International Business 301848-00-1 Simulation Modeling with Business Applications

Course Syllabus Spring 2019

COURSE INSTRUCTOR

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COURSE LOCATION

The class is taught in Commerce Building, the Computer Room on the fifth floor in Commerce Building, on Tuesdays, during Class Periods 1-3 (officially, 8:10-11:00 AM, but we will take a short break between class periods).

COURSE OVERVIEW AND OBJECTIVES

Purpose: The goal for this course is to develop the skills needed to use and create intricate simulation models with Excel and Crystal Ball, geared toward the business community. The course will be project based, with a focus on mortgage-backed securities, securities modeling, financial statement cash flow modeling, and derivative modeling.

In today's information age, managers increasingly rely on quantitative models and big data to make financial decisions that have a profound impact on the performance of their organizations. Often business analysts produce the quantitative models that top management use to support their decision making, but top management must also understand the strengths and weaknesses of the models if they are to use them effectively to support their decisions. The objective of this course is to equip you with the frameworks, tools, and methodologies necessary to build and/or be an educated user of quantitative models for financial decision making. The course is suitable for students seeking a career in finance, but also for students with broader interests who wish to strengthen their general modelling skills.

We will help you master modelling frameworks such as regression analysis, Monte-Carlo simulation, optimization, and binomial trees; and, we will show you how to apply these frameworks in financial contexts such as portfolio management, term-structure estimation, capital budgeting, risk measurement, risk analysis in discounted cash flow models, and pricing of European, American, exotic, and real options. The modelling tools will be illustrated by applying them to a variety of real-world cases. For instance, we will use real options to carry out the valuation of a 10-year lease on a gold mine (taking into account the uncertainty in gold prices and the flexibility to choose when and how much gold to extract); we will show you how to use Monte-Carlo simulation to understand the impact of the different assumptions underlying the discounted cash-flow analysis for a new venture in the airline industry; and, we will show you how to value abandonment, expansion, contraction, and pioneer options on real-world assets.

COURSE DESCRIPTION AND COURSE PREREQUISITE

Course description (Ref: U. of Florida Syllabus of Prof. John C. Banko)

A famous Chinese proverb reads "I hear, I forget. I see, I remember. I do, I learn". The structure of the course "Simulation Modelling with Business Applications" tries to capture the wisdom of this proverb. A typical session consists of three steps. First, the instructor lectures about academic concepts from the fields of Management Science and Finance (I hear). Second, the instructor applies these concepts to a particular business situation (I see). Third, the students themselves apply the optimization and simulation concepts to a real-world business case with the help of the instructor (I do). Students who have taken this course emphasize as a strength that the course structure (lecture + example + workshop) facilitates the learning of otherwise complex quantitative models.

The software used in the course is Microsoft Excel, with the add-ins Solver for optimization and @Risk for simulation, which can be downloaded from the portal. We will discuss spreadsheet modelling best practices, and review useful spreadsheet features such as data tables, database operations, pivot tables and charts, the data analysis tool pack, and other statistical built-in functions. In addition, the use of macros to automate spreadsheet tasks will be illustrated. The table below provides a summary of the financial contexts, modelling frameworks, and spreadsheet features covered.

Financial	Modelling	Spreadsheet
contexts	frameworks	features
 Mean-variance portfolio selection Bond portfolio management Term structure estimation Capital budgeting Risk measurement Discounted cash-flow risk analysis European and American option valuation Exotic option valuation Real option valuation 	 Regression analysis Monte-Carlo simulation Linear, integer, and nonlinear optimization Binomial decision trees 	 Sensitivity analysis with data tables Creating tornado diagrams Database operations Pivot tables and charts Matrix operations Regression analysis Recording and editing macros

Course Prerequisite

The prerequisites for this course are a first course in Statistics, a first course in Financial Management, and a first course in Investments. Familiarity with the following add-ins for Excel is required: "Solver" and either "@Risk" or "Crystal Ball" for Monte-Carlo simulation. Students who do not meet these prerequisites are welcome to take the class provided they are prepared to do some additional reading to catch up. Class participation will account for 20% of the course grade and the student reports for two workshop assignments will account for 80% of the grade.

COURSE MATERIALS TO PURCHASE FROM BOOKSTORE / ONLINE

The materials for the course will be:

- 1. <u>Laptop/Excel</u>. You must have and bring a Windows-based laptop to class that has Excel. Apple will not work, since you cannot run macros in Mac OS.
- 2. You will need simulation software. You have two available:

- a. Simtools by Roger Myerson, Nobel Laureate of Economics of 2007. This is an older simulation package developed by Nobel Laureate Roger Myerson.
- b. Crystal Ball. You can download a 30-day trial from Oracle.
- 3. Coursepack from Harvard Business School Press.
- 4. Lecture Notes.
- 5. The following textbook will be utilized throughout the term: John Charnes, Modeling Financial Derivatives with Excel and Crystal Ball. The second edition of this book is available in pdf format for free from the electronic Wiley Library through NCCU library.
- 6. Several textbooks, however, can be used to complement the materials in the course pack:

• Required for each group of four participants: "Introduction to Management Science, 6th edition", by Hillier and Hillier, McGraw-Hill, 2018. This is the textbook covering the basics of modelling as well as the basics of the prerequisite tools Analytic Solver. Students should read, in particular, Chapters 4, 12, and 13 of this book.

• "Practical Management Science, Sixth Edition", by Wayne L. Winston and S. Christian Albright, Cengage, 2017.

• "Spreadsheet Modeling and Applications", by Albright and Winston, Thomson/Duxbury Press 2005. This is the textbook covering the basics of modelling as well as the basics of the prerequisite tools Solver and @Risk. Students should read Chapters 3 and 9 of this book before Sessions 3 and 5, respectively.

• Required for each group of four participants: "Management Science: The Art of Modeling with Spreadsheets, Fourth Edition", by Kenneth R. Baker, Stephen G. Powell, Wiley, 2014. This is the pedagogically sound textbook covering the seminal models including the Retirement Planning Models and Airlines Revenue Models.

• "VBA for modelers", by Christian Albright, Second Edition, Palisade 2006. This textbook provides a step-by-step guide to using VBA to build decision support systems with Excel.

• "Introduction to Probability, Second Edition" by Joseph K. Blitzstein and Jessica Hwang, Chapman and Hall/CRC, 2019. ISBN: 9781138369917. The book is highly recommended for audience without prior exposure to probability and statistics.

• Required for each group of four participants: Probability and Statistics by DeGroot and Schervish, Pearson New International

Edition, 4th edition, Paperback, 2013, ISBN: 978-1292025049. The book is highly recommended for audience without prior exposure to probability and statistics.

• "Operations Research, Tenth Edition" by Taha is highly recommended for audience to study algorithms in optimization and simulation.

7. Finance examples will be drawn from the following outstanding texts:

• "Principles of Corporate Finance Tenth Edition", by Brealey, Myers, and Allen, 2010. This is the textbook for the prerequisite core course "Corporate Finance" and covers the basic financial frameworks that are required in the course.

• "Investments by Zvi Bodie, et. al., Eighth Edition", McGraw-Hill, 2008.

• "Options, Futures and Other Derivatives, Sixth Edition", by John C. Hull, Prentice Hall 2006. This textbook is recommended for other complementary elective courses such as "Derivatives" and "Financial Engineering and Risk Management". The book is particularly useful to understand the theoretical concepts related to option valuation.

In addition, the following entertaining, easy-to-read, and informative New York Times bestseller gives a good overview of some of the characters and strategies in the quantitative finance industry:

• "The Quants: How a small band of maths wizards took over Wall Street and nearly destroyed it", by Scott Patterson, Random House Business Books 2010.

• "The Intelligent Portfolio: Practical Wisdom on Personal Investing from Financial Engines" by Christopher L. Jones, 2010. ISBN: 978-1-118-03947-2.

COURSE GRADES

Course grades will be calculated using points from each project. Our goal this term is to complete 6 projects. Each of the projects will have a few components, with different requirements, deadlines, and point assignments. Also, each of the 6 projects will have a peer review component.

Course grades will be based on the following numeric scale:

Minimum	Course
Points	Grade
90%	А

87%	A-
84%	B+
80%	В
77%	B-
74%	C+
70%	С
67%	C-
64%	D+
60%	D
57%	D-

The grade cutoffs may be adjusted down, particularly if assignments are more difficult than expected. Grade cutoffs will never be increased.

COURSE TEAM PROJECTS

Course projects will be completed in teams, usually of 4 or 5 members. You will be assigned to one team for the first half of the term, up to midterm week. And then you will be assigned to a different team for the second half of the course. Projects deliverables will be accepted for instructor's improvement suggestions. Part of the grading process is a peer review of the project.

These projects are expected to be professional work. Presentation is important. At a minimum:

- Where required, all text should be typed and presented in a case-like format.
- Spreadsheets and graphs should fit on one page or separated in a logical manner. They should be visually appealing, easy to read and incorporated into the text.
- You should include a cover page/tab with each person's name and project title.
- You should have subsections labeled with brief descriptions immediately preceding the spreadsheet and qualitative analysis.
- All spreadsheets should be labeled with a title and description.

In general, I should be able to read through the project and follow the analysis easily without referencing the assignment.

The project details may change during the course of the term. The possible projects for Spring 2019 include: "Retirement Planning" from Professor Ken Baker of Dartmouth, "Valuation of SimplexCo and ComplexCo Gold Mines" from Professor David Luenberger of Stanford, "Airlines Revenue Models" from Professor Samuel E. Bodily of Virginia, "Pro Forma Financial Forecasting" by Professor Paul M. Healy and Professor Krishna G. Palepu at Harvard Business School.

The projects of the past years include:

1. Valuation model for an MBS (300 points total)

You will be given the layout for a MBS issued by Freddie Mac. Your job is to develop a valuation of the tranches. The primary deliverable is the Excel spreadsheet. A 1-page (or so) write-up will be required to explain tranches that are complicated and deserve some discussion.

2. Performance reporting and risk evaluation (150 points total)

For this project, your team will be given a Harvard case about a small asset management firm. Your job is to develop a 1-page (single-sided or double-sided, up to you) handout that the firm would use to summarize its investment philosophy and performance for the two funds it operates. These are known as "tear sheets". You can (kind of) see examples of such 1-page documents by running a search for a "sample tear sheet" on any of the internet search engines.

I realize this is likely the first time many of you will tackle such an assignment. Your primary job is to get the numbers right – calculate the various portfolio fund performance measures as outlined in the case (correctly) and think about how to present them in a meaningful way. This will be an intermediate deliverable for this project.

More importantly, I want to see the performance report directly tied to the spreadsheet. If I update numbers on the spreadsheet, the performance report is updated as well. From there, develop bells and whistles to make the spreadsheet and report more usable and user-friendly.

The deliverable is the spreadsheet and the report that the spreadsheet creates.

3. Additional Funds Needed model (150 points total)

You will be given the financials and other relevant data for a corporation and/or a scenario. The project involves developing a model to determine the funding needs of the company. Valuation impact based on using debt versus equity will be examined. The deliverable is a 2-3 page executive summary of the results and scenarios. Results from your Excel spreadsheet should be incorporated as Exhibits, Tables, and/or Charts. The full spreadsheet will be also handed-in.

4. DCF / Pitchbook competition (150 points total)

Your team will be responsible for researching a firm and developing a DCF valuation of the firm. Then, your team will update a Powerpoint "pitch" presentation. You will then record a 10-minute presentation of the pitch. The deliverables will be the video and the PPT presentation.

5. Derivatives project (150 points total)

Details and deliverables TBA.

6. Creative case development/presentation and model (100 points total)

For the final project, your team will develop a spreadsheet model of your choice. Your team will develop the project scope and deliverables, and your team will present your project to the class via a prerecorded 10minute presentation. The deliverables will be the video and spreadsheet.

For all cases, peer evaluations (of part of the project) are required. A 5-point penalty will be assigned for a late (by less than 24 hours) peer evaluation. A 10-point penalty will be assigned after 24 hours. Needless to say, this is a critical component of this class.

Course Schedule

Session 1 DIntroduction to Financial Modelling and Spreadsheet Essentials

Frameworks and concepts covered

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- Course mechanics
- Introduction to financial modelling
 - \circ Strengths and weaknesses of spreadsheets
- Six golden rules of spreadsheet design

- \circ Do we make the most of modelling?
- Spreadsheet essentials
 - \circ Lookup and reference functions
 - $_{\odot}$ NPV and IRR functions
 - \circ Data tables
 - \circ Database manipulation

Session 2 DMeasuring Risk

Frameworks and concepts covered

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- Estimating betas with regression analysis
- Using daily, weekly, and monthly data
- Testing market efficiency
- With regression analysis
- With pivot tables
- Recording and editing macros

Preparation

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Read "Modern Risk Measurement".

Sessions 3 and 4 Portfolio Optimization

Frameworks and concepts covered

- Mean-variance portfolio selection
- Computing mean-variance portfolios
- Back-testing portfolio performance
- Research on portfolio selection
- Bond portfolio selection
- Term structure estimation

- Capital budgeting
- Spreadsheet features
- Matrix operations in Excel
- \circ Using Solver for optimization
- $_{\odot}$ Using macros to generate the efficient frontier

Preparation

Students who are not familiar with Solver need to read the following sections of

Albright and Winston before class: 3.1, 3.2, 3.3, 3.4, 3.7, 3.8, 4.1, 4.7, 6.1, 6.2, 6.3, 7.1, and 7.2.

Session 5 🗆 Advanced risk analysis

Frameworks and concepts covered

- Monte-Carlo simulation
- Risk analysis of discounted cash flow models
- Case: London European Airways
- Spreadsheet features
- $_{\odot}$ Using @Risk for Monte-Carlo simulation
- \circ Combining macros with @Risk

Preparation

Students who are not familiar with @Risk should read "Allowing for Risk in Spreadsheet Models--A Tutorial on Risk Analysis with @Risk", and Chapter 9 of Winston and Albright before class.

Session 6 Workshop Assignment on Portfolio Optimization

For this session, we will meet directly at the computer laboratory. The workshop assignment will be distributed, and the students will work in pairs on the assignment with the help of the professor and tutors.

Frameworks and concepts covered

The assignment will build on the concepts covered in Sessions 3 and 4. Specifically, the students will have to build a Solver model to deal with a portfolio management situation.

Preparation

Students who are not familiar with Solver need to read the following sections of Albright and Winston before class: 3.1, 3.2, 3.3, 3.4, 3.7, 3.8, 4.1, 4.7, 6.1, 6.2, 6.3, 7.1, and 7.2.

Session 7 DAmerican Option Valuation

Frameworks and concepts covered

- Review of options
- Binomial trees
- Risk neutral valuation
- American option valuation
- Estimating stock return volatility
- · Matching volatility with a binomial tree

Session 8 DWorkshop Assignment on Real Option Valuation with Binomial Trees

For this session, we will first have a short lecture and then we will move to the computer laboratory. The workshop assignment will be distributed, and the students will work in pairs on the assignment with the help of the professor and tutors.

Frameworks and concepts covered

- Real options
- Valuing an internet start-up with real options

Session 9 Black-Scholes Formula and Exotic Option Valuation

Frameworks and concepts covered

- Black-Scholes formula
- Pricing European options
- Estimating implied stock return volatilities
- Simulating stock price evolution with Monte-Carlo simulation
- Exotic option valuation with Monte-Carlo simulation
- Knockout options
- Lookback options
- \circ Asian options
- As-you-like-it options

Session 10 DReal Option Valuation with Monte-Carlo Simulation

For this session, we will first have a guest speaker and then we will move to the computer laboratory to work on real-option valuation with Monte-Carlos Simulation.

Frameworks and concepts covered

Real Option Valuation with Monte-Carlo Simulation

ADDITIONAL COURSE INFORMATION

Reference 1: U. of Florida Syllabus of Prof. John C. Banko. Reference 2: London School of Business Syllabus of Prof. Victor DeMiguel.