



## Financial Formulas and Lookup Functions (Combined Mac/PC): Sensitivity Tables in Financial Models

Welcome to our next lesson in this module on functions and formulas in Excel. We are going to look at sensitivity tables in this lesson. They're also known as data tables.

You can see on screen here in the DCF spreadsheet, you can see a few basic examples of sensitivity tables where we look at the terminal free cash flow growth rate versus the discount rate, the terminal multiple versus the discount rate, and the scenario versus the discount rate.

The meaning of these tables relates more to financial modeling, so we're not going to cover that in depth here. We're just going to cover the mechanics of how to set up these tables.

**The purpose is that these tables let you change one or two assumptions in a financial model and then see how a third variable, or output, changes based on those.**

**For example, if you change a company's revenue growth rate and margins and you vary the revenue growth from 3% all the way up to 7%, and you let its margins vary from 10% to 15%, how does the company's implied share price change at each point? What are the maximum and minimum share prices under these assumptions?**

[01:04]

For example, it's pretty obvious that the company is going to be worth more if it's growing at 7% and if it has a 15% profit margin. And it's going to be worth less if it has a 3% revenue growth rate and a 10% margin.

But with sensitivity tables, you're not limited to just those. You can see the whole range of values. So, you could enter something like the 3% to 7% here, and then the 10% to 15% here, and then you could see how the company's implied value changes across all those. When you have 3% and 11% for the margin, and then 12% all the way up to 15%, and then you can go to 4% growth and 10%, 11%, 12%, 13%, and so on for the margins.

This is useful because all investing is probabilistic. You never know what the exact outcome will be, but you can create potential outcomes, and you will always want to look at the full range of possibilities. What if a company over-performs? What if a company dramatically underperforms? What if it performs about on-par as what everyone is thinking right now?

[02:08]



**With this topic, we get a lot of questions about what you can do and what you can't do. And the short answer is that, no, you cannot look at multidimensional scenarios with five to 10 different assumptions in the same table. You can't have multiple output variables. You can't have a cube or shape with four or five or six sides instead of just a simple square. None of that is possible in Excel. Maybe if you use more advanced data tools or analytics you can do it, but this functionality is pretty simple and straightforward in Excel. You can let one or two assumptions vary, and then you can have a single output that varies.**

Sensitivity tables are not that complicated to set up, but there are some strict requirements for the setup, and if you don't follow them, you will get tables that do not work properly.

So, we're going to cover the requirements and input process for sensitivity tables first. Then you will complete an exercise where you finish or create two sensitivity tables on your own, and then we'll go through the interpretation of these tables in this Walmart model.

[03:07]

**Let's go to the requirements and input process first. The first one is that the input variables and the output must be on the same spreadsheet in Excel, the sheet on which you are creating the table.**

So, here, for example, the first table, which looks at the terminal growth rate and the discount rate, is fine. Why? Because both of these variables, the discount rate and then the terminal growth rate, are on this direct spreadsheet, so we can vary them here. And then the output variable, the implied share price, is also on the spreadsheet.

All three of these variables or inputs or outputs are on the spreadsheet and so we can use them and reference them in this table. The same goes for the one with the terminal multiple and the discount rate.

But for the one with the operating scenario, we have a problem here because the operating scenario is all the way over in the Walmart model right here. So, we're going to have to cut and paste this or figure out something else to do with the tables when we get to this one.

[04:08]

**That's the first requirement, and then the second requirement is that for the row and column inputs, you cannot link these to or from anything that's in the financial model. These need to be independent, so you need to start each row or column with a hard-coded number and**



**then either hard-code the rest, or just make them increase or decrease by simple percentages or numbers.**

Let's go over and enter these so you can see what I'm talking about. So, right here, for example, for the terminal free cash flow growth rate, we cannot type equals here and then go up and then say, "Okay, we have our terminal growth rate here of 0.5% down to negative 0.75%, so let's link to that directly." You can't do that because Excel is going to get confused when it tries to process all this because it won't know what exactly you're trying to change. Instead, what you have to do is hard-code this as negative 0.75%.

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And then if you want to vary it, you can do it. But, again, you can't link to anything directly in the model. It has to be the first cell that you're linking to.

So, you take this one and then you add the 0.125% to it to make it go up by 0.125% in each period. And I can just copy and paste this as a formula to the right.

And then for the discount rate, same idea. I cannot go up here and say, "Okay, let me link to the discount rate." Instead, what I have to do is put that 5% or so roughly in the middle, so I can start this at 6%, and then I can make it go down by 0.25% in each row. I can copy and paste this as a formula going down, and so we have this.

So, it's okay to have a formula in the row and column inputs here, but the formula cannot be linked to the financial model. You should ideally start each one with a hard-coded number and then make a formula, extend down from that one, and extend across from that one.

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So, that's the second requirement here. **The third requirement is that the row and column inputs and the output must be related to each other in some way.** Now, this one I feel is sort of common sense. Obviously, if you want to track the impact of certain assumptions on the output, they have to be related to the output. However, I'm mentioning it here because we have gotten some rather strange questions to this effect over the years.

So, you can't just enter some random assumptions or numbers and expect this to work. The output's values must be determined directly or indirectly by the row and column inputs.

So, here, for example, if you look at some of these formulas, the baseline terminal value here depends directly on this terminal growth rate and it also depends directly on the discount rate.



From there, if you press Control + ], like we learned in one of the previous lessons, to trace this, you can see that this then feeds into the present value of the terminal value, and this feeds into the implied enterprise value. The implied enterprise value feeds into the implied equity value, and then this feeds into the implied share price from the DCF.

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So, if we press Control + Shift + [, we can see that the terminal free cash flow growth rate is an indirect precedent, and the discount rate is also an indirect precedent.

And that's a quick way to check whether something that you're doing with the sensitivity table is valid. If the output variable doesn't have the input variables as precedents, then it's not going to work properly.

**Let's keep going. Requirement 4 is that you should set "Workbook Calculation" within options to "Automatic Except for Data Tables." Otherwise, your spreadsheet will be very slow.**

So, if you go to Alt, T, O, or ⌘ + , on the Mac, and go to Formulas, you want Workbook Calculation to be set to Automatic Except for Data Tables. If you don't have it set like this, you're going to run into issues with the worksheet refreshing too much. And if it's set to manual, then a lot of the other calculations are not going to work. So, you want Automatic Except for Data Tables.

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**Requirement 5 is that you should then enter a direct link to the output you want to sensitize in the top left-hand corner of the table. Then select the whole table, go to Data, What If Analysis, and Data Table to calculate it. The row input cell should be a direct link for the input at the top, and the column input cell should be a direct link for the input in the column on the left.**

That is a lot of words, so let's enter it in Excel and see how this works.

Let's go to the top left of this table and now I'll type equals, and here we want to go to how the implied share price is calculated under the perpetuity growth method. So, I will link to this cell, the implied share price from the DCF. I like to anchor this with F4 or ⌘ + T. I don't know if it's completely necessary, but I like to do it as standard practice.

And then to create the table, we press Shift + Control + Down Arrow Key, Right Arrow Key, to select the whole thing. In the PC version of Excel, I can press Alt, D, T, to do this, to bring up the



data table dialogue. On the Mac, you won't be able to do this, so you will have to go to Data, and then What If Analysis, and then Data Table.

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And then for the row input cell, we want the input that corresponds to these at the top. And then for the column input cell, we want whatever corresponds to the column on the left.

So, for the row input cell, let's go up and find the terminal free cash flow growth rate. We want this one right here, the selected variable that's actually being used. And then for the column input cell, we want the discount rate over here. Notice how Excel automatically anchors these and uses an absolute cell reference.

So, let's enter both of those and I'll click OK. And let's go down and see how this works. And so, we have our data table.

Now, notice how this is not refreshed yet. That's because under Options, we explicitly told Excel not to refresh the data tables automatically. You could just tell Excel to refresh everything by going to the Formulas menu right here and then going to Calculate Now or Calculate Sheet. And now we see the data table refreshes.

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There's also the F9 shortcut to do that. I didn't press it here because it interferes with the screen recording software I'm using. In any case, now we see the table set up.

**We get some questions about the mechanics of how this works. Literally, what Excel is doing is going through and plugging in all these inputs, running the model, and then pasting in the output right here.**

**So, what Excel does is it goes up, it hard-codes in the negative 0.75% here for the terminal free cash flow growth rate, and then it hard-codes in the 6% for the discount rate. It runs the model, and then it takes the implied share price that it calculates from that and then it pastes it down here in the upper left-hand corner.**

**And then it keeps doing that for each of them. So, then it plugs in the negative 0.63% and the 6% discount rate, calculates it, and then plugs it in here. And it keeps doing that all the way through the table. And that's how the mechanics of this work.**



You can see how in a very large spreadsheet this could make it very slow, especially if it automatically updates all the time. So, that's why you have to be very careful with these settings.

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**And then the last point here is that once you enter a table, you cannot modify individual cells. It's just like it is with array functions, which we learned before. If you want to change something or modify the inputs or change the formula, you need to delete and re-enter the entire table.**

So, you really have to be careful about how you set these up. If I go in here and I try to delete something, it says, "Can't change part of a data table," and that's the key problem here. Even if I select multiple cells or columns, it gives me the same message. To delete this, I have to actually delete the whole table and then start over.

So, be careful with data tables. They can be very useful, but use them sparingly, and you don't want to litter your entire financial model with 20 different data tables all over the place, for example.

With that said, let's now go into your exercise. I want you to create the next two sensitivity tables here.

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Now, for both these tables, you can use the same range for the discount rate, 4% to 6%. The terminal EBITDA multiple can go from 6.9x to 10.9x. And then for the operating scenario one, remember the rule about the inputs needing to be on the same sheet as the tables.

So, pause this video right now, follow the steps that we just completed, and try to create these tables yourself. When you're done, unpause this video, come back, and then we'll walk through this together.

Okay, good. So, for the EBITDA multiples, we can put 6.9 right here. Notice how I'm hard coding this, not linking to anything in the model. And then we can make it go up by 0.4. I will copy this across and see where we get to at the end. And, of course, we get right up to 10.9.

You could have done the math yourself and just counted the number of columns, and then taken four and divided by that to get to the proper interval here. But that's the basic idea.



For the discount rate, for both of these, we can actually do a direct link to this one. That's valid because this is not a part of the financial model that calculates the implied share price. So, it's okay to do this. It's just that we can't go up and link it to something like the discount rate that's in the actual financial model here.

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So, I'll take this and copy the formula down, and then we can do the same thing for this one where we just link to it and then copy it down.

Now, for the operating scenario, I can hard-code this and I can say Downside, Base, and Upside. The issue though is that, right now, that input cell is over in the Walmart model tab, so right where it says, "Paste in scenario box here if necessary," I'm going to select this whole thing, cut it with Ctrl + X or ⌘ + X, go over to the DCF tab, and then paste it in right here.

And then the last step before we create these tables is, we need to link to the proper output cell. So, for the EBITDA multiple versus discount rate one, let's go up and link to terminal value under the multiples method and the implied share price right here. I'll anchor that with that F4.

[13:59]

And then for the next one, we can actually link to the same thing. It doesn't really matter which one we'd link to here because we're not looking at the multiple or the growth rate as the key variable. So, I'll just link to the one that we have here, copy and paste this down with Ctrl + C, Ctrl + V.

Then to create these tables, we'll highlight the whole thing. Shift + Ctrl + Down Arrow Key, Right Arrow Key, Alt D, T, on a PC, or go to Data, What If Analysis, Data Table. And then for the terminal EBITDA multiple, let's go up and select this cell. For the discount rate, we'll select this cell. I'll say OK.

And then for this table, Shift + Ctrl + Down Arrow Key + Right Arrow Key, Alt, D, T. And then for the scenario, we'll link up here and go to this selected scenario box. And then for the discount rate, the one above it. And then I'll press OK.

Once again, the tables here haven't refreshed, so let's fix that by going to Formulas, and then we can go to Calculate Now or Calculate Sheet. And now these tables refresh, and so we have that.

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That's how we can set up the sensitivity tables. Let's now go into the last part and look at the interpretation.

The basic interpretation here is that Walmart looks appropriately valued right now. Its current share price is around \$105 at the time of this analysis, and if you look at everything here, this \$105 number is roughly in the middle of all these tables.

Maybe we could argue that it might be slightly undervalued depending on the table that we look at, but the range around the \$105 is right in the middle of the table for the multiple versus the discount rate. And similarly, for the one on the growth rate versus the discount rate, the \$105 is roughly in the middle.

So, if these are the scenarios that we buy into for this company, it seems like it's not great to bet for or against it right now because there's little downside and there's also little upside in the share price.

Of course, this could change if we had different views and we created different scenarios, but we're not going to get into that. As I said, that really gets into financial modeling. So, take a look at the Fundamentals course and all the modules there on valuation and DCF analysis.

[16:04]

Let's now do a recap and summary since we've reached the end.

Sensitivity tables are very useful in financial models because they let you vary one or two assumptions and then see how the third variable, or output, changes based on those.

All investing is probabilistic, so you always want to look at a wide range of potential outcomes and see the full range of possibilities from those.

Now, to set up sensitivity tables, the input variables and output must be on the same spreadsheet in Excel, the spreadsheet on which you are creating the table. So, everything has to be on the same sheet.

For the row and column inputs, you can't link to anything directly in the model. You need to hard-code the first entry for both of those and then increment them or decrement them by simple percentages or numbers.

The row and column inputs and the output must be related in some way. They can't just be random variables or random cells that you enter. They have to affect each other in some way.



You should set Workbook Calculation to Automatic Except for Data Tables so your spreadsheet doesn't slow down.

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Then you enter a direct link to the output that you want to sensitize in the top left-hand corner of the table.

Then you can select the whole table and go to Data, and What If Analysis, and Data Table, or use the Alt, D, T, shortcut on the PC.

And then if it doesn't show up correctly right away, go to Formulas and then you can refresh everything or just refresh and calculate this current sheet, or try the F9 shortcut.

Once you enter the table, you can't modify individual cells. It's just like with array functions. If you want to change one thing, you have to delete the whole table and then re-enter it.

And the basic takeaway here was that Walmart seems appropriately valued right now. Not much upside, not much downside.

That's it for our lesson sensitivity tables. Coming up next in our final lesson in this module, you will learn how the Goal Seek function works in Excel and how you can use it to quickly back-solve for numbers that are required to produce certain outcomes in financial models.