

“Spreadsheet Modeling in Finance and Investments Courses”

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Finance is an inherently quantitative subject, and educators at both the undergraduate and graduate levels often struggle with finding the optimal approach that maximizes understanding and retention for their students, especially for students who are mathematically challenged.

In this column, we offer and encourage an approach we label “Spreadsheet Modeling” that has been quite successful in our classes and is growing in popularity. Obviously, spreadsheet modeling is not new. Academics and practitioners have benefited from it since the early 80’s. Nor is our recommended approach completely new or the definitive final word on the subject. Our primary conviction is simply that the optimal use of spreadsheets for teaching finance and investments has been only modestly explored, and the benefits of using them is strictly “positive NPV” for initial student learning and concept retention.

In this column, we first summarize the pedagogical issues of why “Spreadsheet Modeling” as an overall approach works so well, and the value of differing sub-approaches. Then we offer several examples from our own classes and a survey of available resources (including textbook supplements) especially for investments-type courses.

BENEFITS AND MOTIVATIONS FOR SPREADSHEET MODELING

BENEFIT #1: CONQUERING EQUATION-PHOBIA: Finance academics themselves typically have a high comfort level with both mathematical expressions and abstract theoretical concepts. It is common for rookie teachers to attribute those talents to their students also, but veteran teachers usually concede that such attribution is overly optimistic, especially if the goal is content understanding by 80% or more of the class. Even a mathematical equation as fundamental as the summation of the present value of the cash flows from periods 1 to N may be difficult for the average student to visualize, even though the same student can easily understand the intuition of the concept when presented with a graph or table of the values. Trying to repair these significant deficiencies in the language of mathematics by forcing students to acquire them just for a finance course is usually too costly and almost always a negative NPV project. Spreadsheet Modeling can bypass this equation-phobia by examining equations in non-equation form, either in terms of a spreadsheet time-line or a graph.

BENEFIT #2: BRIDGING FROM CONCEPTS TO PROBLEM SOLVING: Teaching a concept is often done by “talking about it.” This is the other end of the spectrum from the “presenting the equations” approach. It is often the case that students understand and can articulate the concept (or, at least they think they can) but when they are given a case, even a modest one, and asked to

do something like an NPV analysis, they are paralyzed; they don't know where to start. In our view (and almost surely in the view of their potential employers), if they can't "do" it, they don't know it. Interestingly, teachers often find that if students can "do" an example (knowing where all the numbers come from and go to), they can understand and hence articulate a concept or reproduce a problem solution. However, the inverse is not true. They cannot easily move from the general concept to a problem solved. For these typical students, spreadsheet modeling actually creates the understanding through "doing" rather than just being an example of the concept.

A DISTINCTION: SPREADSHEET MODELING VS. SPREADSHEET TEMPLATES: There is a wide range of approaches in the use of spreadsheets. At a simple level, there are "Spreadsheet Templates" which provide students with already-built spreadsheet solutions. The student fills in appropriate input cells and out pops an answer. Sometimes these templates have substantial value. For example, the dynamics of option valuation can be visualized as input parameters are varied. The problem with "Templates" is that they can often be "black boxes" to students. If they do not build the equations or graphs themselves, they may not appreciate how you get from inputs to outputs or even have a clue as to what the spreadsheet is doing. Our preferred idea of "Spreadsheet Modeling" is based on an active build-it-yourself approach. Whereas templates are often passive learning, Spreadsheet Modeling is active. As recently as Fall 1998, few if any of the top 40 textbooks in investments and corporate finance included spreadsheet *modeling*, whereas 21 of the top 40 textbooks included spreadsheet *templates*. This has changed dramatically as spreadsheet *modeling* has exploded. By Fall 2001, 30 of the top 40 textbooks will include spreadsheet *modeling* as a built-in feature or via an independently available supplement in the notation of the primary textbook. These 30 textbooks represent more than 90% of the market share of investments and corporate finance textbooks. For details of this survey, go to (http://www.spreadsheetmodeling.com/Survey_of_the_Top_40_Textbooks.htm).

BENEFIT #3: OUTFITTING THE STUDENT WITH REAL-WORLD TOOLS: It is probably safe to say that there is no finance function in a post-college job in the year 2000 that does not use a spreadsheet like Excel regularly. For nearly 20 years, since the emergence of PCs, Lotus 1-2-3, and Microsoft Excel in the early 80's, spreadsheet models have been the dominant vehicles for finance professionals in the business world with which to implement their financial knowledge. Professors often take their assignment ("to teach finance") quite literally and assume that students' learning of spreadsheet skills is someone else's job. Such a narrow and archaic focus is tantamount to saying "I teach financial theory. *They* have to figure out how to use it. Whether they *really* learn what they need to know to *do* finance is not my job." We feel that teaching students how to actually build spreadsheet models of finance concepts is the best way to prepare them for the business world.

A DEBATE: THE CALCULATOR VS. SPREADSHEET MODELING: Many finance professors have relied for years on homework exercises and cases that were solvable by calculator, and indeed there is often a conservatism (a.k.a. laziness) bias that what has worked moderately well does not need to be changed. Yet, there is an important movement that suggests a change is needed. The computing platform required in Business Schools is changing – now far more than the majority of Business Schools require their students to own a portable computer. Many schools have network data jacks at each student station in classrooms. In those Business

Schools where the platform has shifted, calculators are no longer viable as the only option. In fact, at both the Tuck and Kelley Schools, some programs have stopped requiring students to have a calculator. The advantages of spreadsheet modeling over the calculator are obvious: the spreadsheet provides a rich canvas by which to build complex, realistic finance models; the calculator doesn't. For example, consider a short list of topics calculators could not perform easily or at all:

1. Pro-forma financial projections linking the income statement, balance sheet, cash flow, and financial ratios,
2. Multi-stage valuation models to value firms or projects and perform sensitivity analysis of the key inputs,
3. Binomial trees to price any derivative using 10 steps, 20 steps, or more,
4. Portfolio optimizers using real data with 10 assets, 20 assets, or more, and
5. Life-cycle financial planning performing pro-forma project over a lifetime.

The spreadsheet is a natural platform for quantitative models. It combines:

1. Easy graphing of key relationships,
2. Use of optimization tools such as the solver in Excel (for example, to find the implied volatility of an option),
3. Use of menu-driven regression tools (for example, estimate the parameters of the security market line),
4. "Dynamic Charts" to interactively show comparative statics or dynamic relationships over time (download free examples at http://www.spreadsheetmodeling.com/free_samples.htm),
5. A rich set of build-in functions for present value, future value, annuities, bond pricing and duration, the cumulative normal, etc., and
6. Add-in software, such as @RISK and Crystal Ball to perform monte-carlo simulation (for example, to value a European exotic option by simulation).

Indeed, spreadsheet modeling is spreading rapidly in other quantitative disciplines, such as operations management and business statistics

GETTING STARTED WITH SPREADSHEET MODELING

Once the educator is convinced of the value of using spreadsheets, the next step is implementation. Many professors are advanced users of Excel but have never thought through its optimal use in finance courses. Others are amateur users and need to upgrade their own skills before trying to teach others the basics. Fortunately, there is a plethora of recent books to address the latter problem, with the gamut from basic to intermediate to advanced skills. See the bibliography below for recommendations.

Our first recommendation is that part of a class session be devoted to "efficient" modeling, if students are not familiar with the idea. By "efficient" we mean:

1. Teach students to communicate well with spreadsheet models by labeling everything and by clearly identifying key inputs (perhaps in the upper left-hand portion of the spreadsheet) and key outputs (going down the spreadsheet to the bottom right).
2. Optionally, one can have students write a project report to a hypothetical boss, which intuitively explains their method of analysis, key assumptions, and key results.

The key issue is for students to be able to distinguish between the inputs they need (and where to get those inputs) and outputs that come from extensions of formulas and Excel functions.

Additional recommendations are:

1. Devote a modest amount of class time to demonstrating the construction of part of the spreadsheet model. This helps students to get going in the right direction.
2. Provide optional support by scheduling an extra help session in a computer lab. The idea is that students can work on their spreadsheet modeling assignment while you and/or your assistant are available to answer spreadsheet and/or finance questions.
3. For a graded assignment, have your students turn in a printout of the spreadsheet, as well as a disk. Grading the printout is about twice as fast, because you avoid the time involved in opening and closing files. However, sometimes the disk files are necessary to determine partial credit. That is, sometimes students will perform good modeling with bad inputs, and it is difficult to determine whether the modeling is correct without the file.
4. If you devote a portion of a midterm or final to testing the live construction of a spreadsheet model, then remove time as a factor. That is, allocate about twice as much time as you would otherwise think is reasonable, so that "hunt and peck" typists are not disadvantaged by their slow typing speed. Also, if you are having them turn in their exam product on a disk, then verify that the disk is not blank before they leave the room. Surprisingly, about 5% will accidentally turn in a blank disk, because they made a simple mistake in copying the file from the hard disk at the end.

A DETAILED EXAMPLE

Here is a detailed example of implementing spreadsheet modeling in the classroom. At Indiana University, the course F303 Intermediate Finance is half investments and half corporate finance. It is a required course for all finance majors. It has as a prerequisite the Introductory Finance course and it in turn is a prerequisite for most of our finance elective courses. F303 contains four graded spreadsheet modeling projects:

1. An individual project in Ex-Ante Portfolio Formation. Given five years of data on international stock indices, calculate the means, standard deviations, and correlations using the built-in spreadsheet functions. Calculate value-weights, equal-weights, and precision-weights. Enter these inputs into the Excel-based Interactive Optimizer and interpret the results using a mean - standard deviation graph, a graph of optimal risky portfolio weights, and the weights of various portfolios.
2. A group project, creating a Lifetime Financial Plan. Develop a lifetime financial plan designed to meet the consumption, home/business ownership, and retirement needs for a particular client taking into account their life-cycle saving needs, taxes, risk preferences, and investment opportunities. Forecast key financial variables and decide on investment strategies. Teams make a "sales presentation" to attract clients.

3. An individual project in Option Prices and Volatilities. Based on the Black-Scholes formula, calculate and graph the value of a European calls and puts using the built-in spreadsheet functions, such as the cumulative normal. Using actual European stock index option data, calculate the implied volatilities using the solver module and graph the "smile" pattern of implied volatility.

4. A group project in Corporate Valuation and Financial Risk. Given the actual 10K financial statement for a firm, each team will project the firm's cash flows in Europe, Asia, and the Americas, value the firm, and then calculate firm's exchange rate exposure with respect to the DM and JY. Teams will present their findings to the firm's "board of directors."

For more information on the course setting, click on [Syllabus of Intermediate Finance \(F303\)](#). For student handouts describing the projects in detail, click on [Ex-Ante Portfolio Formation](#), [Lifetime Financial Plan](#), [Option Prices and Volatilities](#), and [Corporate Valuation and Financial Risk](#).

RESOURCES FOR THE EDUCATOR

(1) "Spreadsheet Modeling" – a textbook and CD-ROM series by Holden, published by Prentice Hall. Each member of the series is available as a \$20 (suggested retail price) supplement for non-Prentice Hall textbooks or as a \$5 valuepack supplement for Prentice Hall textbooks. Available now: (a.) "Spreadsheet Modeling in Investments" and (b.) Spreadsheet Modeling in the Fundamentals of Investments." Coming in Fall 2001: (a.) "Spreadsheet Modeling in Corporate Finance," (b.) "Spreadsheet Modeling in the Fundamentals of Corporate Finance," and (c.) "Spreadsheet Modeling in the Introduction to Finance." (<http://www.spreadsheetmodeling.com>)

(2) "Spreadsheet Modeling Exercises" – a textbook on CD-ROM by Holden, bundled with "Finance," First Edition by Bodie and Merton, published by Prentice Hall (<http://www.prenhall.com/financecenter/>).

(3) "Spreadsheet Strategies" boxes in "Essentials of Corporate Finance," Second Edition by Ross, Westerfield, and Jordan and "Fundamentals of Corporate Finance," Fifth Edition by the same authors – published by Irwin McGraw-Hill (<http://www.mhhe.com/info/websites.mhtml>).

(4) "Excel boxes" in "Fundamentals of Corporate Finance," Third Edition by Brealey, Myers, and Marcus, published by Irwin McGraw-Hill (<http://www.mhhe.com/info/websites.mhtml>).

(5) Spreadsheet modeling paragraphs in "Fundamentals of Financial Management," Ninth Edition by Brigham and Houston, published by Harcourt. Also, spreadsheet modeling textbook / templates on CD-ROM (<http://www.harcourtcollege.com/finance/>).

(6) "Financial Modeling" by Benninga, published by MIT Press (<http://finance.wharton.upenn.edu/~benninga/mit.html>)

(7) "Corporate Finance: A Valuation Approach" First Edition, by Benniga and Sarig, published by Irwin McGraw-Hill (<http://www.mhhe.com/info/websites.mhtml>).

(8) "Financial Analysis with Microsoft Excel" First Edition, by Mayes and Shank, published by Harcourt (<http://www.harcourtcollege.com/finance/>).

(9) "Financial Models Using Simulation and Optimization" First Edition, by Wayne Winston, published by Palisade Corporation (<http://www.palisade.com/>).

(10) List of spreadsheets modeling resources in other disciplines:
(<http://sunsite.univie.ac.at/Spreadsite/spreaded.html>).

FOR LEARNING INTERMEDIATE AND ADVANCED SKILLS IN EXCEL:

(1) Microsoft Excel 97 (and 2000) Advanced Topics Step by Step, by Reed Jacobson, Microsoft Press.

(2) Excel 2000 Programming For Dummies by John Walkenbach, IDG Books. This book is the best we have seen in introducing the basics of the Visual Basic programming language which resides inside Excel.