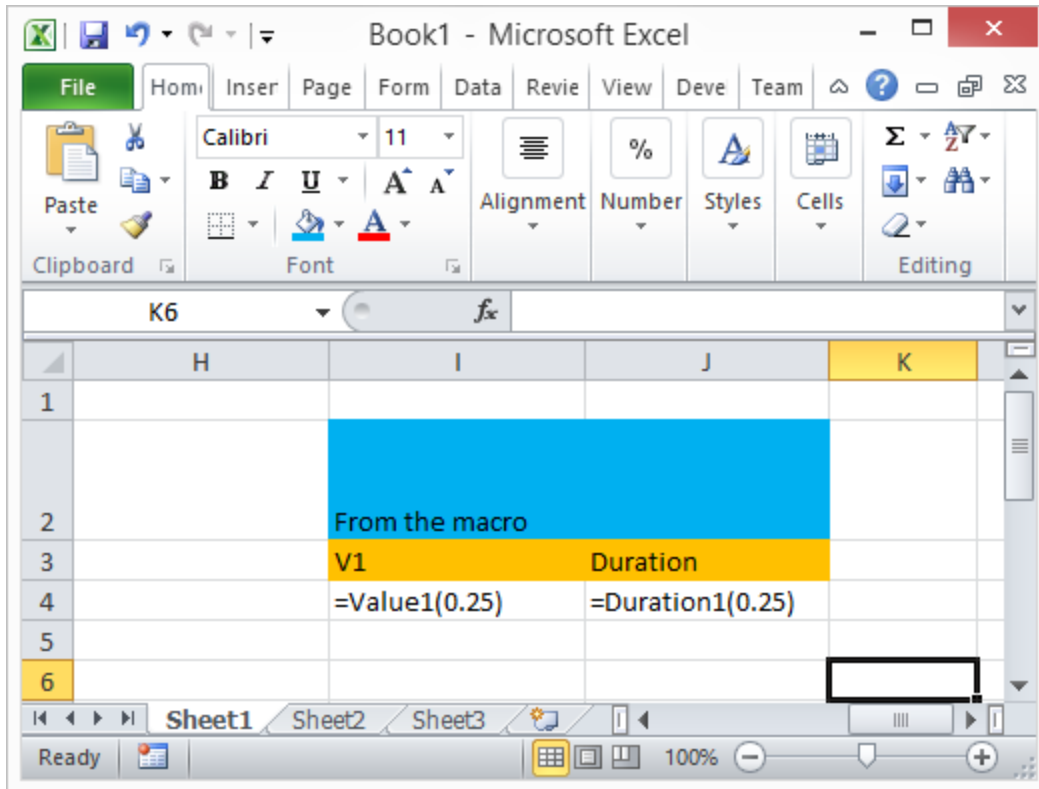
Now, in the Module 1 (Code) window, put at the very top “Option Explicit” This makes sure that you have to declare any variable you use, and is a great help in reducing errors. Then, type in a function as shown below.



Notes:

- We have included the period 1 calculation just to show you the general equation, even though the period 1 cash flow for Sec 1 is zero.
- The interest rate is an argument to the function; this allows you to recalculate values for different interest rates

Now, in the spreadsheet, you can call the function in any cell; we show you the function as well as the calculated value:



Using the duration calculation

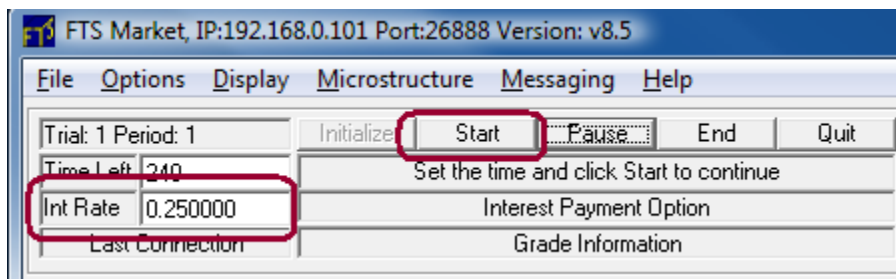
The bond immunization theorem tells you that to hedge interest rate risk, you need to make sure that the duration of your assets and liabilities is the same and the values of the assets and liabilities is the same. The value of Sec 1 is 307.2 and its duration is 3. So you should calculate the values and durations of the 2 Yr Zero and 3 Yr Zero.

Now, consider the position where you start with -14 of Sec 1 and 51 of Zero 3.

- Calculate the duration of your initial portfolio
- Suppose you trade n of 2YrZero and m of 3YrZero and the prices you have calculated. Find the values of n and m such that
 - The value of your assets (i.e. things that you have a long position in) is equal to the value of your liabilities (the things you have a short position in)
 - The duration of your assets is equal to the duration of your liabilities
- If you trade to this position, what is the value of your portfolio in each of the 5 interest rate scenarios?
- The values of n and m provide a theoretical solution to hedging interest rate risk. However, you should be careful that you don't pay exorbitant prices to get to that position. If you do, you may hedge the interest rate risk, but get locked in to a losing position! The theory is a useful guide, but is based on the assumption that you can trade at theoretical prices.

Instructor's notes

- You can assign the duration calculation as an exercise
- By changing the interest rates, you can reinforce the concepts. It is easy to change the interest rate in the case: all you do is enter the rate in the market screen prior to clicking start:



For these variations, students should prepare a spreadsheet where the values are calculated as a function of the interest rates. You can then announce the interest rate, give them a few seconds to re-calculate, and then let them trade.

Student Preparation Notes: Case RE1

[Case RE1](#) is an exciting trading case where you have to figure out what other people may know from their trading activity. The case focuses on market efficiency. A financial market is efficient if the prices of financial securities “reflect all available information.” There are different definitions of market efficiency that you can read about in your textbook or online. We will focus on what it means in this case and how you build a support system to exploit information that you have.

In the case, you trade the stocks of two firms. You trade over two periods, and there are different events that can occur that affect the prospects of each stock. The interest rate on cash is set to zero since discounting is not really germane to the case.

The first firm is called ABC, and what it pays to shareholders is defined in this table:

Firm ABC

Period 1 Event	Period 2 Event		
	X	y	z
X	0,0	0,0	0,12
Y	12,0	12,12	12,24
Z	24,12	24,12	24,24

This is a barebones summary, you can find details of what x, y, and z mean in the actual case description. But you can see from the table that x is bad and z is good.

The entries in the table are what the stock pays in period 1 and in period 2 depending on what happens in each period. You can check that the period 1 payoff only depends on the period 1 event: if x happens in period 1, it pays zero in period 1 no matter what happens in period 2. If y happens, it pay 12, and if z happens, it pays 24 at the end of period 1.

The period 2 payoffs for ABC depends on both the period 1 event and the period 2 event. For example, if y happens in period 1 and z happens in period 2, the firm pays 12 in period 1 and 24 in period 2.

The second firm has 4 events in each period 1, and the payoffs are:

Firm CRA

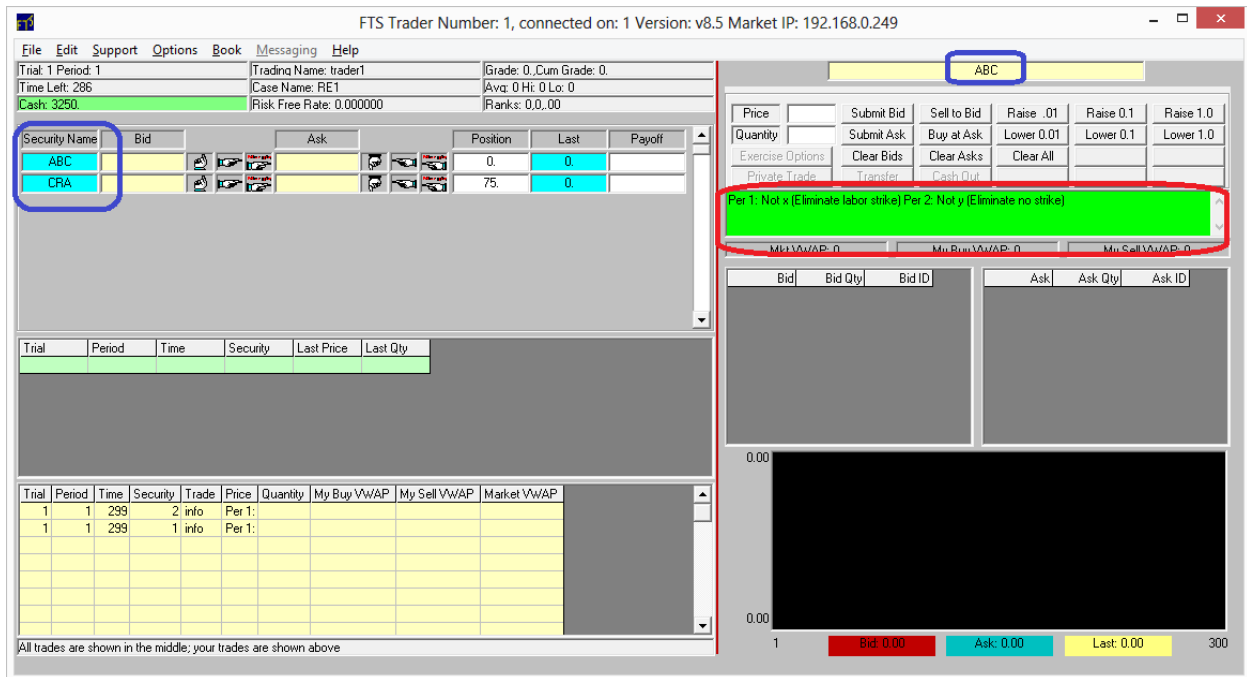
Period 1 Event	Period 2 Event			
	w	x	y	Z

W	0,8	0,8	0,12	0,18
X	12,8	12,8	12,12	12,18
Y	12,8	12,8	12,12	12,18
Z	24,8	24,8	24,12	24,18

Note that here, w is the worst event. Note also that the x and y rows are the same. We will explain the reason behind this in just a bit.

Information you receive

At the beginning of period 1, you may receive information about one firm or both. You see this information on the trading screen in the area outlined in this picture:



Remember that the information relates to the security you are viewing; to see the information for another security, click on its name on the bid-ask montage on the left, also outlined in the picture.

Market Efficiency

Different people can receive different information. For example, at the beginning of period 1, you may receive information such as: “Per 1: Not x, Per 2: Not z.” Someone else may receive the information “Per 1: Not y, Per 2: Not x.” So the market *as a whole* knows that the true realization is z in period 1 and y in period 2, though no individual will know this. The efficient market prediction in the case is very clear: in an efficient market, *the prices would be the same as if everyone had all the information*

available. In this example, the prices in an efficient market would be those that would have occurred if everyone knew that the true events are z in period 1 and y in period 2.

But, of course, no one is given that information. So how does the information get reflected in prices? The answer is via the price discovery process. You don't only bid and ask and buy and sell based on your information. You see what others are doing, and try to infer what they know. Let's see how this works.

Analysis of ABC in Period 1

At the beginning of period 1, suppose you receive information "**Per 1: Not x, Per 2: Not z**."

Then, you know

- The period 1 payoff will be either 12 or 24.
- The payoff in period 2 will be either 0 or 12.
- The lowest price for ABC in period 1 must be 12
 - Remember that if you buy ABC in period 1, you receive two cash flows; in this case the least you receive is 12 in period 1.
- What should be the maximum price for ABC in period 1?

Question to ask:

- What do others know?
 - You know the possible outcomes are (yx, yy, zx, zy)
 - So others may have the following information:
 - "Per 1: Not y, Per 2: Not x"
 - "Per 1: Not y, Per 2: Not y"
 - "Per 1: Not z, Per 2: Not x"
 - "Per 1: Not z, Per 2: Not y"
 - How would they behave in each case?
 - Specifically, what would be the minimum and maximum prices given their information?
 - What does tell you about their behavior in each case? For example, if the price in the market was below the minimum price they saw, they would presumably buy the stock; if it was greater than the maximum price, they would presumably sell.
 - So observing their activity can tell you something about what they know
 - Unless they are strategic and trade in ways inconsistent with their information to mislead you!

Company CRA

As we mentioned earlier, CRA has an extra event: w; this makes inferences about CRA a little more difficult than for ABC. It also means that some people can get significantly less valuable information than others. As you can figure out, knowing "Not w" is a lot less valuable than knowing that it is "Not z."

Building a support system

For this case, the simplest support system is a piece of paper with grids like a tic-tac-toe game. The grids are copies of the payoff tables for each stock. When you get information, you simply cross out the rows and columns that cannot occur. Then you can see what remains, and correlate the price activity you see on the trading screen and make inferences about what others know.

A more complex system can be built in Excel. For example, you could calculate the minimum and maximum prices based on your information. This can be very useful. For example, consider the following, showing the minimum and maximum price of ABC in period 1:

	Period 1	Period 2	My min	My max
My Information	Not x	Not x	24	48
Their Information			Their min	Their max
	Not x	Not x	24	48
	Not x	Not y	12	48
	Not x	Not z	12	36
	Not y	Not x	0	48
	Not y	Not z	0	36
	Not y	Not z	0	36
	Not z	Not x	0	36
	Not z	Not y	0	36
	Not z	Not z	0	24

At the top, we have the information we received and the minimum and maximum values for ABC based on this. Then, we enumerated all the possible information anyone could receive (we used a macro to enumerate all the possibilities, it is given below). For every type of information they could receive, we calculate the minimum and maximum price.

This lets you make an inference. In this example, suppose you see that someone keeps selling ABC if the price goes above 24. Then, you could infer that they know it is not z in either period. Combined with your information, this would indicate that what has actually happened is (y,y).

To use this when trading, all you would do is enter the information you receive at the top, look at the behavior of others to see if you can infer what they may know, and then decide what to do.

The macros

The first macro lists all the information possibilities. You send in a number, either 1, 2, or 3 corresponding to x,y or z. It reports an error if you enter some other number.

Function re1ABCInfo(ByVal iState As Integer) As String

```
Select Case iState
  Case 1
    re1ABCInfo = "Not x"
  Case 2
    re1ABCInfo = "Not y"
  Case 3
    re1ABCInfo = "Not z"
  Case Else
    re1ABCInfo = "Error"
End Select
```

End Function

Calculating the minimum and maximum requires the information and the table. Here is a “brute force” way of doing it, simply enumerates all the possibilities:

Function re1ABCMin(per1Info, per2Info) As Double

```
per1Info = LCase(per1Info) 'lower case to make comparisons easier
per2Info = LCase(per2Info)
Select Case per1Info
  Case "not x"
    Select Case per2Info
      Case "not x"
        re1ABCMin = 24
      Case "not y"
        re1ABCMin = 12
      Case "not z"
        re1ABCMin = 12
    End Select
  Case "not y"
    re1ABCMin = 0
  Case "not z"
    re1ABCMin = 0
  Case Else
    re1ABCMin = -999 ' flags an error
End Select
```

End Function**Function re1ABCMax(per1Info, per2Info) As Double**

```
per1Info = LCase(per1Info) 'lower case to make comparisons easier
per2Info = LCase(per2Info)
Select Case per1Info
  Case "not x"
    Select Case per2Info
      Case "not x"
        re1ABCMax = 48
      Case "not y"
```

```
        re1ABCMax = 48
    Case "not z"
        re1ABCMax = 36
    End Select
Case "not y"
    Select Case per2Info
        Case "not x"
            re1ABCMax = 48
        Case "not y"
            re1ABCMax = 48
        Case "not z"
            re1ABCMax = 36
    End Select
Case "not z"
    Select Case per2Info
        Case "not x"
            re1ABCMax = 36
        Case "not y"
            re1ABCMax = 36
        Case "not z"
            re1ABCMax = 24
    End Select
Case Else
    re1ABCMax = 999 ' flags an error
End Select
```

End Function

Student Preparation Notes: Case RE2

[Case RE2](#) is an extension of RE1. There are 3 firms, trading is over 2 periods, and the payoffs from the firms are shown in the following two tables:

Period 1 payoffs:

	Firm 1	Firm 2	Firm 3
Event x	0	0	30
Event y	12	15	15
Event z	24	30	0

Period 2 payoffs:

Period 1 event	Period 2 events								
	Firm 1			Firm 2			Firm 3		
	x	y	z	x	y	z	x	y	z
x	50	50	100	0	50	100	150	100	50
y	50	100	150	0	75	150	150	75	0
z	50	150	150	50	100	150	100	50	0

Note that as in RE1, the period 2 payoff depends on both the period 1 event and the period 2 event.

You will receive information only about Firm 1 and Firm 2, in the same way as in case RE1. You do not get any information about firm 3. Except, as you know from the case description, firms 2 and 3 compete in the same market, and so they experience the same events. So information about Firm 2 tells you something about Firm 3.

Building a support system

This is the same as RE1: the best support system is a sheet of paper with grids like a tic-tac-toe game. The grids are copies of the payoff tables for each stock. When you get information, you simply cross out the rows and columns that cannot occur. Then you can see what remains, and correlate the price activity you see on the trading screen and make inferences about what others know.

A more complex system can be built in Excel as in RE1. For example, you could calculate the minimum and maximum prices based on your information, the expected value, and so on. That can help you figure out how the behavior of others reflects their information.

Student Preparation Notes: Case RE3

[Case RE3](#) has an interesting twist to the market efficiency series: it adds option markets to a case similar to RE2. You actually don't need to know much about options except what they are to trade this case. The question posed is whether the existence of option markets helps markets become more efficient.

Case Data

There are two firms, and each trades for 2 periods. Neither firm pays out anything at the end of period 1. At the end of period 2, the payoffs are:

Period 1 event	Period 2 events					
	1 Share in Firm 1			1 Share in Firm 2		
	x	y	z	x	y	z
X	0	20	40	0	20	40
Y	0	25	45	0	25	45
Z	0	35	60	0	35	60

You can see that the firms are identical in terms of their payoffs, but the events for the firms are drawn independently.

Option Payoffs

The case has a put and call option on Firm 1 only. The payoffs on the options are:

Period 1 event	Period 2 events					
	1 Call 30, Firm 1			1 Put 30, Firm 1		
	x	y	z	x	y	z
X	0	0	10	30	10	0
Y	0	0	15	30	5	0
Z	0	5	30	30	0	0

If you don't have much experience with options, you can find basic definitions at the [Option Tutor online text website](#). The fact that firms 1 and 2 are identical, but only firm 1 has options, lets you see whether the option markets in fact do make a difference to market efficiency.

The information you receive is of the same type as in RE1 or RE2, e.g. “Per 1: Not x Per 2: Not y”

The informational role of options

Compare the tables for Firm 1 and for the options, here shown side by side:

Period 1 event	Period 2 events								
	Firm 1			Call Option			Put Option		
	x	y	z	x	y	z	x	y	z
X	0	20	40	0	0	10	30	10	0
Y	0	25	45	0	0	15	30	5	0
Z	0	35	60	0	5	30	30	0	0

To understand the role of options, consider what happens if you know “Per 2: Not z.” This tells you right away that the call option will pay at most 5. In fact, if you know “Per 1: Not z, Per 2: Not z” you know the call option is worthless (it will always pay 0). *This implies that if you see someone selling the call option and driving down its price toward zero, you can infer that they know it is worthless.*

As another example, suppose you know “Per 1: Not y, Per 2: Not y” which leaves you with a wide range of possibilities for the stock: 0, 40, 60.

- Look carefully at the payoffs of the options.
 - The put must be either 30 or 0
 - The call must be one of 0, 10 or 30.
- There is another relationship
 - You will see that if you buy a stock, buy a put, and sell a call, the portfolio payoff is always 30, no matter what events occur (this is called put-call parity; 30 is the strike price or exercise price of the options).
 - Let S , P , and C be the prices of the stock, put, and call. Then
 - $S+P-C = 30$
 - It’s hard to have prices that line up correctly without revealing information. For example, suppose the stock is trading at 30. Then, it must be the case that $P-C = 0$
 - If $P-C > 0$, then $S+P-C > 30$ so you should sell the stock, sell a put, but a call, and you will get more than 30 and only have to pay out 30 in the future.
 - If $P-C < 0$, then $S+P-C < 30$ so you buy the stock, buy the put and sell the call. It will cost you less than 30 and you will get 30 for sure at the end of period 2.
 - So how do you get $P-C = 0$ and be consistent with your information? If P is high, say near 30, then C must also be high, near 30.
 - But that has to conflict with someone’s information. Anyone who knows “Not z” in period 2 knows that the call is overpriced. Anyone who knows “Not x” in period 2

knows the put is overpriced. So in this way, options give you more ways to deduce the information than the stock by itself.

Building a support system

You have several choices here, depending on how sophisticated you want to be:

- The simplest support system is a sheet of paper where you have copies of the payoffs.
 - When you receive information, you cross out rows and columns, and use that to guide your trading
- You could follow the route in RE1 and enumerate the possibilities in an Excel worksheet and use that to help infer what others know
- You can also follow the route in Case B03, and create a real-time Excel link that shows you when the put-call parity relationship is violated.

Student Preparation Notes: Case CA1

In [case CA1](#), you face a new type of problem: determining the value today of uncertain outcomes in the future. This is a pretty general problem: for most financial assets, you don't know what the future value will be, but when you buy or sell such an asset, you are determining a value today for those uncertain future values. A byproduct of the determination of prices is the determination of risk premiums. After we show you how to prepare your trading support, we will describe (in the section called Risk Premiums) how to calculate the implied risk premiums.

In the case, there are three stocks, and the future values of the stocks are given in this table:

	1	2	3	4	5	6	7	8	9	10	Average
Co. 1	5	5	5	24	25	30	32	68	75	75	34.4
Co. 2	4	5	10	21	66	65	65	20	20	20	29.6
Co. 3	55	55	49	22	22	20	10	10	10	10	26.3

There are 10 possible future paths that can take place, numbered 1 to 10. The same path applies to all three companies. So if path 1 occurs, Co. 1 is worth 5 and Co. 3 is worth 55. You can see that what is good for companies 1 and 2 is bad for company three. This has an important implication, discussed below in the section on Risk Premiums.

Understanding the grade cash

In the case, the grade cash is related to your end of trial market cash as follows:

$$\text{Grade Cash} = \alpha(\text{Market Cash} - \beta * \text{Market Cash}^2)$$

You should read the details in the case description, but what this essentially does is reward you for higher returns and penalizes you for taking more risk, which makes you risk averse: you like return but don't like risk.

The alpha and beta parameters, as well as the initial positions, can be different; as noted in the case description, there are four sets of these.

Preparing for the case

The first step is to understand the relationship between your position and grade cash. We will do this in Excel with the Excel link. Our goal is to be able to calculate:

- Your expected grade cash given your current position
- How this changes if you trade at current the current bids and asks.

You should do this for all 4 trader types, since your type can be any one of those. In this guide, we will perform the calculations for two of the types. We will make use of VBA, since it greatly reduces the complexity of the spreadsheet.

The final product looks like this.

	A	B	C	D	E	F	G	H	I	J	K	L	M
1		Security	Bid	Bid Qty	Ask	Ask Qty	Units	Payoff	Last	Last Qty	VWAP		
2		Co. 1	28	9	29	10			28	1	28		
3		Co. 2	26	9	27	10			26	1	26		
4		Co. 3	25	9	26	10			25	1	25		
5		Cash	4200										
6													
7		Time Left	Total Time Trial	Period	RiskFree								
8		206	300	1	1	0.12							
9													
10			1	2	3	4	5	6	7	8	9	10	
11		Co. 1	5	5	5	24	25	30	32	68	75	75	
12		Co. 2	4	5	10	21	66	65	65	20	20	20	
13		Co. 3	55	55	49	22	22	20	10	10	10	10	
14													
15		Expected Grade Cash		Type 1	Change Positive		Type 2	Change Positive					
16		Type		1			2						
17		Current Position		7.456652			5.406504						
18		Buy 1 of Co. 1		7.462321	Yes		5.411973	Yes					
19		Buy 1 of Co. 2		7.459356	Yes		5.409131	Yes					
20		Buy 1 of Co. 3		7.456935	Yes		5.406800	Yes					
21		Sell 1 of Co. 1		7.449749			5.399976						
22		Sell 1 of Co. 2		7.452751			5.402827						
23		Sell 1 of Co. 3		7.455230			5.405173						

You can see the result of the spreadsheet link at the top. The relevant cells are the current bids and asks, your current position in the Units column, your cash, and the risk free rate.

Below that, we have put in the table of cash flows simply by copying and pasting from the case description.

We created a macro to calculate the expected grade cash and what would happen to the expected grade cash if you were to buy or sell one unit of each of the securities. Basically, if grade cash improves, then that is an advantageous trade. However, this is only a static calculation relative to your current position. It does not include, for example, the result of buying Co. 1 and Selling Co. 2.

The formulas are:

Expected Grade Cash Type	Type 1
Current Position	=expectedgradecash(\$C\$11:\$L\$13,\$G\$2:\$G\$4,\$C\$5,\$F\$8,D\$16, \$C\$2:\$F\$4,1,0)
Buy 1 of Co. 1	=expectedgradecash(\$C\$11:\$L\$13,\$G\$2:\$G\$4,\$C\$5,\$F\$8,D\$16, \$C\$2:\$F\$4,1,1)
Buy 1 of Co. 2	=expectedgradecash(\$C\$11:\$L\$13,\$G\$2:\$G\$4,\$C\$5,\$F\$8,D\$16, \$C\$2:\$F\$4,2,1)
Buy 1 of Co. 3	=expectedgradecash(\$C\$11:\$L\$13,\$G\$2:\$G\$4,\$C\$5,\$F\$8,D\$16, \$C\$2:\$F\$4,3,1)
Sell 1 of Co. 1	=expectedgradecash(\$C\$11:\$L\$13,\$G\$2:\$G\$4,\$C\$5,\$F\$8,D\$16, \$C\$2:\$F\$4,1,-1)
Sell 1 of Co 2	=expectedgradecash(\$C\$11:\$L\$13,\$G\$2:\$G\$4,\$C\$5,\$F\$8,D\$16, \$C\$2:\$F\$4,2,-1)
Sell 1 of Co 3	=expectedgradecash(\$C\$11:\$L\$13,\$G\$2:\$G\$4,\$C\$5,\$F\$8,D\$16, \$C\$2:\$F\$4,3,-1)

They call a function called expectedGradeCash. You send in the cash flow table, the units columns(called “qty” in the macro), and also the trade you are contemplating (buying or selling one of any of the stocks). The function is reproduced at here, and by working through it, you can see how it is constructed. You can also see that a single function can let us calculate lots of variations; this is much easier than working with cell formulas.

Function expectedGradeCash(cashFlows As Range, qty As Range, cash As Double, riskFree As Double, iType As Integer, bidAsk As Range, iStock As Integer, iQty As Integer) As Double

Dim iCol As Integer, jRow As Integer
 Dim alpha As Double, beta As Double
 Dim cashValue As Double

If (iType = 1) Then
 alpha = 0.002105031
 beta = 0.0000525

Else
 alpha = 0.001282015
 beta = 0.000022

End If

cashValue = cash * (1 + riskFree)

If (iQty < 0) Then 'sell to bid, iQty is negative so negative sign for cash to increase

cashValue = cashValue - iQty * bidAsk.Cells(iStock, 1).Value

Else 'buy at ask, iQty is positive so negative sign to make cash decrease

cashValue = cashValue - iQty * bidAsk.Cells(iStock, 3).Value

End If

```

Dim x As Double
For iCol = 1 To cashFlows.Columns.Count
  x = cashValue
  For jRow = 1 To 3
    x = x + qty.Cells(jRow, 1).Value * cashFlows.Cells(jRow, iCol).Value
  Next
  x = x + iQty * cashFlows.Cells(iStock, iCol).Value
  If (x < 0) Then x = 0
  If (x > 10000) Then x = 10000
  expectedGradeCash = expectedGradeCash + alpha * (x - beta * x * x)
Next
expectedGradeCash = expectedGradeCash / cashFlows.Columns.Count

```

End Function

Risk Premiums

The determination of the price of a risk security implicitly determines the risk premium, or the extra return beyond the risk free return, demanded by investors to buy the security. Suppose that the stock of company 1 is 28 in your market. Since the expected value is 34.4 (the average of Co. 1's future values), the expected return is $(34.4 - 28)/28 = 22.85\%$. The risk free rate is 12%, so the risk premium for company 1 is 10.85%.

Risk premiums cannot be determined independently of each other. This is because the compensation you require for bearing risk (i.e. the risk premium) depends on the ability to diversify risk. If you compare the future values of the three stocks, you will see that the future value of Co. 3 is negatively related to that of company 1. This means that if you hold Co. 1 and Co. 3, it reduces your risk. The presence of Co. 3 therefore reduces the risk premium you would require from Co. 1 because you can reduce the risk yourself.

This also affects the risk premium for Co. 3. Since it is useful in reducing risk, you may be willing to pay a higher price for it, which reduces the expected return and thus its risk premium.

Student Preparation Notes: Case CA3

In [case CA3](#), you face the same problem as CA1 with one big difference: you are rewarded for taking risk! By comparing the outcomes in CA1 with those in CA3, you can see for yourself how differences in risk tolerance affect market prices and risk premiums.

As in CA1, grade cash is determined by:

$$\text{Grade Cash} = \alpha(\text{Market Cash} - \beta * \text{Market Cash}^2)$$

But while beta was a positive number in CA1, here is a negative number.

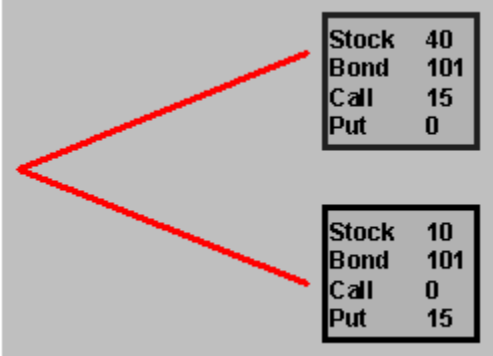
Case preparation

The preparation is the same as CA1. The only thing you need to change is the sign of the beta coefficient in the macro

Student Preparation Notes: Case OP1

[Case OP1](#) is the first options cases. The aim of the case is to help you understand the 1-period binomial option pricing model. Specifically, the focus is on determining the prices of options. We will also show you how to take advantage of incorrect prices in the market. You can find background material in the [Option Tutor online text](#).

In the case, there is a stock, a bond, and a put and call option on the stock. At the end of period 1, the payoffs from the securities are as shown in the following table:



Stock	40
Bond	101
Call	15
Put	0

Stock	10
Bond	101
Call	0
Put	15

The risk free interest rate is 1%. One feature of this case is that the price of stock 1 is fixed at 20. So you can buy and sell as much of it as you want without affecting the stock price.

The market has to figure out the prices of the put and call option, and also of the bond, but that is easy!

Understanding the Put Option

A put option gives its owner the right to sell a stock at a predetermined price. The predetermined price is called the strike price or the exercise price. In this case, the strike price of the put option is 25.

Consider what you would do at the end of period 1 if you owned 1 put option. You have the right to sell one stock for 25. If the stock price is 40, would you exercise your right to sell at 25? The answer is no; you would lose money if you did so! So in that case, the put option is not worth anything.

On the other hand, if the stock price is 10, you would want to exercise the put: you would sell something worth 10 for 25, making a profit of 15.

So in the “up” state, where the stock price is 40, the put is worth 0. In the “down” state, where the stock is worth 10, the put is worth 15.

Understanding the Call Option

A call option gives its owner the right to buy a stock at a predetermined price. The predetermined price is again called the strike price or the exercise price. In this case, the strike price of the call option is 25.

Consider what you would do at the end of period 1 if you owned 1 call option. You have the right to buy one stock for 25. If the stock price is 40, would you exercise your right to sell at 25? Definitely; you would pay 25 for something worth 40, so you would make a profit of 15.

On the other hand, if the stock price is 10, you wouldn't want to exercise the call; if you did, you would be paying 25 for something worth 10 and would lose money. Better to let it be.

So in the "up" state, where the stock price is 40, the call is worth 15. In the "down" state, where the stock is worth 10, the call is worth 0.

The price of the bond

If you have been through any of the B01 to B03 cases, this should be very easy: the face value of the bond is 101 and the interest rate is 1%. Simple discounting gives you the bond price.

The price of a constant amount in the future

You will see in a second why we pose this question.

The bond pays a constant amount in the future; the amount is 101 per bond. Suppose the price of the bond you just calculated is B. What is the "price" or value today of amount X at the end of period 1 in both the up and down states? It should be $(X/101)*B$. If $X=101$, you this is just B. If $X=202$, so you have two bonds, they cost 2B. If X is 50, so you have less than half a bond, the price is just under 0.5B.

The Price of the Put Option

To think about how to figure out what is a fair price for the put option, consider what happens if you buy 1 stock and buy n puts. Then, the payoffs to you are:

Up state: 40

Down state: $10+15n$

Think about the following: what if you picked n so that $40 = 10 + 15n$. Then, you would have a constant amount in the future, say X. You know what that is worth: $(101/X)*B$.

So, a portfolio of 1 stock and n puts (with n chosen correctly) is worth $(101/X)*B$. The stock is worth 20, so this tells us what the put is worth during the trading period.

The Price of the Call Option

Same idea: buy 1 stock and n calls:

Up state: $40 + 15N$

Down State: 10

Choose n to make these equal (n will be negative). This is now a constant amount, so you know its price. This tells you the price of the call option.

Locking in a profit

Suppose you have figured out that the correct price of the call option is C^* and the correct price of the put option is P^* . Now, you are trading in the market and someone offers to sell the call option for $C < C^*$. What should you do? The first thought is that you should buy it: it is worth C^* and you can get it for less. That is true, but not quite the end of the story. If you buy it for C , you still face some risk: if the down state occurs, you will have paid C and it will be worthless.

So think about how you may be able to buy it for C but not face any risk. This is related to the “constant amount” discussion earlier. Maybe buy or sell some amount of the stock?

Instructor’s notes

- We suggest running about 3 or 4 trials to focus on the option pricing problem.
- After that, you should log in as a trader and offer to buy or sell at incorrect prices, and see if students can lock in the profit.