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SPEAKERS

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Hello, and welcome. Glad to have you with me. Today, we've got a really great Excel video planned, we're going to look at rates of change, we're going to look at approximate rates of change, and then we're going to compare it against the actual rate of change. In this case, it's using bond prices and the market interest rate or just interest rates. And so we're going to look at the dollar value change in bond prices. And we're going to do some neat graphical analysis with Excel that goes a little bit deeper than I may have gone in other videos. So that said, let's get started. Take a look at Excel in front of you, I hope you have a copy of your own and you can work through and do these commands, use Excel the same way I am, use that on your own, so that you can learn by doing.

Let's get started by calculating the price of a bond. Now, maybe we don't need the first row to be quite that big. We'll start off with the information that we need to calculate the price of any bond. So we need to know how much it's going to pay off. Now keep in mind, this is a zero coupon bond. So maybe it's gonna pay off \$1,000. Per usual, that looks kind of small, so maybe I will increase the font size here from 11 to 16, get that a little bit bigger. I might even zoom in a little bit. And there we have our face value of a bond of \$1,000. We'll start off with, and this time, we do need a market interest rate. So how about how about an interest rate of 5%? Do we need more information? Well, we need to have a time to maturity. So let's pick a time to maturity of 10 years, just like one of the examples we looked at previously. And we're going to use this information to calculate the price of the bond. And the price of this bond is going to be equal to using the equal sign so that Excel knows we're going to make a calculation. I select the cell E2, press on my keyboard it's shift eight, I want to get that star for multiplication, you need to tell Excel that you're performing a multiplication. It doesn't realize that two numbers beside each other should be multiplied automatically. And I'm going to call up the function exponent by typing in exp, and then selecting it right here where my cursor is. And in the exponent, we're gonna have negative the interest rate multiplied by T, the time to maturity, which is 10. Now keep in mind that interest rate is actually 0.05. And there is our price, I want to make sure that Excel knows that this is a currency. So I'm going to right click on the cell and change the format number to currency.

Now we're going to want to calculate the change in the bond price if the market interest rate changes. So let's look at, let's create a new column and let's call this change in R, change in the

market interest rate. The first change we'll have, how about we go with a minus 5%. So that would take the interest rate down to 0%. We'll look at increments of 0.5%. I'm gonna highlight the cell I3. I could have hit the equal sign. And I'm going to let it be equal to the cell I2. But I'm going to want to add 0.005. Now for consistency, I'm going to highlight both these cells and change the format to a percentage, that's more agreeable. And I guess we could actually have that percentage with one decimal place. Now I'm going to highlight this cell I3 and only that one and start dragging down. And you can see that each cell is operating on the one above it. And we're going to get a change in R from negative 5%, that would be a very big decrease in the market interest rate, to an increase of 5%.

Now how about our approximation? How about our approximate change in, I'll say price? That was just equal to the change in R, right, that was DR that we saw in a previous video, multiplied by its time to maturity. And so that's going to give the percentage change in price. And then we want to multiply that percentage change in price by the price itself. Now we have negative \$303.27. So if we have a bond with a maturity of 10 years interest rate of 5%, it's going to pay us \$1,000 in 10 years, and nothing before that. It currently has a price of a little over \$606. If the interest rates fell, tomorrow, by 5%, the value of this bond would, well wait a second, I must have made a mistake, which I noticed a little earlier, because a decrease in interest rates should increase the price of the bond. So I need to change my formula here. So I'm up at the formula bar, and I'm going to add in a negative sign there at the very beginning, so that the change in the price is positive. So the interest rate drops, the price is going to increase by \$327. That's the estimate. What does that mean, the actual prices? That means the approximate price of this bond is going to be equal to well, the change plus the initial value \$909.80.

Now turning our attention back to column J, let's calculate the approximate change in price for all these changes in R that we have in column I. We want to do a few things. One, I'm going to just hide, I'm going to just create a cell down here, I'm going to highlight E3, and I'm gonna hit the equal sign. I'm gonna select the cell above it. And I'm just gonna hit Enter. And so I'm just going to copy the cells above, I just want to make sure the formatting is correct. So column F, it's formatting should be a percentage. And we don't really need to have it with so many decimal places. And T is just a number, so I'll format that cell, it's just a number with no decimal places. And the price, format this cell, make it a currency with dollars and cents.

What I want to do is, I can just pull down and have Excel recreate the formula that was in J2, have it do that for J3 and update, update it so that it calls on these new columns down here. Go ahead, I'll bring this one down as well. I'm going to highlight all this row and see if I can bring them down all together without damaging anything or changing anything. And it seems to work reasonably well. We've got our approximate change in price here. Notice that I'm just repeating this top cell F is just being repeated all the way down. So this is slightly different way than I did before. And I did this just to show you different options. And we can play, well we're still going to be able to play with things a little bit later when we do our graphical analysis.

So there we have the approximate price, I want to insert a new column where K is, so I kind of want to move what's in the column K to the column L. I'm going to highlight column K, I'm going to right click on it and I'm going to click Insert. Now we'll add a column for me and I'm going to call this column actual change in price. And I'll just double click here to resize it. And I want to calculate the actual

price. So let's, so if we want to calculate the actual change in price, we need to have the starting value price which we already have right here under the column H, so now we need to calculate the new price based on the new interest rate which is going to be 5% plus negative 5%, which is actually going to be zero. So to do that, let's highlight cell K12. Hit the equals equal button, equal sign. And we're going to take our face value, multiply it by the natural exponent function that is in Excel. And now we're going to have 5% plus this negative 5%. And I want to surround it in parentheses, because that operation needs to happen first before it interacts with any other operations. And I need to also remember that I have a negative sign at the beginning of the entire term and in the exponent. And this change in this new interest rate is going to be multiplied by T. And if I did it correctly, and I hit Enter, it says, see it says I've made a mistake. And it wants me to correct it. And I see where the mistake is. Now we want to subtract the new price, we need to subtract the old price offered, which is can be found in cell H2, I hit Enter there, this we don't need. And I'm going to just pull this all the way down to populate all the cells, and there we can see we've got the actual change which is the new bond price minus the old bond price.

We have the new price of the bond, but we didn't calculate the actual change in price. So we have to go back to the formula bar. And this time, we're going to press the subtract button, the dash, and select the starting price value rate here, which is \$600.53. Now when we hit Enter, we're going to have the actual change in price. Now if I drag this down, we see that we have the change in the bond price as the interest rate is changing. Remember, the original interest rate is 5% right here. And so if it's negative 5%, that means it's at zero. If the change is zero, that means it's still at 5%, the change is 3%. That means the interest rates is going to be at 8%. And notice that as the interest rate is getting, the change in the interest rates getting smaller, it's getting more negative, the approximate change and the actual change in price are increasing. Now we're ready to create a graph for some analysis. So I'm going to highlight the change in R, remember, the column on the far left, Excel is going to identify that as the X axis. And we've got two variables on the Y axis. Our Y axis is going to be the change in price, and our X axis variable is going to be the change in R. And I'm going to go to Insert, I'm going to choose our scatter plot diagram. And I'm going to select this one, this one looks good to me. Don't really, so I'll just take that one. And I'm going to make this bigger, maybe drag it down a little bit.

Now maybe you could go we go to chart design again, and try and pick something that's a little prettier. This one looks good. It looks, speaks to me, when I look at this, it looks like finance to me. And I'm gonna move the chart over a little bit to the right here. And you can see we've got two curves, we've got our legend down here, which we saw last time, we can make a little bit bigger by going to home and then clicking this larger text button. We've got the actual, which is this more curved line, this orange line, and the blue line is linear. And these lines look a little narrow, I'm going to select this line and I'm going to go to width over here. And I'm going to increase its width maybe three times as big to 2.25 point. And similar with this orange line, I'm going to increase it to 2.25. There. So hopefully that's a little bit clearer to see for you at home. Now, we know that this is like the analysis we did before by hand. The approximate change in price is more accurate when the change in the interest rate is small. You can see they start together. This is the point of tangency right here or when it's zero. And then as the interest rate is getting bigger and bigger, they sort of move farther apart.

Let's play around with some of these numbers that we have over here. So for example, I could change the face value. how much the bond pays out to 2000. And you could see that the chart is updated.

the Y axis is actually changed, but the graph doesn't look much different. So that's not so interesting. What would happen if the interest rates started at 10%, instead of at 5%? Well, we see our Y axis has changed again, it's actually become smaller, the change in price is smaller. Interest rates, you think a change from point five to 1%, point 5% to 1%, that's like 100% increase. But a change from 10% to 10.5%, that's, that's less, that's like a 5% increase. For that reason, bonds are more sensitive to interest rates when interest rates are low than they are when, when interest rates are high. Now how can we better see that on this chart? Well, let's freeze this Y axis. So let's freeze this Y axis. First, let's go back and let's return our interest rate to 5%. Now, I'm going to double click on this Y axis, I'm going to go to access options. So over here where my cursor is, there's access options. And these auto buttons mean that it's these things are just being set automatically. So if we change the numbers, the automatic, Excel will automatically change our axes. Let's make the minimum negative 400. And let's make the maximum 500. I just changed the numbers and hit Enter. You notice the auto turn to reset. So we've changed what's going to happen. Let's go over here. So we got the interest rate. Let's see what happens if I increase the interest rate from 5% to 10%. You see how the, the curves tilted. And so the changes aren't as drastic. And if you want to see that again, here they are where they started. What happens if R was started at 2%, you can see even more drastic price changes. What if R was at 0%, it gets bigger and bigger, the change is getting larger and larger. In fact, it's going off the diagram because we've fixed the axis scales.

Now suppose let's go to let's go back to 5%. What about time to maturity? So if the time to maturity increases, is that going to cause bigger changes in bond prices or smaller? Well, if we made this a 25 year bond, that's going to increase, the price changes. And it looks like also our approximation, consequently, our approximation, is actually it looks like it's not as good as it was when time to maturity was low. So let's see that again. Let's take T back to 10. You can see that the blue and the orange line are closer together. But if we take T to 25, they're further apart. In the case of bonds, when T is small, that maturity is smaller, the prices are going to be less drastic, and therefore there's less mistakes to be made with an approximation. If we go to T is equal to one, you can see on this scale, the approximation and the actual are almost on top of each other, it's really hard to tell them apart. And as we get bigger and bigger, you can see, almost like a moving graph here, you can see that they're getting farther and farther apart and the approximation is less accurate for the same change in the market interest rate.