

Teaching Finance through Computer Modeling

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Version January 15, 2003

Abstract

Finance is perceived as one of the glamorous, but also more difficult subjects taught in business schools as it is an inherently quantitative subject in which at least some math is required to understand the basic concepts. However, even if students possess such quantitative skills, they often find it hard to really grasp the meaning of theories in finance. Here a practical “hands-on” approach through computer and in particular spreadsheet modeling can provide a means of enhancing understanding and retention for students. At the same time, this approach improves employability of students as they become more productive in their use of analysis tools which are widely used in today’s work environment. In this paper we review selected software and text book resources available to the educator and we share some of our experience in teaching dedicated courses in Financial Modeling at University of Waikato Management School.

Teaching Finance through Computer Modeling

Finance is perceived as one of the glamorous, but also more difficult subjects taught in business schools as it is an inherently quantitative subject in which at least some math is required to understand the basic concepts. However, even if students possess such quantitative skills, they often find it hard to really grasp the meaning of theories in finance. In this paper we present computer and in particular spreadsheet modeling as a means of maximizing the understanding and retention of finance concepts by students. We discuss a few of the most important text book and software resources available to the educator and share some of our experience in teaching dedicated courses in financial modeling at University of Waikato Management School.

MOTIVATION

In this first section we deal with some of the benefits and motivations for using computer modeling in teaching finance. These have also been explored by Holden & Womack (2000) in a brief note titled "Spreadsheet Modeling in Finance and Investment Courses". The issues and ideas raised by them are actually very much in line with this author's own teaching experience at Waikato University.

Bringing Mathematical Formulae to Life

All major theories in finance, beginning with the time value of money concept right through to the most complex models of stochastic processes in financial markets, are inherently quantitative and require at least a basic understanding of math. Many students in management schools, including those majoring in economics and finance, do not feel fully comfortable with algebra, even if it just involves understanding a basic annuity formula. In their article, Holden & Womack (2000) term this

an "equation-phobia" that has to be overcome. Using spreadsheets, and for more advanced courses computer languages like VBA, brings life into unworldly looking formulas containing summation signs, derivatives, integrals etc. For instance, while the intuition behind the time value of money concept will be easy to grasp for most students, only its implementation on a spreadsheet by summing a series of discounted cash flows will actually provide a real understanding for most learners.

Such benefits are not purely limited to simple concepts in finance. Take option theory as an example. The meaning of a Geometric Brownian Motion underlying most standard option pricing models really becomes clear if implemented as a discrete process on a spreadsheet. Similarly, numerical and simulation methods to price options beyond the simple European type are better understood if implemented by the student as a VBA program. Paul Wilmott, author of numerous books on quantitative finance, has been a pioneer in this area, illustrating some of the mathematically most challenging concepts in finance as spreadsheet or VBA solutions. His works will be briefly reviewed later in this article.

Equipping Students for a Finance Job

What would be a typical job of a finance student upon graduation? They will not enter organizations as CFOs, but many will commence their career doing analytical work for their bosses. It is even safe to say that there will be no entry-level finance function nowadays that will not require the use of spreadsheets like Excel on a regular basis. While some finance professors might think teaching students spreadsheet skills to be someone else's job, in reality they will fail to equip students with the skills to do an actual finance job. In the words of Holden & Womack (2000), such a narrow focus on pure finance is tantamount to saying "I teach financial theory. They have to figure have to

figure out how to do it. Whether they really learn what they need to know to do finance is not my job".

There is another aspect that might elude instructors who have spent their careers teaching finance in academic institutions. For most financial analysis type work, the actual "finance content" in a strict academic sense is in fact fairly minimal. The very few real "finance quants" are typically recruited from science and math PhDs and the work of an ordinary financial analyst is in fact much less thrilling. They will spend much of their energy retrieving, rearranging, and analyzing information. In the process they will detect missing, conflicting and erroneous data items that need cleaning and filtering. To determine, for example, an EVA (Economic Value Added) requires little effort compared to retrieving and condensing the data from an antiquated accounting system before this calculation can be done. Knowing how to effectively use spreadsheets, including all the data handling and analysis tools that come with them, is thus key to success in this profession. This is not to say that we should convert finance classes to IT courses but if we can pass on such essential computer skills in the process of teaching finance, we actually kill two birds with one stone.

RESOURCES

Computer and specially spreadsheet modeling is not new to finance and researchers and educators alike have widely used it since the first spreadsheet programs became commercially available in the early 1980's. Accordingly, quite a great number of articles and books relating to, respectively supporting the use of computer modeling in teaching not just finance but also other business school subjects such as accounting, economics, operations research have come to the

market over the past few years. The following quote from Heap (1985) gives one of the earlier descriptions of a spreadsheet's functionality :

Spreadsheet packages are used to model financial and other numeric situations within the memory of a computer. A wide range of features and facilities are available on the more sophisticated packages. The spreadsheet model's basic structure is a matrix of columns and rows that are identified by numeric or alphabetic labels. An intersection of a row and column is called a cell. A change in one cell will cause all the other cells related to it to change. Users can take advantage of this feature to conduct "what if" analyses.

With spreadsheet having come into common use, there would hardly be the need to introduce them in similar fashion these days. These software packages to support analytical work have greatly evolved and names like VisiCalc, Multiplan, Symphony have all disappeared from the spreadsheet scene. MS Excel has become not only market leader but one could say industry standard, with Lotus 123 and Corel's Quattro Pro in distant second and third place. No need therefore to dwell on the past; we will focus on more recent publications that present the use of models in the current web-based teaching environment.

In the following overview we will limit ourselves to true financial modeling resources. These include both dedicated modeling books as well as models provided with standard textbooks. For more details on the publications discussed below refer to the references section at the end of this article. Note that quite a few finance textbooks these days are accompanied by a computer disk containing files to support the learning of students. Many of them, however, provide just little calculators to determine and visualize results of models explained in the book. Examples of this would be Hull's widely used textbooks for derivative classes (e.g. Hull 2000, Options, Futures & Other Derivatives). This author provides Derivagem, a "black box" option calculator together with his books. Similarly, the Internet is full of such black box finance calculators, usually based on Java

Applets. Such software may help explore the dynamics of the models but there is no creative element in this process.

Holden

Craig Holden, Professor at Kelley School of Business and co-author of the article referred to above (Holden & Womack 2000), is a strong advocate of using spreadsheets in teaching finance. He authored a number of modeling books and sample Excel models to accompany popular teaching texts for both corporate finance and investments like Brealey/Myers, Ross/Westerfield/Jordan, and Body/Kane/Marcus. His books employ little mathematical language, the models are fairly transparent and thus cater to an undergraduate audience. Holden's credo, which is fully shared by the author of this article, can best be summarized in a sentence found on Holden's personal website that reads: *"My goal in writing the Spreadsheet Modeling book / CD series is simply to change finance education from being calculator based to being spreadsheet modeling based."* (retrieved from www.spreadsheetmodeling.com January 2003)

Benninga

Another "champion" of financial modeling is undoubtedly Simon Benninga, author of a widely used textbook (Benninga & Czapczkes 2000). Benninga goes beyond the simple spreadsheets by adding the use of VBA to solve some more advanced analytical and numerical problems in finance. He presents models from the following broader topic areas: corporate finance, portfolio theory, option pricing, fixed income models. There are more technical sections that introduce mathematical and finance features available in Excel but also give a primer on VBA. In our opinion, Benninga's book is best suited for a dedicated course in financial modeling at an undergraduate level.

Benninga is currently preparing a more basic modeling book "Principles of Finance with Excel", of which draft chapters can be found on his personal web site (<http://finance.wharton.upenn.edu/~benninga/home.html> retrieved January 2003). It will omit VBA and present purely spreadsheet based models.

Hovey

Martin Hovey, currently lecturer in finance at Griffith University (Australia), has written the book "Spreadsheet Modelling in Corporate Finance" to supplement an introductory corporate finance textbook chosen for a particular class. The approach is very similar to Holden but it has a stronger "Teaching Excel" focus. It explains the implementation of models through innumerable figures showing the Excel function wizard and other Excel dialogues.

Mayes & Shank

Mayes & Shank (2001) are authors of a book called "Financial Analysis with Microsoft Excel". Based on its table of contents and without having reviewed it in detail, we see it as a supplementary text for undergraduate courses in financial management or possibly as a text for a basic spreadsheet modeling paper. The authors claim that their book teaches the finance fundamentals and spreadsheet usage at the same time. Yet according to some reviewers, the spreadsheet part is too basic while it is lacking general explanations on the financial concepts.

Jackson and Staunton

With Jackson and Staunton (Jackson & Staunton 2001), authors of "Advanced modelling in finance using Excel and VBA", we move into a higher sphere of financial modeling. The book has been compiled from material developed for modeling courses at various leading European business schools which becomes apparent in a certain lack of structure. Having said this, the book shows how to implement a great number of advanced finance models and would thus be most suitable for a graduate level course. It also includes a primer on VBA but the reader would probably need another resource to become familiar with this programming language.

Wilmott

One could describe Paul Wilmott almost as a cult author. Titles of his two most recent books on quantitative finance include his personal name like the two volume advanced version "Paul Wilmott on Quantitative Finance" or the smaller teaching version "Paul Wilmott Introduces Quantitative Finance". His company operates an extensive website that includes forums where finance quants discuss most advanced modeling and programming problems. His books are not on financial modeling per se but they use Excel and sometimes VBA code fragments to illustrate complex concepts and numerical methods, mostly from the world of derivatives.

Models with Standard Textbooks

As indicated there are many finance textbooks that provide students with software models and we limit our review to just two better known publications.

Aswath Damodaran specializes in corporate finance textbooks. An example would be his "Corporate Finance Theory and Practice" where the author provides the student with a great number of spreadsheet templates such as models to determine the optimal financing mix or for valuing a firm. These spreadsheets can be freely downloaded from the author's website (<http://pages.stern.nyu.edu/~adamodar> retrieved January 2003). While we generally find his sample models very useful, they often contain so many parameters that it takes some time to ascertain which ones actually affect the model output. Admittedly, the process of exploring the dynamics of such an open-code template can be a valuable learning experience by itself. In general though, we prefer an approach with models that have to be developed by the students themselves.

Bodie, Kane & Markus are authors of "Investments", one of the leading textbooks in the field. Now with the fifth edition they provide students with a small number of Excel spreadsheet applications that help them explore the topics covered. Again they are downloadable from a website (www.mhhe.com/bkm retrieved January 2003) and usually involve little assignments to be completed by the learner.

FINANCIAL MODELING AT WAIKATO UNIVERSITY MANAGEMENT SCHOOL

The finance curriculum at University of Waikato Management School includes modeling and spreadsheet exercises both as part of regular courses and in dedicated financial modeling courses. This begins right with the introductory finance paper FINA201 which includes spreadsheet assignments that count towards the final grade. In a major project, students have to retrieve a personal set of securities data from a financial data base which they then use to determine returns and an index, to conduct an event study and, finally, a risk return analysis.

There is a dedicated fourth year financial modeling paper at an undergraduate level. Classes are held as computer lab sessions but capacity constraints might force a change to a lecture/tutorial type format. It is recommended that students acquire the Benninga Financial Modeling book discussed above but the course does not follow it closely. Rather it uses proprietary models and provides students with specific handout where required.

Table 1 below splits the topics of this course into two parts. First, the actual finance topics most of which the student should have heard about in previous finance papers. Modeling helps them refresh their memories and gives them an actual understanding of "how it is done". Secondly, we list the specific financial analyst skills that are to be developed. They are not taught on their own but usually practiced by solving the kinds of finance problems mentioned above.

Table 1

FINA415 Computer Modeling in Finance: Finance Topics and Financial Analyst Skills

Finance Topics	
Company Financial Modeling	Practical development of proforma financial statements (starting point: historical financials of listed company) Use this company model to conduct a valuation (DCF, DDM) and other types of financial analysis (e.g. EVA, credit analysis)
Time Value of Money Problems	Modeling solutions of standard time value of problems (e.g. project finance, lease vs. buy)
Fixed Income Analytics	Bond yield, duration, convexity Topics in term structure of interest modeling
Models in Portfolio Theory and Statistics	Meaning of basic statistical parameters. Regressions applied to CAPM, APT problems. Two, respectively multi-asset portfolio problems: efficient frontier, minimum variance and optimal portfolio
Financial Analyst Skills	
Spreadsheet Structuring and Handling	(Selection of some of the EXCEL/VBA features covered) Freezing, splitting panes. Effective cell formatting. Print set-up. Working with several sheets. Hyperlinks for efficient navigation. Auditing/debugging spreadsheets. Automating repetitive tasks.
Analysis of Financial Data	Data tables. Pivot table data analysis. Data group and ungroup. Excel data analysis functions and data analysis features. Financial and statistical functions. Simple user-defined functions. Data validation.
Visualization of Financial Data	Graphing and charting features. Effective use of drawing objects. Application of controls on forms/control toolbox toolbars.

As can be seen from the table above, this course goes beyond simple spreadsheet modeling. Applying VBA for repetitive tasks and some more advanced financial functions adds another tool to the box of a proficient financial analyst. Often one immediate feedback from students working on larger finance papers is that these newly gained skills come extremely handy for the data mining work typical in such projects.

Assessment is based on three individual class tests and five project assignments. The tests are fully electronic. Students are given an Excel file they have to complete in a two-hour computer

lab session. At the conclusion of the test they use a web-based file submission facility to hand in their solutions. This submission facility is also used for the five projects in this course for which Table 2 below describes the contents.

Table 2

FINA415 Computer Modeling in Finance: Project Assignments (Status 2002)

Project	Description
Company Valuation Project	Student teams build a company valuation model (DCF method) for Auckland International Airport and present their results in a brief report and slide show to Auckland City Council, a major shareholder that intends to dispose of its holding. The teams' goal is to gain an advisory mandate on the disposal of this strategic stake.
Spreadsheet Automation	Small VBA program to rearrange a set of financial data (to be used for further analysis)
Mortgage Calculator	Design an interactive mortgage calculator to advise bank clients on optimal financing solutions. The calculator in its basic version can be implemented as a spreadsheet solution but some optional features require VBA programming.
Cash Flow Valuation	Project involves bootstrapping zero rates from quoted swap rates (real time source) and valuation of a series of cash flows. No VBA required but some additional marks given for VBA based functions.
Simulation of Feasible Portfolios	Random simulation of a few hundred feasible portfolios composed of 6 stocks to identify optimal portfolio. Visualize results and check solution with alternative methods. Basic solution does not require VBA programming.

The finance department at Waikato Management School also runs an advanced modeling module (half course) for graduate students. It is based on skills acquired in FINA415 Computer Modeling in Finance but students with advanced spreadsheeting and/or programming skills are admitted without completing this course. Table 3 below shows the topics covered in the 2002 module.

Table 3

FINA518 Advanced Financial Modeling: Topics Status 2002

Topic	Description
Forex Arbitrage	Develop cross-currency foreign exchange arbitrage tool fed by Reuters real time data.
Options	Analysis of ASX warrants: pricing, the “Greeks”, volatility smiles etc.
Advanced Programming	For reasons of performance, advanced finance models are often not programmed in Excel/VBA. Some other tools are shown that are often used (C++, Gauss, Mathematica etc.). Programming exercise with Java Script as example of lower level language.
Simulation	Simulation of stock price paths (Brownian motion, jump diffusion). Monte Carlo simulation for option valuation. Programming exercise: replicate Longstaff&Schwartz (2001) American option valuation.
Numerical methods	Finite differences methods in finance and tree models to value options, convertibles etc.
Risk Management	Value at risk models, portfolio insurance
Topics in corporate finance	Company valuation with stochastic parameters (Schwartz&Moon 2001)

Models in this module are inspired by articles like the examples mentioned in the above table or by some of the more advanced modeling books discussed earlier in this article. They are in particular Wilmott 2000, Jackson&Staunton 2001, Haug 1997 but also Hull 2000. There are no tests and the assessment is based on two set assignments and a major modeling project chosen by the student.

Teaching Experience

What has been the experience teaching such modeling courses at Waikato University? The undergraduate FINA415 paper was first taught in 1999 and the graduate FINA518 in 2001. The comments below relate primarily to the first of these two dedicated modeling papers.

With regard to spreadsheet skills of students entering the course, these were initially overestimated which meant more time had to be spent on getting the class more familiar with Excel. With the introduction of spreadsheet exercises in prerequisite finance courses, these abilities have

been steadily improving, however. As the course progresses, one can observe a kind of polarization among students. There is a larger group that will do fine with basic spreadsheet handling but will touch VBA only as much is required. On the other hand, there are the programming aficionados that seem to spend incredible amounts of time on their projects. It does not mean that these keen programmers in fact achieve higher marks as they often lose control of their software development. With their overly sophisticated, error prone solutions, they sometimes find it hard to satisfy even the basic requirements of an assignment.

Too much time spent with spreadsheets also means that the students at times lose sight of the purpose of financial models. An example would be the company modeling and valuation exercise for a listed company. A small report and a presentation are important components of this project and consequently less than 50% of the marks are in fact assigned to the valuation model itself. It must nevertheless be suspected that students spend close to 90% of their time on it. They forget that any model only has value if its results are also communicated well to an interested user, respectively client. This means, successful financial modelers must also be gifted communicators who are able to explain results found in an intuitive way. They must know how to employ a language understood by the decision-makers and not just by fellow finance wizards.

With so much energy and time going into spreadsheet modeling, it is a challenge to actually preserve the course as a finance paper. This is best achieved by applying the modeling to examples of the real finance world. Students must be able to relate to the usefulness of an application. The design of a mortgage calculator, for instance, provokes an incredible diversity of most creative and innovative solutions.

As a final note, one can observe that some students find it particularly hard to meet due dates in a modeling course. In other courses they might be able to finish that important report in the night before the due date. Not so in modeling assignment. If stuck with a software problem at 2am in the

morning on the day the model is due, the student will find little help. Overall, however, the teaching of such modeling papers has been a very gratifying experience and demand has been exceeding the lab space available. Students are highly motivated as they realize the meaning and application of what is taught. Some show incredible talents and it has been particularly pleasing to hear about cases of students being short-listed for interviews and later obtaining a job because of their modeling skills.

CONCLUSION

In the application of finance, an important technological advancement has been the development of spreadsheet software programs such as Excel. Freshly minted business school graduates are expected to possess a fundamental knowledge of spreadsheets because these programs enable users to conduct financial analysis in an efficient and sophisticated manner. In teaching finance such spreadsheet software provides an excellent tool for understanding the computational intricacies involved in financial modeling. Thus by integrating computer modeling into the teaching of finance courses one will actually achieve two goals at once: students find it easier to understand finance concepts and become more employable as they pick up valuable real-world skills.

In light of such benefits, it is no surprise that numerous books on financial modeling have been published, some of which we have presented in this paper. Moreover, many finance texts are accompanied by some kind of software these days and there are business schools that have actually moved away requiring students to buy financial calculators but have fully switched to spreadsheet-based teaching (Holden & Womack 2000). Waikato University Management School has not been that radical in its approach but has incorporated financial modeling in its finance curriculum for many years now. Modeling starts in the introductory finance course and students can pick up advanced modeling skills in dedicated courses at an undergraduate and graduate level. There is great demand for these courses and limited lab space has required limiting student numbers in some instances. In our view, continued demand by the business world for graduates who "can do the job" will further strengthen the role of modeling in teaching business students.

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