MFIN 706 Computational Finance

DeGroote School of Business McMaster University

Course Outline Fall, 2022

COURSE OBJECTIVE: To introduce key computational methods and practical resources that are widely used to solve quantitative problems in investment decisions and financial risk management.

Method and Scope: The course is designed to guide the students through a set of practical problems and projects that are done on a computer programming environment. There is no requirement for prior coding experience, however students are expected to dedicate time to build programming and data analysis skills throughout the term. Mathematical and financial concepts will be briefly discussed and explained in class. Then, related programming and data resources will be presented.

Students are expected to employ computational tools to deliver solutions to issues encountered in areas such as risk analysis, portfolio construction, strategy back-testing, optimization, derivative pricing and asset pricing models. There will be weekly assignments and a term project.

Students are also expected to raise their level of knowledge on recent developments in the global financial markets. It is important for the Master of Finance students to develop a background on the policy, political economy and market dynamics.

Quantitative methods are often useless without a qualitative context.

INSTRUCTOR AND CONTACT INFORMATION

Instructor Name: Mehmet Beceren, Ph.D.

Email: becerenm@mcmaster.ca

TAs: Hamidreza Masoumi & TBA

COURSE DESCRIPTION

Topics of study will cover some common quantitative methods used in portfolio construction, optimization, numerical simulation methods, measures of risk, derivative pricing, factor-based risk models, quantitative strategy back-testing, yield curve fitting, interest rate models, and credit risk models. The lectures will also touch on recent developments in Fintech and machine learning methods.

This course is designed to improve applied quantitative skills of students. Open-source coding will be the primary tool. The focus will be to develop data analysis and programming capabilities. MFIN 706 students will have an opportunity to use their theoretical knowledge and computer skills to work on various projects.

Timely, neat, and coherent work will be rewarded in a 'business-like' setting. Untidy, unclear, and delayed delivery will not be accommodated.

The main programming tool will be **R** and **RStudio**. **Python** examples will also be presented but the coursework will require coding in R only.

R programming language provides a free, open-source development environment with many powerful tools. MS Excel will also be handy. Bloomberg and Refinitiv (if available) will be used as a data source, as a pricing tool and a risk analysis platform. An account for Wharton Research Database (WRDS) through the library will be set up to access historical financial data as well.

Additionally, current developments in global financial markets and topical business cases will be discussed.

COURSE MATERIALS AND READINGS

There is no required textbook.

Suggested reference text books are as follows.

- **R Programming and Its Applications in Financial Mathematics** *by Shuich Ohsaki, J. Ruppert-Felsot, D. Yoshikawa, CRC Press, 2018*
- **Computational Finance – An Introductory Course with R**, *by Argimiro Arratia, Atlantis Press*
- **Active Portfolio Management***, by Richard Grinold and Ronald Kahn, MaGraw Hill*
- **An Introduction to Statistical Learning with Applications in R**, *by Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani*
- **Handbook of Financial Risk Management***, by N.H Chan, H.Y. Wong*
- **Python for Finance Cookbook,** *by Eryk Lewinson, 2020*
- **Mastering Pandas for Finance,** *by Michael Heydt, 2015*
- **Financial Risk Management and Financial Institutions** *by John C. Hull, John Wiley & Sons*

COURSE SCHEDULE MFIN 706

Approximate Course Program:

Broad Topic and Approximate Week	Specific Topics of Discussion
Introduction: ***Week # 1***	Programming and Data Logistics: RStudio IDE tips and examples, Python/Anaconda/Spyder/ Jupyter Notebooks Fields of Computational Finance: Summary of key topics and discussion of projects Simulations of simple stochastic processes
Portfolio Risk Models and Analysis ***Week # ~ 2, 3***	Further examples of stochastic process simulations Common approaches for portfolio risk analysis, CAPM and APT model summary Single-factor and multi-factor models Estimation of risk exposures and covariance matrices Factor-based investment products and portfolio selection Back-testing simple factor models and rule-based portfolios
Interest Rate Models ***Week # ~3, 4***	Stochastic Interest Rate Models & Parametric Yield Curve Models Credit Risk Models (KMV etc.)
Credit Risk **Week ~4, 5**	Credit Risk Models (KMV etc.) Project Discussions
Derivatives Pricing ***Week #: ~ 6, 7***	Numerical Methods in Equity Option Pricing, Delta Hedging Examples, Binomial tree models etc. Interest Rate Derivatives Examples Exotic Options, Structured Products Volatility Models
Optimization Applications **Portfolio Optimization** **Decision Trees** **Index Tracking** **Week #: 8~9**	Quadratic optimization algorithms Search algorithms Mean-var optimal portfolios Optimization with nonlinear risk, group and allocation constraints Curve fitting and index tracking examples
Numerical Simulations of Multi-Asset Portfolios ***Week #: ~ 9&10***	Monte-Carlo techniques, Var-Cov Assumptions, Covariance/Copula Models Examples with Equity/Credit/Bond Portfolios

	Fintech Developments and Examples (time permitting)
Statistical Learning and Pattern Recognition Basics ***Week # ~ 10-11***	Basic discussion on the concepts behind so called Machine Learning, Introduction to programming tools & resources in R and Python Limits and fallacies about machine learning in finance: Artificial Intelligence or Computerized Ignorance?
Project Presentations	Last Class

EVALUATION GUIDELINE

Weekly (9 or 10) Assignments *(with different weightings according to difficulty level*)	**67%**
Term Project	**33%**
Total	**100%**

Late assignments will not receive full mark. A significant discount will be applied according to the severity of delay.

Communication and Feedback

Students who wish to correspond with instructors or TAs directly via email must send messages that originate from their official McMaster University email account. This protects the confidentiality and sensitivity of information as well as confirms the identity of the student.

Emails regarding course issues should NOT be sent to the Area Administrative Assistants.

Instructors are required to provide evaluation feedback for at least 10% of the final grade to students prior to Week #9 in the term. Instructors may solicit feedback via an informal course review with students by Week #4 to allow time for modifications in curriculum delivery.

ACADEMIC INTEGRITY

You are expected to exhibit honesty and use ethical behaviour in all aspects of the learning process. Academic credentials you earn are rooted in principles of honesty and academic integrity. Academic dishonesty is to knowingly act or fail to act in a way that results or could result in unearned academic credit or advantage. This behaviour can result in serious consequences, e.g. the grade of zero on an assignment, loss of credit with a notation on the transcript (notation reads: "Grade of F assigned for academic dishonesty"), and/or suspension or expulsion from the university. It is your responsibility to understand what constitutes academic dishonesty.

For information on the various types of academic dishonesty please refer to the Academic Integrity Policy, located at:

www.mcmaster.ca/academicintegrity

The following illustrates only three forms of academic dishonesty: 1. Plagiarism, e.g. the submission of work that is not one's own or for which other credit has been obtained. 2. Improper collaboration in group work. 3. Copying or using unauthorized aids in tests and examinations

REQUESTING RELIEF FOR MISSED ACADEMIC WORK

Students may request relief from a regularly scheduled midterm, test, assignment or other course components. Please refer to the policy and procedure on the DeGroote website at the link below;

http://ug.degroote.mcmaster.ca/forms-and-resources/missed-course-work-policy/

STUDENT ACCESSIBILITY SERVICES

Students who require academic accommodation must contact Student Accessibility Services (SAS) to make arrangements with a Program Coordinator. Academic accommodations must be arranged for each term of study. Student Accessibility Services can be contacted by phone 905-525-9140 ext. 28652 or email sas@mcmaster.ca. For further information, consult McMaster University's Policy for Academic Accommodation of Students with Disabilities:

http://www.mcmaster.ca/policy/StudentsAcademicStudies/AcademicAccommodationStudentsWithDisabilities.pdf

ACADEMIC ACCOMMODATION FOR RELIGIOUS, INDIGENOUS OR SPIRITUAL OBSERVANCES (RISO)

Students requiring academic accommodation based on religious, indigenous or spiritual observances should follow the procedures set out in the RISO policy. Students requiring a RISO accommodation should submit their request, including the dates/times needing to be accommodated and the courses which will be impacted, to their Faculty Office normally within 10 days of the beginning of term or to the Registrar's Office prior to their examinations. Students should also contact their instructors as soon as possible to make alternative arrangements for classes, assignments, and tests.

POTENTIAL MODIFICATION TO THE COURSE

The instructor reserves the right to modify elements of the course during the term. There may be changes to the dates and deadlines for any or all courses in extreme circumstances. If either type of modification becomes necessary, reasonable notice and communication with the students will be given with explanation and the opportunity to comment on changes. It is the responsibility of the student to check their McMaster email and course websites weekly during the term and to note any changes.

ACKNOWLEDGEMENT OF COURSE POLICIES

Your enrolment in MFIN 706 will be considered as implicit acknowledgement of the course policies outlined above, or of any other that may be announced during lecture and/or on A2L. It is your responsibility to read this course outline, to familiarize yourself with the course policies and to act accordingly. Lack of awareness of the course policies cannot be invoked at any point during this course for failure to meet them. It is your responsibility to ask for clarification on any policies that you do not understand.