2020

Equipping Students with Advanced Excel Skills in the Classroom - Building Flexible, Robust, and Self-Adaptive Financial Models

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Both Excel skill and financial modeling skill are essential for finance students. When building a financial model in Excel, it is important to keep it clear, concise and consistent. But an even better model would be flexible, robust, and dynamic. This paper uses three detailed examples to demonstrate how finance professors can equip students with advanced Excel skill and financial modeling skill at the same time in finance classes, and in turn, helps the students be competitive when they are on the job market and be successful in their future careers.

Keywords: Advanced Excel skills, financial modeling skill, pedagogy, finance classroom, financial models

Introduction

Excel skills are one of the most valued skills in the workplace. But most business schools do not offer Excel classes or integrate Excel into their business courses. Students usually lack the motivation to explore and learn Excel by themselves. Some students may develop some basic Excel skills on their own. However, it is very difficult for them to become an advanced Excel user if there is no appropriate guidance. This paper shows how finance instructors can help student master some advanced Excel skills in the classroom. I will use three detailed examples to demonstrate how to create flexible, robust, and self-adaptive financial models in Excel. Equipping students with advanced Excel analysis and modelling skills will help them stand out from other job candidates and be successful in their careers down the road.

Financial modelling is widely used in financial decision-making processes including business valuation, asset valuation, financial forecasting, and capital budgeting decisions. A financial model usually contains a set of input assumptions, calculations, and output presentations. A good financial model should be flexible, robust, and self-adaptive. financial model is one that can automatically adjust and recalculate everything in the spreadsheet when some key inputs change. Self-adaptive models work for similar scenarios with different inputs, thus are robust and flexible. For example, a self-adaptive bond valuation model can calculate the price of a semi-annual bond or an annual bond without changing the actual Excel formulas. A self-adaptive mortgage amortization loan table would be able to automatically adjust the number of months to display without manually adding or deleting rows when the loan term changes or when extra payment is added to the monthly payment.

Robust and self-adaptive models can save us a lot of work time from creating similar models with different assumptions. Job candidates with advanced Excel and financial modeling skills are very needed in the workplace. This paper will shed light on how some advanced Excel skills can be developed in finance classes. Hopefully this will spark some meaning discussions on teaching innovation and curriculum improvement among finance professors and faculty in other business fields.

Literature Review

Integrating Excel in the classroom can make students more engaged in learning as it provides some hands-on experience. Carini, Kuh, and Klein (2006) show that student academic performance and learning outcomes are positively correlated with student engagement. I often incorporate Excel into my finance courses and this method has proven to be very effective and efficient in student learning process. As indicated in Zhang (2014), all learning goals defined for my Excel-integrated Financial Analysis and Strategy course have been achieved. In a post-course survey, more than 90% of the students stated that integrating Excel in the course not only deepened their understanding of the most difficult finance concepts, but also prepared them well with the essential Excel skill to be competitive in the job market and be successful in their future career.

In recent years, there has been an increasing amount of literature on incorporating Excel into the teaching and learning. Zhang (2014) shows how Excel's sensitivity analysis tools can be used to teach finance classes more efficiently and effectively. McNeil (2015) points out that Excel modeling skills are commonly listed as a desired qualification for many jobs in the financial services industry. He presents an automated grading system which can lessen the instructors' burden to grade Excel modeling assignments. Zhang (2015) demonstrates how to use Data Table and Chart tools in Excel in various finance courses to help professors teach and students learn some key finance concepts and theories. Fairchild, Misra and Shi (2016) shows how to create and implement a short VBA macro code in Excel to generate the triangular distribution function, which is very useful in project analysis and in the analysis of rival entry on the cash flows.

So far, however, there has been no discussion about creating flexible and dynamic financial models in Excel and equipping students with this advanced Excel skill. This paper attempts to provide a starting point for further discussion on this area. Finance professors and professors from other disciplines may learn some ideas on integrating Excel skill into students' learning, and think about other creative ways to engage students in the classroom.

Creating Flexible, Robust, and Self-Adaptive Financial Models

When we are planning, designing, and developing a financial model, we should always keep conciseness, flexibility, and robustness in mind. Conciseness means to present your inputs, core model, and outputs in a clear and effective way. You include only what is essential to your model and exclude the non-essential, or irrelevant information. Flexibility means that your model should work under different scenarios. When some inputs change, you need to change the inputs only with no or minimum intervention in the core of your model. Robustness means that your spreadsheet should be free of errors and does not crash under any circumstances.

In the following, I will use three detailed examples to demonstrate how a finance professor teaches students to create flexible, robust, and self-adaptive models in Excel in the classroom. These models are chosen to illustrate how flexibility, robustness and self-adaptiveness can be built into a financial model from different aspects.

Model 1: Corporate Federal Tax Calculation

Corporate tax calculation is an essential topic in Introduction to Financial Management, Corporate Finance, or Taxation course. After Students learn the concepts of tax liability, average tax rate and marginal tax rate, they need to know how to calculate each of them for a given taxable income.

There are various ways to create an Excel spreadsheet to calculate tax liability, average tax rate and marginal tax rate. For example, we can first enter the corporate tax table as shown in Exhibit 1, the taxable income is entered in Cell B11, we then calculate the tax liability in Cell B12. Assume the taxable income is $12,500,000, then the tax liability can be calculated as $3,400,000 + 35% of the amount over $10,000,000. The corresponding Excel formula in Cell B12 would be "3400000+35%*(B11-10000000)", which gives $4,222,500. The average tax rate in Cell B13 is simply the tax liability divided by the total taxable income. Using cell references, we enter "=B12/B11" in B13 to get 34.19%. Finally, according to the tax table, if the taxable income is increased by $1, the firm would need to pay an extra tax of 0.35 dollars or 35 cents. Therefore, the marginal tax rate can be entered directly as 35% in B14.

The problem with this method is that when we want to calculate tax liability, average tax rate and marginal tax rate for another amount of taxable income, say $600,000, we need to change the formulas in Cell B12 since the base amount and the lower bound of the tax bracket are different now. We do not need to change the formula for the average tax rate calculation, but we need to manually adjust the marginal tax rate in B14 each time when the taxable income falls into a different tax bracket.

Exhibit 1: Traditional way to Calculate Corporate Federal Tax

	A	B	C	D
2	**Taxable Income ($) in between**		**Base**	**Tax Rate**
3	$ -	$ 50,000	$ -	15%
4	$ 50,000	$ 75,000	$ 7,500	25%
5	$ 75,000	$ 100,000	$ 13,750	34%
6	$ 100,000	$ 335,000	$ 22,250	39%
7	$ 335,000	$ 10,000,000	$ 113,900	34%
8	$ 10,000,000	$ 15,000,000	$ 3,400,000	35%
9	$ 15,000,000	$ 18,333,333	$ 5,150,000	38%
10	$ 18,333,333	and up	35%	
11	Taxable Income	$ 12,350,000	=3400000+35%*(B11-10000000)	
12	**Tax Liability**	$ 4,222,500	=B12/B11	
13	**Average Tax rate**	34.19%		
14	**Marginal Tax rate**	35%		

Can we create a more flexible and robust corporate tax model which reports the tax liability, average tax rate, and marginal tax rate automatically when a different taxable income is entered? The answer is yes! In a flexible and dynamic model, we do not need to modify anything except the inputs. In another word, we say the model can self-adapt to any changes in the inputs.

Here are the general steps to create a flexible corporate federal tax model. First, we add Column E and use Excel's IF statement to check if the entered taxable income in Cell B11 is greater than or equal to the lower bound of the corresponding bracket. The syntax of an Excel IF statement is: =IF(logic_test, value_if true, value_if_false). If the logic_test is true, then value_if_true is returned, otherwise, value_if_false is returned. For example, in Cell E11, we enter

=IF($B$11>=A3,"Yes","No")

and it returns "Yes" when the taxable income is $12,350,000. Note that $B$11 is an absolute reference, which will remain unchanged when the formula is copied to another cell. A3 is a relative reference, so the column header A and row header 3 will change according to the relative position of the cell where you paste the formula. The logic test of "the taxable income is greater than or equal to the value in Cell A3, 0 in this case" is true, so a "Yes" is returned. Similarly, we add Column F to test if the taxable income is smaller than the upper bound of the corresponding bracket.

If both Columns E and F return a "Yes" in a specific row, it indicates that the entered taxable income falls into the tax bracket in that row. We add Column G as an indicator which equal 1 when both Columns E and F return are "Yes", and 0 otherwise. The formula for Cell G11 is

=IF(AND(E3="Yes",F3="Yes"),1,0)

We will see later that this indicator provides us a convenient way to find the marginal tax rate. show how much tax they pay

In Column H, we calculate how much tax the firm pays in each tax bracket. If the corresponding F column is a "No", that is, the taxable income is not less than the upper bound, the tax component should be the corresponding tax rate times the range (the difference between the upper and lower bounds) of the bracket. If the corresponding F column is a "Yes", and Column G is 1, the component would be calculated as the corresponding tax rate times the difference between the taxable income and lower bound of that bracket. Otherwise, the tax component is zero. This can be achieved by using an imbedded IF statement in another IF statement. As an example, the formula for Cell H3 is

=IF(F3="No",(B3-A3)*D3,IF(G3=1,($B$11-A3)*D3,0))

We copy the formulas in Cells E3, F3, G3, and H3 and paste them for other tax brackets. Then the total tax liability in Cell B12 is simply the sum of the tax components in Column H. The average tax rate is calculated as before. Remember that Column G is an indicator, which is equal to 1 if the taxable income falls into the corresponding tax bracket, and 0 otherwise. We can multiply the tax rate in Column D and Column G and sum the result up to obtain the marginal tax rate. This can be readily accomplished by using Excel's SUMPRODUCT function. We enter

=SUMPRODUCT(D3:D10,G3:G10)

in Cell B14 to find the marginal tax rate.

Exhibit 2 shows the complete model for a taxable income of $12,350,000. If we want to calculate the tax liability, average tax rate, and marginal tax rate for a firm that has $600,000 in taxable income, the only thing we need to do is to change the value in Cell C11 to this new amount. The model will generate the three outputs without needing any other intervention. Note that we can always hide columns E, F, G and H to keep the spreadsheet clear and concise. If we hide these four columns, the final spreadsheet would look exactly the same as Exhibit 1. But as we have seen already, this model is more flexible and robust, and can self-adapt to any changes in taxable income.

To help readers visualize the formulas in this model, Appendix 1 presents the cell formulas instead of cell values. In Excel, we can always use shortcut Ctrl+~ to toggle between viewing values and formulas in cells.

Exhibit 2: Corporate Federal Tax Calculation

	A	B	C	D	E	F	G	H
1	**Corporate Federal Tax Calculations**							
2	**Taxable Income ($) in between**		**Base**	**Tax Rate**	**> Lower Bound?**	**< Upper Bound?**	**Bracket Indicator**	**Tax Component**
3	$ -	$ 50,000	$ -	15%	Yes	No	0	$ 7,500
4	$ 50,000	$ 75,000	$ 7,500	25%	Yes	No	0	$ 6,250
5	$ 75,000	$ 100,000	$ 13,750	34%	Yes	No	0	$ 8,500
6	$ 100,000	$ 335,000	$ 22,250	39%	Yes	No	0	$ 91,650
7	$ 335,000	$ 10,000,000	$ 113,900	34%	Yes	No	0	$ 3,286,100
8	$ 10,000,000	$ 15,000,000	$ 3,400,000	35%	Yes	Yes	1	$ 822,500
9	$ 15,000,000	$ 18,333,333	$ 5,150,000	38%	No	Yes	0	$ -
10	$ 18,333,333	and up		35%	No	Yes	0	$ -
11	Taxable Income	$ 12,350,000						
12	**Tax Liability**	$ 4,222,500						
13	**Average Tax rate**	34.19%						
14	**Marginal Tax rate**	35%						

After the paper was initially written, the Tax Cuts and Jobs Act of 2017 (TCJA) changed the corporate tax rate to one single flat rate of 21%. This change makes the corporate tax calculation much easier. However, income from small business such as sole proprietorships, partnerships, and LLCs is taxed at personal level, which is still progressive. The method above can be easily extended to individual tax calculations.

Model 2: Creating Dynamic Amortization Loan Schedule

The traditional amortization loan table is static. This means that we have to manually adjust the entries in the table whenever the loan term changes, or if extra money is planned to be added to the monthly payment. In this section, we will see how a dynamic amortization loan schedule can be created in Excel.

In Model 1, we demonstrated how to create a flexible spreadsheet to calculate the federal tax liability, average tax rate, and marginal tax rate for a company. The flexibility lies in the fact that the only thing needs to be changed in the model for a different taxable income is the input itself. But what we have done in Model 1 is not enough for a flexible, dynamic, and robust amortization loan schedule. In the following, we will see the details about creating a dynamic and self-adaptive amortization loan table.

Suppose you are considering a 30-year mortgage loan of $250,000 at an interest rate of 4.275%. You want to create an amortization loan table to see how your loan is paid off over time. At the same time, you also want to check some other options, such as a 15-year loan, or how soon you can pay your loan off if you add $200 to your monthly payment. The goal here is to create a dynamic amortization loan table so that the number of rows will be automatically adjusted based on the loan term and/or the additional payment amount.

We start off by entering the input values: loan amount (D2), mortgage rate (D3), loan term in years (D4), number of payments per year (D5), and optional extra payments (D6). The monthly payment can be found using Excel's PMT function. As shown in Exhibit 3, the formula in Cell D7 is

=PMT(D3/12,D4*D5,-D2,0)

Exhibit 3: 30-Year Mortgage Loan Amortization Schedule

	A	B	C	D	E	F
1	**Mortgage Loan Amortization Schedule**					
2	Loan Amount			$ 250,000		
3	Mortgage Rate			4.275%		
4	Loan Term (in years)			30		
5	Number of Payments per Year			12		
6	Optional Extra Payments			$ -		
7	Monthly Payment			$ 1,233.51		
8						
9	**Month**	**Beginning Balance**	**Monthly Payment**	**Interest Payment**	**Repayment of Principal**	**Ending Balance**
10	1	$ 250,000.00	$ 1,233.51	$ 890.63	$ 342.89	$ 249,657.11
11	2	$ 249,657.11	$ 1,233.51	$ 889.40	$ 344.11	$ 249,313.01
12	3	$ 249,313.01	$ 1,233.51	$ 888.18	$ 345.33	$ 248,967.67
13	4	$ 248,967.67	$ 1,233.51	$ 886.95	$ 346.56	$ 248,621.11
366	357	$ 4,890.41	$ 1,233.51	$ 17.42	$ 1,216.09	$ 3,674.32
367	358	$ 3,674.32	$ 1,233.51	$ 13.09	$ 1,220.42	$ 2,453.90
368	359	$ 2,453.90	$ 1,233.51	$ 8.74	$ 1,224.77	$ 1,229.13
369	360	$ 1,229.13	$ 1,233.51	$ 4.38	$ 1,229.13	$ 0.00
370						

A typical amortization loan schedule should include “Month”, "Beginning Balance", "Monthly Payment", "Interest Payment", "Repayment of Principal", and "Ending Balance" columns. For the first month, the beginning balance (B10) is just the original loan amount (=D2); The monthly payment (C10) is the payment we calculated in Cell D7 plus the optional extra payments in D6 (=$D$7+$D$6); The interest payment (D10) is the beginning balance times the monthly mortgage rate (=B10*$D$3/12). The mortgage rate is usually quoted in annual terms. The monthly interest rate is then the mortgage rate divided by 12. The repayment of principal (E10) is the difference between monthly payment and interest payment (=C10-D10); Lastly, the ending balance (F10) is the remaining loan amount at the end of the first month, which is the beginning balance minus the repayment of principal (=B10-E10).

For a 30-year mortgage, there will be 360 monthly payments assuming no extra payments are made, so there will be 360 rows in the loan table. But if you decide to take a 15-year loan instead, then there will be only 180 rows. Or if you pay some extra amount each month, it will take less than 360 months to pay your mortgage off. To accommodate these possibilities, we cannot just fill 1 through 360 in the "Month" column. Instead, starting from month 2, we use an IF statement to check if the previous month number is less than the maximum number of monthly payments, which is the product of loan term in years and number of payments per year ($D$4*$D$5). If the logic test is false, we will leave the cell as a blank. But remember, if you decide to add optional extra payments, then the cell should also be a blank if the loan is paid off in the previous month. That is why we need a second IF statement as the value_if_true argument of the first IF statement. The nested IF statement checks if the remaining balance of the previous month is zero. For rounding reasons, the logic test we actually use is to check if the previous ending balance is less than 0.01. If true, it returns a blank, otherwise, we add 1 to the previous month number and display it. The formula in the "Month" column for the second month (Cell A11) is

=IF(A10<$D$4*$D$5, IF(F10<0.01," ", A10+1), " ")

Note that there are several different ways to accomplish the same task. We could check if the previous ending balance is less than 0.01 first, then embed the second IF statement to check if the previous month number is less than the maximum number of monthly payments. In this case, the formula in A11 would be

=IF(F10<0.01, " ", IF(A10<$D$4*$D$5, A10+1, " "))

Alternatively, we can also use an OR statement to combine these two situations when the month number should be a blank, and use that as the logic test for the IF statement. The formula would be

=IF(OR(F10<0.01, NOT(A10<$D$4*$D$5)), " ", A10+1)

Next, we calculate the other columns. If the corresponding month is a blank, then we don't need to display the other columns as well. We use this as the logic test in the formulas of other columns. The beginning balance in a given month should be the ending balance of the previous month. In Cell B11, we enter

=IF(A11<>" ",F10, " ")

The monthly payment (C11) is a little bit tricky. If the scheduled monthly payment is greater than the beginning balance plus the interest in that month, then you don't have to pay the full amount of the scheduled payment and your mortgage will be paid off in that month. Therefore, we add another IF statement to check if this is the case. If true, then the payment is just the beginning balance plus interest. Otherwise, you still pay the scheduled full amount. The formula in Cell C11 is then

=IF(A11<>" ", IF(B11*(1+$D$3/12)<($D$7+$D$6), B11*(1+$D$3/12), $D$7+$D$6), " ")

The formulas in "Interest Payment", "Repayment of Principal", and "Ending Balance" columns are similar to those in month 1, except that we need to consider whether the corresponding month number is a blank. So, we use IF statements in these columns to choose between a blank or a regular formula as in month 1 to calculate each of these entries. The formulas in Cells D11, E11, and F11 are

=IF(A11<>" ",B11*$D$3/12," "), =IF(A11<>" ",C11-D11, " ") , and =IF(A11<>" ",B11-E11," ") respectively.

After all the formulas in the second month are correctly entered, we can copy and paste them over for month 3 through month 360. When the optional extra payment is set to zero, you will be able to pay the mortgage off in exactly 360 months. So, the ending balance should be 0 in month 360. Exhibit 3 shows that this is the case. To save space, we used "Freeze Panes" function in Excel so only the first four and the last four rows in the loan table are shown

We can test our model out by changing the loan term to 15 years. The result is shown in Exhibit 4. Again, we only show the first four and last four rows. As expected, the ending balance in month 180 is zero and the loan table just ends here without showing anything for month 181 and beyond. That is, our loan table automatically adapts to the new loan term and there is no need to modify anything in the formulas.

Exhibit 4: 15-Year Mortgage Loan Amortization Schedule

	A	B	C	D	E	F
1	**Mortgage Loan Amortization Schedule**					
2	Loan Amount			$ 250,000		
3	Mortgage Rate			4.275%		
4	Loan Term (in years)			15		
5	Number of Payments per Year			12		
6	Optional Extra Payments			$ -		
7	Monthly Payment			$ 1,883.86		
8						
9	**Month**	**Beginning Balance**	**Monthly Payment**	**Interest Payment**	**Repayment of Principal**	**Ending Balance**
10	1	$ 250,000.00	$ 1,883.86	$ 890.63	$ 993.24	$ 249,006.76
11	2	$ 249,006.76	$ 1,883.86	$ 887.09	$ 996.77	$ 248,009.99
12	3	$ 248,009.99	$ 1,883.86	$ 883.54	$ 1,000.33	$ 247,009.66
13	4	$ 247,009.66	$ 1,883.86	$ 879.97	$ 1,003.89	$ 246,005.78
186	177	$ 7,468.81	$ 1,883.86	$ 26.61	$ 1,857.25	$ 5,611.55
187	178	$ 5,611.55	$ 1,883.86	$ 19.99	$ 1,863.87	$ 3,747.68
188	179	$ 3,747.68	$ 1,883.86	$ 13.35	$ 1,870.51	$ 1,877.17
189	180	$ 1,877.17	$ 1,883.86	$ 6.69	$ 1,877.17	$ 0.00
190						

Let us change the loan term back to 30 years and assume that we add $200 to our monthly payments. As shown in Exhibit 5, the loan table automatically cut off at month 274 because the ending balance is zero. This means we now can pay our loan off in 274 months, which is about 7 years sooner than if no extra payment is made.

We have created a dynamic amortization loan table that can change the number of rows to show based on the loan term and additional payment amount. For the convenience of the readers,

Appendix 2 shows the formulas used for the first three rows in the loan table. The formulas in other rows can be obtained using Excel's copy and paste function.

Exhibit 5: 30-Year Mortgage Loan Amortization Schedule with Optional Extra Payments

	A	B	C	D	E	F
1	**Mortgage Loan Amortization Schedule**					
2	Loan Amount			$ 250,000		
3	Mortgage Rate			4.275%		
4	Loan Term (in years)			30		
5	Number of Payments per Year			12		
6	Optional Extra Payments			$ 200		
7	Monthly Payment			$ 1,233.51		
8						
9	**Month**	**Beginning Balance**	**Monthly Payment**	**Interest Payment**	**Repayment of Principal**	**Ending Balance**
10	1	$ 250,000.00	$ 1,433.51	$ 890.63	$ 542.89	$ 249,457.11
11	2	$ 249,457.11	$ 1,433.51	$ 888.69	$ 544.82	$ 248,912.29
12	3	$ 248,912.29	$ 1,433.51	$ 886.75	$ 546.76	$ 248,365.53
13	4	$ 248,365.53	$ 1,433.51	$ 884.80	$ 548.71	$ 247,816.82
280	271	$ 4,328.95	$ 1,433.51	$ 15.42	$ 1,418.09	$ 2,910.87
281	272	$ 2,910.87	$ 1,433.51	$ 10.37	$ 1,423.14	$ 1,487.72
282	273	$ 1,487.72	$ 1,433.51	$ 5.30	$ 1,428.21	$ 59.51
283	274	$ 59.51	$ 59.72	$ 0.21	$ 59.51	$ 0.00
284						

Model 3: Supernormal Growth Model

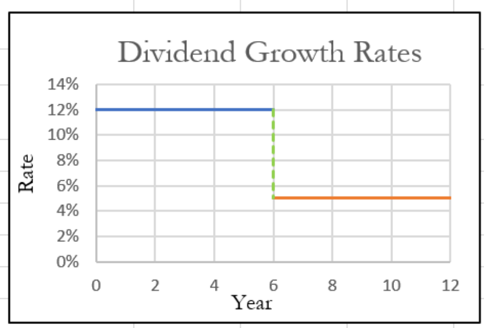
Supernormal growth model is an important tool for valuing a stock which is expected to have higher than normal growth in dividend payments for some period in the future. After this supernormal growth period, the dividend is expected to grow at a more sustainable constant rate. Students often have hard time using this model to calculate a stock price because there are so many steps involved in the calculation. They need to calculate the dividend payments in each of the supernormal growth period first, then find the terminal value or horizon value. Next, they find the present values of those dividend payments and terminal value, and add them up to get the stock price. When facing another problem, they have to do all these steps again, and they often make mistakes here or there.

This section shows how a supernormal growth stock valuation problem can be solved in Excel. In fact, this Excel model is so flexible and robust that it can solve any supernormal growth stock valuation problem. What we need to do is just change the key input values, then the model will return the stock price instantly.

The setup of the model is shown in Exhibit 6. The first five rows provide the information for dividend just paid, initial growth rate, sustainable growth rate, high growth period in years, and discount rate. In row 9, we label columns A, B, C, D and E as Year, Growth Rate, Dividend, Terminal Value, and Present Value, respectively. For year 0 in row 10, the dividend is given in Cell D2 (=D2).

Exhibit 6: Supernormal Growth Model

	A	B	C	D	E	F	G	H	I
1	**Supernormal Growth Model**								
2	**Dividend just paid**			$ 1.45			X-axis	Y-axis	
3	**Initial Growth Rate**			12%			0	12%	
4	**Sustainable Growth Rate**			5%			6	12%	
5	**High Growth Period (in years)**			6			6	5%	
6	**Discount rate**			9.0%			12	5%	
7	Stock price based on the Supernormal Growth Model			$54.37					
8									
9	**Year**	**Growth Rate**	**Dividend**	**Terminal Value**	**Present Value**				
10	0		$ 1.45						
11	1	12%	$ 1.62		$1.49				
12	2	12%	$ 1.82		$1.53				
13	3	12%	$ 2.04		$1.57				
14	4	12%	$ 2.28		$1.62				
15	5	12%	$ 2.56		$1.66				
16	6	12%	$ 2.86	$ 75.13	$46.50				
17	7	5%							



As illustrated in Model 2, a flexible model should be able to adjust the number of rows needed based on given inputs. To find the stock price using supernormal growth model in a spreadsheet, we only need the dividend payment and growth rate information up to the point when the sustainable growth starts. So, starting from row 11 in the Year column, we check if the first year of sustainable growth, which is one year after the supernormal growth period, is reached. If not, we add 1 to the previous year number and return that number in the cell. Otherwise, a blank cell will be returned, meaning the model will end here. The formula in Cell A11 is

=IF(A10<$D$5+1,A10+1," ")

If the Year column is blank, then there is no need to fill the corresponding Growth Rate in that row. If it is not a blank, then depending on the actual year value, the growth rate is equal to the initial growth rate when the year value is less than or equal to the high growth period, and the sustainable growth rate otherwise. So, we use a nested IF statement for the True outcome in the first IF statement in Cell B11, which is

=IF(A11<>" ",IF(A11<=$D$5,$D$3,$D$4), " ")

We can also use

=IF(A11<>" ",IF(A11>$D$5,$D$4,$D$3), " ")

to accomplish the same task.

The dividend payments for each period is just the previous dividend payment times one plus the dividend growth rate in that year. Of course, we only need to calculate the dividend payment up to the terminal year, the last year of the fast growth period. Fox example, the formula used in Cell C11 is

=IF(A11<$D$5+1, C10*(1+B11), " ")

The terminal value (TV) is calculated as

$$\text{TV} = \frac{D_n(1 + g_L)}{r - g_L}$$

where D_n is the dividend payment in the last year of supernormal growth period, g_L is the long-term sustainable growth rate, and r is the discount rate. We translate this into an Excel formula, and enter it in Cell D11.

=IF(A11=$D$5,C11*(1+$D$4)/($D$6-$D$4), " ")

The IF statement makes sure that the terminal value is only calculated for the ending year of the fast growth period.

Lastly, we calculate the present value of total cash flow in each year during the supernormal growth period using Excel's PV function. For the terminal year, the total cash flow is the sum of dividend payment and the terminal value. The total cash flow is the dividend payment for the previous years. In Cell E11, we have

=IF(A11<$D$5+1,-PV($D$6,A11,0,SUM(C11:D11)), " ")

We then copy the formulas in the range of A11:E11 and paste them to the next 20 rows. In a typical supernormal growth problem, the fast growth period should be less than 20 years. Therefore, pasting the formulas for the next 20 rows should be enough.

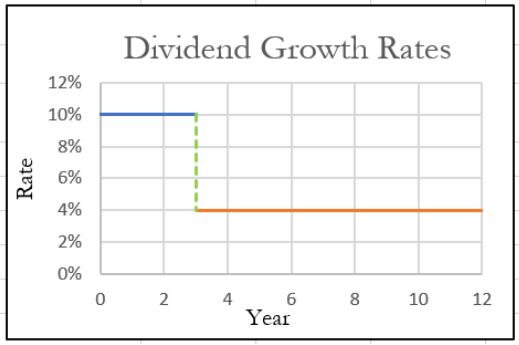
Finally, we calculate the stock price in Cell D7 by summing the present values in Column E up. The formula is

=SUM(E11:E31)

Let us test our model out by changing all five inputs. The new values are shown in red in Exhibit 7 and they are the only things we changed in the spreadsheet. As we can see, the model automatically adjusted what needs to be calculated and what rows to show, reflecting its flexibility, robustness and self-adaptability. The formula view of this model is shown in Appendix 3.

Exhibit 7: Supernormal Growth Model with New Inputs

1	**Supernormal Growth Model**						
2	**Dividend just paid**			$ 2.00		X-axis	Y-axis
3	**Initial Growth Rate**			10%		0	10%
4	**Sustainable Growth Rate**			4%		3	10%
5	**High Growth Period (in years)**			3		3	4%
6	**Discount rate**			11.0%		12	4%
7	Stock price based on the Supernormal Growth Model			$34.81			
8							
9	**Year**	**Growth Rate**	**Dividend**	**Terminal Value**	**Present Value**		
10	0		$ 2.00				
11	1	10%	$ 2.20		$1.98		
12	2	10%	$ 2.42		$1.96		
13	3	10%	$ 2.66	$ 39.55	$30.86		
14	4	4%					
15							



In the model, we also include a little graph to show the two different dividend growth rates. Although it is not necessary to plot this graph. The point of showing it is that we can not only create flexible and dynamic models in Excel, but also make graphs dynamic and self-adaptive. The graph in Exhibit 7 reflects the new growth rates and high grow period when their values are changed.

This model can save finance professors a lot of time in the process of writing and grading quizzes or exams. With this spreadsheet in hand, finance professors can rewrite another supernormal growth stock valuation problem in less than one minute, reducing the need to manually calculate the stock price themselves first. This model also makes assigning different problems to different students in a homework possible, thus can avoid the problem of some students copying solutions directly from others.

Assurance of Learning

I adopted this teaching method in a 16-week financial modeling class during Spring 2016 (14 students) and Spring 2018 (13 students). Throughout the semester, I constantly reminded students the essential elements of a good financial model: clarity, conciseness, consistency, flexibility, robustness, and self-adaptivity. Students followed my detailed instructions in class and built about 20 financial models in Excel. In compliance with the AACSP Assurance of Learning requirement of providing direct measures of learning, I designed a midterm exam and a final exam with five problems in each. For each problem, students need to either complete a financial model with a provided template or build a model from scratch in Excel based on some instructions on paper.

The midterm grade ranges from 72.5 to 100 with an average of 86.94 out of 100. The final grade ranges from 68 to 98 with an average of 91.41 out of 100. Among these 27 students from both cohorts, 20 students (74%) scored higher in the final exam than in the midterm exam, indicating that two-thirds of students improved their Excel financial modeling skills during the second half of the semester. In the final exam, 26 out of 27 students exceeded the required desired threshold level of 75 percent by scoring 75 points or higher.

Conclusion

For finance students, developing both Excel skill and financial modeling skill is very important for their career success. This paper uses three detailed examples to demonstrate how finance professors can equip students with these two crucial skills at the same time in finance classes.

In addition to clearness, conciseness, and consistence, a good financial model should be flexible, robust, and dynamic. In the first example, we created a model to calculate the federal tax liability, average tax rate, and marginal tax rate for a firm. This model is flexible and self-adaptive because it can automatically recalculate these three outputs for any taxable income. The amortization loan schedule model and supernormal growth model can add or delete rows automatically without any intervention in the core calculations. We also see in the last example that plots and graphs can be made flexible and dynamic as well.

I hope this paper will spark some meaningful discussions on how Excel can be incorporated into the classroom among finance and business faculty. Business schools may consider offering Excel classes or at least including Excel elements in their curriculum. Equipping students with advanced Excel skills will help them stand out from other job candidates and be successful in their future careers.

References

Carini, R. M., Kuh, G. D. and Klein, S. P. (2006). Student engagement and student learning: Testing the linkages. *Research in Higher Education*, 47, 1-32.

Fairchild, Keith Wm., Lalatendu Misra, and Yilun Shi (2016). Using Triangular Distribution for Business and Finance Simulations in Excel. *Journal of Financial Education*, Vol. 42, No. 3 & 4, pp. 313-336.

McNeil, Chris R. (2015). Excel Modeling Assignments and Automatic Grading. *Journal of Financial Education*, Vol. 41, No. 3, pp. 86-97.

Zhang, Chengping (2014). Incorporating Powerful Excel Tools into Finance Teaching. *Journal of Financial Education*, Vol. 40, No. 3 & 4, pp. 87-113.

Zhang, Chengping (2015). Using Excel's Data Table and Chart Tools Effectively in Finance Courses. *Journal of Accounting and Finance*, Vol. 15, No. 7, pp. 79-93.

Appendix 1. Formulas used in the corporate federal tax model

	A	B	C	D	E	F	G	H
1	Corporate Federal Tax Calculations							
2	**Taxable Income ($) in between**		**Base**	**Tax Rate**	**> Lower Bound?**	**< Upper Bound?**	**Bracket Indicator**	**Tax Component**
3	0	50000	0	0.15	=IF($B$11>=A3,"Yes","No")	=IF($B$11<B3, "Yes","No")	=IF(AND(E3="Yes",F3="Yes"),1,0)	=IF(F3="No",(B3-A3)*D3,IF(G3=1,($B$11-A3)*D3,0))
4	50000	75000	7500	0.25	=IF($B$11>=A4,"Yes","No")	=IF($B$11<B4, "Yes","No")	=IF(AND(E4="Yes",F4="Yes"),1,0)	=IF(F4="No",(B4-A4)*D4,IF(G4=1,($B$11-A4)*D4,0))
5	75000	100000	13750	0.34	=IF($B$11>=A5,"Yes","No")	=IF($B$11<B5, "Yes","No")	=IF(AND(E5="Yes",F5="Yes"),1,0)	=IF(F5="No",(B5-A5)*D5,IF(G5=1,($B$11-A5)*D5,0))
6	100000	335000	22250	0.39	=IF($B$11>=A6,"Yes","No")	=IF($B$11<B6, "Yes","No")	=IF(AND(E6="Yes",F6="Yes"),1,0)	=IF(F6="No",(B6-A6)*D6,IF(G6=1,($B$11-A6)*D6,0))
7	335000	10000000	113900	0.34	=IF($B$11>=A7,"Yes","No")	=IF($B$11<B7, "Yes","No")	=IF(AND(E7="Yes",F7="Yes"),1,0)	=IF(F7="No",(B7-A7)*D7,IF(G7=1,($B$11-A7)*D7,0))
8	10000000	15000000	3400000	0.35	=IF($B$11>=A8,"Yes","No")	=IF($B$11<B8, "Yes","No")	=IF(AND(E8="Yes",F8="Yes"),1,0)	=IF(F8="No",(B8-A8)*D8,IF(G8=1,($B$11-A8)*D8,0))
9	15000000	18333333	5150000	0.38	=IF($B$11>=A9,"Yes","No")	=IF($B$11<B9, "Yes","No")	=IF(AND(E9="Yes",F9="Yes"),1,0)	=IF(F9="No",(B9-A9)*D9,IF(G9=1,($B$11-A9)*D9,0))
10	18333333	and up		0.35	=IF($B$11>=A10,"Yes","No")	=IF($B$11<B10, "Yes","No")	=IF(AND(E10="Yes",F10="Yes"),1,0)	=IF(F10="No",(B10-A10)*D10,IF(G10=1,($B$11-A10)*D10,0))
11	Taxable Income	12350000						
12	**Tax Liability**	=SUM(H3:H10)						
13	**Average Tax rate**	=B12/B11						
14	**Marginal Tax rate**	=SUMPRODUCT(D3:D10,G3:G10)						

Appendix 2. Formulas used in the amortization loan schedule model

	A	B	C	D	E	F
1	**Mortgage Loan Amortization Schedule**					
2	Loan Amount			250000		
3	Mortgage Rate			0.04275		
4	Loan Term (in years)			30		
5	Number of Payments per Year			12		
6	Optional Extra Payments			200		
7	Monthly Payment			=PMT(D3/12,D4*D5,-D2,0)		
8						
9	**Month**	**Beginning Balance**	**Monthly Payment**	**Interest Payment**	**Repayment of Principal**	**Ending Balance**
10	1	=D2	=$D$7+$D$6	=B10*$D$3/12	=C10-D10	=B10-E10
11	=IF(A10<$D$4*$D$5, IF(F10<0.01," ", A10+1), " ")	=IF(A11<>" ",F10, " ")	=IF(A11<>" ",IF(B11*(1+$D$3/12)<($D$7+$D$6), B11*(1+$D$3/12), $D$7+$D$6), " ")	=IF(A11<>" ",B11*$D$3/12," ")	=IF(A11<>" ",C11-D11, " ")	=IF(A11<>" ",B11-E11," ")
12	=IF(A11<$D$4*$D$5, IF(F11<0.01," ", A11+1), " ")	=IF(A12<>" ",F11, " ")	=IF(A12<>" ",IF(B12*(1+$D$3/12)<($D$7+$D$6), B12*(1+$D$3/12), $D$7+$D$6), " ")	=IF(A12<>" ",B12*$D$3/12," ")	=IF(A12<>" ",C12-D12, " ")	=IF(A12<>" ",B12-E12," ")
13	=IF(A12<$D$4*$D$5, IF(F12<0.01," ", A12+1), " ")	=IF(A13<>" ",F12, " ")	=IF(A13<>" ",IF(B13*(1+$D$3/12)<($D$7+$D$6), B13*(1+$D$3/12), $D$7+$D$6), " ")	=IF(A13<>" ",B13*$D$3/12," ")	=IF(A13<>" ",C13-D13, " ")	=IF(A13<>" ",B13-E13," ")

Appendix 3. Formulas used in the supernormal growth model

	A	B	C	D	E
1				Supernormal Growth Model	
2	**Dividend just paid**			1.45	
3	**Initial Growth Rate**			0.12	
4	**Sustainable Growth Rate**			0.05	
5	**High Growth Period (in years)**			6	
6	**Discount rate**			0.09	
7	**Stock price based on the Supernormal Growth Model**			=SUM(E11:E20)	
8					
9	**Year**	**Growth Rate**	**Dividend**	**Terminal Value**	**Present Value**
10	0		=D2		
11	=IF(A10<$D$5+1,A10+1," ")	=IF(A11<>" ",IF(A11<=$D$5,$D$3,$D$4), " ")	=IF(A11<$D$5+1, C10*(1+B11), " ")	=IF(A11=$D$5,C11*(1+$D$4)/($D$6-$D$4), " ")	=IF(A11<$D$5+1,-PV($D$6,A11,0,SUM(C11:D11)), " ")
12	=IF(A11<$D$5+1,A11+1," ")	=IF(A12<>" ",IF(A12<=$D$5,$D$3,$D$4), " ")	=IF(A12<$D$5+1, C11*(1+B12), " ")	=IF(A12=$D$5,C12*(1+$D$4)/($D$6-$D$4), " ")	=IF(A12<$D$5+1,-PV($D$6,A12,0,SUM(C12:D12)), " ")
13	=IF(A12<$D$5+1,A12+1," ")	=IF(A13<>" ",IF(A13<=$D$5,$D$3,$D$4), " ")	=IF(A13<$D$5+1, C12*(1+B13), " ")	=IF(A13=$D$5,C13*(1+$D$4)/($D$6-$D$4), " ")	=IF(A13<$D$5+1,-PV($D$6,A13,0,SUM(C13:D13)), " ")