Financial engineering at Columbia University

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1. Introduction

Columbia University is home to a vibrant community of financial engineering research and education. Faculty and students from business, engineering, mathematics and statistics share classes and collaborate on research in all areas of quantitative finance, including derivative securities, risk management, portfolio optimization, trading strategies, asset pricing, computational methods and econometrics. Faculty expertise, recognized through numerous awards and publications, covers the whole range from theory to practice. Columbia also takes full advantage of its New York location, drawing on expert practitioners for teaching, seminars, conference participation, research collaborations and internships for students. This overview of financial engineering at Columbia describes degree programs and research activities and highlights some connections with industry.

2. Degrees and programs

Columbia regards financial engineering (FE) as a multidisciplinary field integrating financial theory with economics, methods of engineering, tools of mathematics and the practice of programming. The university offers many programs that focus on financial engineering or related skills, at levels ranging from undergraduate to PhD.

The Department of Industrial Engineering and Operations Research (IEOR) in the School of Engineering and Applied Science (SEAS) offers a flagship Master of Science in Financial Engineering, a twelve-month program that offers an initial core education in financial engineering techniques followed by a variety of electives from both the buy- and sell-side, taught by IEOR and Business School faculty with the assistance of adjuncts who work in the financial industry in New York. There are typically about 60–80 students graduating a year who come from all parts of the world, including large numbers from Asia and Europe. Many of the 150 or so students pursuing a Master of Science in Operations...

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Research also focus on financial applications. Columbia also offers a Master of Arts in Financial Mathematics, administered by the Mathematics Department and the Statistics Department.

At a more advanced level, IEOR offers a PhD in Operations Research in which many of the theses written are on financial engineering and computational finance. The Business School’s Decision, Risk and Operations Division offers PhD study and research in financial engineering and operations research applied to financial decision making, and the Finance and Economics Division offers doctoral studies in financial economics. Many PhD students in Mathematics and Statistics also choose financial topics for their research. Doctoral students in one department frequently choose to work with faculty in another department.

For undergraduates, IEOR offers an OR degree with a major in FE that has become increasingly popular with students seeking to get into the field early.

A majority of our students at all levels are placed in the New York area in buy- and sell-side positions at major investment banks, hedge funds, money management and financial technology companies. However, graduates have been placed all over the world, including London,
Graduate School of Business, Columbia University.

Engineering terrace, Columbia University.
Hong Kong, Tokyo, Mumbai, Bangkok, Toronto, Singapore and Paris, and various locations in the United States. Columbia also has an excellent placement record for PhD students who pursue academic careers.

3. Research

Columbia faculty and students are active in studying modeling, computational, and empirical issues in all major areas of financial engineering, including asset pricing models; volatility modeling and volatility derivatives; credit risk and credit derivatives; fixed income markets; commodities; path-dependent options; risk measures and risk management; asset allocation; empirical asset pricing models; model calibration; corporate finance; and the theoretical foundations of mathematical finance. Some recent research projects address topics related to the financial crisis, such as hedge fund management; systemic risk and contingent capital; behavioral finance; real estate finance; and longevity risk. With advances in information technology, high frequency trading and algorithmic trading have also gained increasing research attention. There is also a growing interest for applying financial ideas to engineering management.

Several faculty members bring expertise in related methodological issues, such as stochastic processes, Monte Carlo simulation, numerical analysis, statistical inference, robust optimization, and stochastic optimization. Many ideas and techniques developed by Columbia financial engineering faculty are now widely used in the industry, and several books and articles written by Columbia faculty members have become standard references in the field.

Honors and awards received by Columbia financial engineering faculty members include: the IAFE/Sungard Financial Engineer of the Year, Risk Magazine’s Quant of the Year Award, the Lanchester Prize, the Erlang Prize, Presidential/NSF Young Investigator Awards, NSF Faculty Career Award, and the Wilmott Award for Cutting-Edge Research in Quantitative Finance. Jointly, the faculty members are on the editorial board of more than a dozen leading journals in financial engineering and related fields, including Mathematical Finance, Finance and Stochastics, SIAM Journal on Financial Mathematics, Journal of Computational Finance, Quantitative Finance, Management Science, Operations Research, Mathematics of Operations Research, Advances in Applied Probability, and Journal of Applied Probability.

4. Industry connections

Columbia has many connections with industry, thanks in part to our location in the heart of New York City, the financial capital of the world. Through conferences and seminars, industry liaisons, adjunct teaching and guest speakers, students and faculty have opportunities to interact closely with finance professionals in many formal and informal settings.

Columbia’s flagship financial engineering conference has run annually for over fifteen years. The conference brings together speakers from industry and academia together with an audience of students, faculty and industry professionals. Past speakers have included winners of the Nobel prize and Financial Engineer of the Year award. Columbia is a co-sponsor of the New York Quantitative Finance seminar series, which meets about once per month in a downtown location and draws a large industry audience. Columbia also runs a weekly practitioner seminar series on campus that is open to the public and is held in the early evenings for the convenience of all participants. Students and faculty can keep up-to-date with the latest developments through these frequent seminars and conferences.

Research and teaching collaborations with industry occur in small and larger scales. Individual faculty members often participate in joint research projects with counterparts in industry. More formal connections between groups of faculty members and industry also occur, as in the case of research partnerships with Credit Suisse and JP Morgan. Columbia also plays a leadership role, and collaborates with, the industry groups PRMIA and ERMII. PRMIA, the Professional Risk Managers’ International Association, with over 70,000 members, promotes risk management standards and practices. PRMIA has partnered with Columbia to provide classroom training in the latest advances in risk management theory and practice. Columbia is a founding member of ERMII, the Enterprise Risk Management Institute International, whose mission is to provide education, research and training in ERM.

Many financial engineering courses at Columbia, including risk management, algorithmic trading, computational finance and many others, are taught by expert adjunct professors from industry. Courses taught by full-time faculty often bring traders, researchers, and risk managers to present individual guest lectures. Columbia and the Portfolio Management Institute (PMI) offer a Certified Portfolio Manager (CPM) program.

5. Concluding remarks

Columbia’s interdepartmental community of faculty, students and practitioners in financial engineering has unparalleled breadth. Virtually all aspects of quantitative finance are represented on the campus, which provides an energetic environment for research and education with the flexibility to stay at the cutting edge of this dynamic field.