Financial Modeling

The Little VBA Book, Robin Grieves, Mark Griffiths and Myoung Cheoi Seo,
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Benninga’s Financial Modeling is our textbook and is supplemented by material developed by the instructor.

The Little VBA Book will help you learn Visual Basic in as little as one afternoon. This course uses VBA when we study options to build our own user-defined function. A warm-up exercise is due for our second class meeting.

Course Goals
Financial modeling is an essential part of sophisticated financial operations from corporations to investment banks to research firms. The skills you learn in this course will make you an attractive candidate for prestigious financial companies and enhance your opportunities within your current company. Take your time to develop elegant models as you work through the assignments in this course and you will have a portfolio of projects that will help you get interviews, jobs, and promotions. This course is a hands-on, application-oriented tour of financial models used in corporate finance, investment analysis, and portfolio management. You will make extensive use of Excel and learn Visual Basic—two of the financial modeler’s essential tools. Because most of these models were covered in basic corporate finance, we will only spend a little time on the financial theory behind each model. If the motivation behind each model is a bit obscure to you, I have provided a list of books and articles in the course schedule that you should consult to learn more about the models that are unfamiliar to you. As always, ask if you need help.

Risk
Financial models are designed either to determine an asset’s current or future value, or both. In all cases the modeler needs to be concerned with helping the firm manage risk. While financial models can help quantify financial risk, they also create their own modeling risk. Spectacular failures like Long Term Capital Management (subject of the book, When Genius Failed: The Rise and Fall of Long-Term Capital Management) were caused by model risk because the models failed to account for events that happened very rarely or had not (yet) happened. The Economist (October 13, 2008, When Fortune Frowned, p. 12), referring to the financial crisis, wrote: “Wall Street’s fancy computer models, based on recent price histories, underestimated how much the innovation was pushing up house prices, underestimated the odds of a national house-price decline in America and so encouraged an unsustainable explosion of debt.” You can read more about model-related financial failures in The Big Short: Inside the Doomsday Machine, by Michael Lewis and in The Black Swan by Nicholas
Managing risk involves three teams, each with its own players. One team wants to avoid risk—these participants are the hedgers. Another team is willing to take on risk—they are the speculators. The financial modeling team occupies the middle ground, building models that help both hedgers and speculators understand their positions. We use the terms hedging and speculation without casting dispersion on either—they simply describe two halves of any risk management strategy.

**Corporate Models**
The job of a corporate manager could be described as controlling (hedging away) financial risk. We assume corporations exist to take on operating risk. When a corporation seeks out financial risk it can quickly dilute its comparative advantage. Designing models that examine the risk inherent in any corporate strategy will help financial managers make better operating and financial decisions.

**Managing Investment and Financial Risks**
The financial management of the corporation spans both investment in real capital and financing those investment decisions by means of securities. When a corporation invests to introduce a new product or service it takes on risk. Every new operating venture typically requires capital and by definition its success cannot be a sure thing. Without some risk, however, the corporation cannot expect to earn more than the risk-free rate.

Capital budgeting and financing are the two sides of the financial management coin. The modeler’s role is to help the corporation understand the risks on both the investment and financing sides of the business. A corporation should welcome risk in operating capital investments where it has expertise or some other form of comparative advantage. The bigger their advantage, the more risk the managers should be willing to take. Too much financial capital risk, however, can quickly undo any operating gains. Models should help corporate managers control both investment and financial risk.

**Modeling Financial Risks**
Corporations should think of their financial decisions in terms of risk and reward. We will look at models that help forecast financial structure and measure a firm’s cost of capital. Because we will use real companies, your assignments won’t sugar coat the problems inherent in building these models. I don’t believe you learn enough from simplified textbook models to be truly prepared for the real world.

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1 If a project reliably produced a return greater than Treasury bills people would rush to invest, produce a lot, and drive down the price until the excess return was competed away. Both existing and new products and services carry significant risks. While the first to bring an innovative project to market may reap a windfall, it is unlikely to be the normal course of competitive mature business.
Hedgers and Speculators
A market populated only by hedgers would be problematic. Hedgers who are equity investors want to lay off some of their risk. One possibility is to sell a portion of their portfolio. If the market only has hedgers, however, albeit with different risk tolerances, the impact of the sale on the market will result in a lower price than prevailed before the trade. In effect the hedgers-only market with diverse risk tolerances is willing to absorb an increased supply of equities but only at a lower price. If the speculators’ team is also allowed to play, the outcome is different. Speculators are willing to take on risk in hopes of a higher return so they absorb some of the increased supply, blunting the price impact. A market for risk with both hedgers and speculators is called well-functioning because some of the risk the hedgers want to avoid is borne by speculators.

Corporate financing decisions are part of the company’s hedge. Corporations may have comparative financial advantages due to their home currency, regulatory status, credit history or the like. Few non-financial corporations, however, make financial speculation their primary business. Investment and merchant banks provide many of the speculative financing trades by using their own or their investors’ money. Several of our security pricing models work equally well whether you are a corporation issuing, the investment bank underwriting, or the investor buying the security.

Managing Real and Financial Asset Risk
Sophisticated financial models have been developed for every imaginable financing need. Derivatives like forwards, futures, options, swaps, structured notes, asset-backed bonds, and so on all cater to the specialized financial hedging needs of corporations. At the same time these securities offer speculators opportunities to earn rates of return commensurate with the risks. Consequently, derivatives serve both corporations and investors.

Models that serve to measure and manage risk on the real asset (capital budgeting) side are not as well developed. Academics and some practitioners talk about the option-like characteristics of capital investments and a variety of value-at-risk methods are available to gauge the risk of the firm’s real assets. None of these tools, however, are as effective or as widely used on the asset side as financial derivatives are on the financing side. Nevertheless, corporate modelers must consider both real and financial capital to effectively serve the corporation.

We will not spend much time in this course on budgeting models. These models are typically unsophisticated and solidly entrenched in corporate lore. We will, however, build some relatively sophisticated corporate models that should be useful to any corporation senior executive.
**Axioms of Modeling**

**Errors**
- The number of mistakes produced by any model increases exponentially with model complexity.
- The number of mistakes decreases linearly with the age of the model. The only relatively mistake-free model is an old, often-used model. Reuse old code to protect against errors.

Worse-is-better—a philosophy that is famous among programmers and fits modeling, too. In priority order strive for:

1. **Simplicity**—the design must be simple, both in implementation and interface. It is more important for the implementation to be simple than the interface. Simplicity is the most important consideration in a design.

2. **Correctness**—the design must be correct in all observable aspects. It is slightly better to be simple than correct. Correctness and precision are two different qualities. Precision can be sacrificed for any other quality as long as the resulting decision is functional under the circumstances. Beware of precision masquerading as correctness.

3. **Consistency**—the design should be consistent in that it produces similar results in similar situations. Consistency can be sacrificed for simplicity in some cases, but it is better to drop those parts of the design that deal with less common circumstances than to introduce either implementational complexity or inconsistency.

4. **Completeness**—the design must cover as many important situations as is practical. All reasonably expected cases should be covered. Completeness can be sacrificed in favor of any other quality. In fact, completeness must be sacrificed whenever implementation simplicity is jeopardized. Consistency can be sacrificed to achieve completeness if simplicity is retained; especially worthless is consistency of interface.

[http://www.jwz.org/doc/worse-is-better.html](http://www.jwz.org/doc/worse-is-better.html)

**Security**
Data security and integrity are major worldwide concerns. Modelers should build in privacy. Modelers should also make sure no parts of their models can be changed without an audit trail. Models will have to be changed but be sure who changed it and why are recorded. Don’t delete old models—they are an invaluable back-up when things get out of control.

Audit yourself before you get to the end. Devise tests for the model to which you know the answer. Audit early and often.
Cleanliness is best. Clean, well-organized models will produce better results and be used longer. Make the organization obvious.

The perfect is the enemy of the good.² Don’t waste time making it perfect—make it work.

Leave plenty of tracks. It shouldn’t take more than an hour for someone else to completely understand and modify your most complicated model. Comments are cheap.

Write a description of your model and what it will do before you build it. Plan your model and model your plan. If you are building a model someone else might use (every model fits this category), make sure they understand what your model is supposed to do so they’ll know if it is working properly.

No model worth constructing is ever finished.

² The original quote in French is "Le mieux est l'ennemi du bien," from Voltaire's Dictionnaire Philosophique (1764), literally translated as "The best is the enemy of good."
Financial Modeling

**Class 1  September 14  Overview of Financial Modeling (in person)**

**Discussion Topics:** Philosophy of Learning: Class organization, objectives, and philosophy; Learning Styles; The Role of Modeling in Contemporary Finance; Visual Basic programming

**Sidebar:** Market for MBAs with financial modeling skills


**In Class Case:** Models in Corporate Finance

**Homework Problems:** 1-1 through 1-14 (Note: Use the workbook provided on the CD—these worksheets show how the problems are set up. Sometimes you have to alter the spreadsheet to find the solution. These problems should improve your understanding of the chapter material – we will have a quiz on these calculations.)

**In Class Exercise:** Visual Basic programming (continued on your own after class)

**In Class Quiz:** Basic financial calculations in Excel

**Learning Objectives:** philosophy of learning and teaching, overview of financial modeling, review of corporate finance

**Learning Outcomes:** understand the major philosophical and practical issues confronting financial models, introduction to VB programming

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**Class 2  September 21  Corporate Finance – Cost of Capital (students work on their own after a one hour class session)**

**Discussion Topics:** Alternate models of the cost of capital

**Read Before Class:** Benninga: Chapter 2; The Cost of Capital

**In Class Cases:** Computing the Cost of Capital for Kraft

**Case Due:** VBA Project – Submit your VBA project workbook via the assignment function in Blackboard before the beginning of class.

**Learning Objectives:** using financial information to analyze the cost of capital

**Learning Outcomes:** strategic insights to be gained from alternative cost of capital models

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2 All readings are available on Blackboard except the textbooks.
Class 3 September 28 Corporate Finance – Financial Statement Modeling (students work on their own after a thirty minute class session)

Discussion Topics: Financial statements from a finance perspective

Read Before Class: Benninga: Chapters 3 and 4, Financial Statement Modeling

Case Due: Kraft’s Cost of Capital – Submit your cost of capital workbook model via the assignment function in Blackboard before the beginning of class.

In Class Case: PPG’s Financial Model

Learning Objectives: financial statement modeling, pro forma forecasts, free cash flows, return on equity
Learning Outcomes: understand how to model financial statements to aid strategic planning and forecasting

Class 4 October 5 Time Series Analysis in Finance (students work on their own after a one hour class session)

Discussion Topics: trend models (linear and log-linear); autoregressive models; random walks; moving average models; exogenous driver models


Case Due: PPG’s Financial Model. Submit your workbook model via the assignment function in Blackboard before the beginning of class.

Learning Objectives: financial forecasting using a sample of techniques
Learning Outcomes: understand the importance of economic rationale for financial forecasts and some of the models available for modeling financial variables

Class 5 October 12 Investments – Mean-Variance Portfolio Models (students work on their own after a one hour class session)

Discussion Topics: Markowitz-Sharpe Portfolio Models

Read Before Class: Benninga: Chapters 8, 9, 10 and 12 (skim) and Portfolio Models (this reading replaces the Benninga chapters, although you’ll want to be familiar with those chapters as a reference)

Case Due: Time Series Modeling. Submit your workbook via the assignment function in Blackboard before the beginning of class.

In Class Exercise: Portfolio Models
Learning Objectives: quantitative portfolio management techniques; strengths and weaknesses; efficient markets
Learning Outcomes: understand how to apply quantitative portfolio management techniques to stocks, bonds and alternative assets

Class 6 October 19 Investments – Black-Litterman Models (students work on their own after a thirty minute class session)
Discussion Topics: Black-Litterman portfolio models

Read Before Class: Benninga: Chapter 13

Case Due: Mean-Variance Portfolio Models. Submit your Portfolio Model workbook via the assignment function in Blackboard before the beginning of class.

Learning Objectives: alternative quantitative portfolio management techniques; strengths and weaknesses; extracting implicit weights
Learning Outcomes: understand how to apply alternative quantitative portfolio management techniques to stocks, bonds and alternative assets; comparison with traditional models

Class 7 November 2 Value-at-Risk (students work on their own after a one hour class session)
Discussion Topics: Monte Carlo Historically-based VAR models

Read Before Class: Benninga: Chapter 15; In Plato’s Cave: Mathematical models are a powerful way of predicting financial markets. But they are fallible, The Economist, January 22, 2009 (available on Blackboard)

Case Due: Black-Litterman Portfolio Model. Submit your Portfolio Model workbook via the assignment function in Blackboard before the beginning of class.

In Class Case: Portfolio VAR

Learning Objectives: basics of value-at-risk analysis
Learning Outcomes: understand the pros and cons of VAR; understand the practical application of alternative VAR methods

Class 8 November 9 Option Pricing (three hour presentation and discussion)
Discussion Topics: Binomial option pricing models

Read Before Class: Benninga: Chapter 16, 17 (My advice is to read 16.1 through 16.5.2 and skim the rest of Chapter 16. After reading this material you should be able to value a European put and call options at expiration.) Then read Modeling Options.

Class Presentation: Option Pricing Theory and Practice
**Case Due:** Portfolio VaR Model. Submit your VaR workbook via the assignment function in Blackboard before the beginning of class.

**Learning Objectives:** option pricing; binomial models; implement a binomial option pricing model  
**Learning Outcomes:** understand the basics of options; how and when to use binomial pricing models

**Class 9 November 16  Option Pricing (help session only) and Neural Network Models**

**Discussion Topics:** Black-Scholes option pricing models; neural network models

**Read Before Class:** Modeling Options should be enough to get you through the assignments (skim) Benninga: Chapters 18, 19, and 20.

**Case Assignment Due:** Modeling Options. Submit your workbook model via the assignment function in Blackboard before the end of class.

**Learning Objectives:** Black-Scholes models; building a Black-Scholes user-defined function in Excel  
**Learning Outcomes:** compare and contrast binomial and Black-Scholes models

**Class 10 November 23  Bond Portfolio Management (two hour class meeting after which students work on their own)**

**Discussion Topics:** Duration and immunization strategies; term structure models

**Read Before Class:** Benninga: Chapter 25, 26, 27; Duration: A Practitioner’s View, Bob Kopprasch, *Journal of Applied Finance*, Fall 2006 p. 138 (available on Blackboard)—read primarily to get an idea of the breadth of duration measures used by practitioners; Using the Lattice Model to Value Forward Start Swaps and Swaptions by Gerald W. Buetow and Frank J. Fabozzi

**In Class Case:** Modeling immunization strategies and term structures: A Better Mousetrap. Submit your solution via the assignment function in Blackboard before the end of class.  
**Case Assignment Due:** Neural Networks. Submit your workbook model via the assignment function before the beginning of class.

**Learning Objectives:** bond price dynamics; term structures, market predictions  
**Learning Outcomes:** be able to model an immunization strategy; understand basic term structure models

**Class 11 December 7  Swaps and Bond Options (two hour class meeting followed by students completing assigned model on their own)**

**Discussion Topics:** Swaps and swap pricing; swap curves as an alternative to government bond yield curves; Neural network models in finance; Bond options
Reading Assignment: Fabozzi, Chapter 14, Analysis of Bonds with Embedded Options, Valuing Bond Options

Case Assignment Due: Do Forward Rates Predict Future Spot Rates? Submit your workbook model via the assignment function in Blackboard before the beginning of class.
In Class Case: Swap Models. Submit your workbook model via the assignment function in Blackboard before the end of class.

Learning Objectives: bond option basics; conforming models to the term structure; swap analysis and pricing models
Learning Outcomes: techniques of bond option pricing; strengths and weaknesses of swap models; swap spreads and swap curves

Class 12 December 14 Calculating Default-Adjusted Expected Bond Returns

Reading Assignment: Benninga: Chapter 28

In Class Case: Modeling expected returns of bonds with default risk using transition matrices

Case Assignment Due: Bond Option Pricing Models. Submit your workbook model via the assignment function in Blackboard before the beginning of class.
In Class Case: Bond Default Models. Submit your workbook model via the assignment function in Blackboard before the end of class.

Learning Outcomes: strengths and weaknesses of bond default models; risk partitioning