



Principles and practices for
an evolving global economy

Finance

at MIT Sloan





FINANCE HAS A PROUD AND LONG TRADITION

at MIT. But the world of finance and the challenges faced in today's markets are changing and so are the faces of finance at MIT. My colleagues continue to be thought leaders with groundbreaking research and ideas that impact the world. This is reflected in many new initiatives the Finance Group is spearheading like the MIT Center for Finance and Policy under the leadership of Professor Deborah Lucas, the CancerX initiative headed by Andrew Lo or our work in entrepreneurial finance in emerging markets. You'll read about some of the remarkable research that is being worked on through these centers in this brochure.

The teaching of finance in the classroom is also changing at MIT Sloan. While we are committed to our tradition of exposing students to cutting edge research, we complement the learning of fundamental concepts with an opportunity to apply these tools in real world settings through our action learning and practice of finance courses. Our Master of Finance Program, now completing its fifth year, is the most selective program at MIT Sloan and was ranked #1 by *The Financial Engineer* in 2015, its first year eligible for ranking. We are excited about welcoming the graduates from this new "asset class" into our family of alumni.

MIT Sloan plays a role in defining the future of finance and we are eager to engage with alumni and friends of the School in sharing our faculty's perspectives on the evolving global economy. We recently created the MIT Sloan Finance Forum series, which brings faculty presentations on cutting-edge research to alumni audiences around the world. We hope to welcome you at one of these upcoming events.

At MIT Sloan, our finance faculty remains excited to advance the frontier of finance to propose innovative solutions for the challenges of the future.

ANTOINETTE SCHOAR
Michael M. Koerner (1949) Professor of Entrepreneurship
Finance Group Head

The science and art of finance

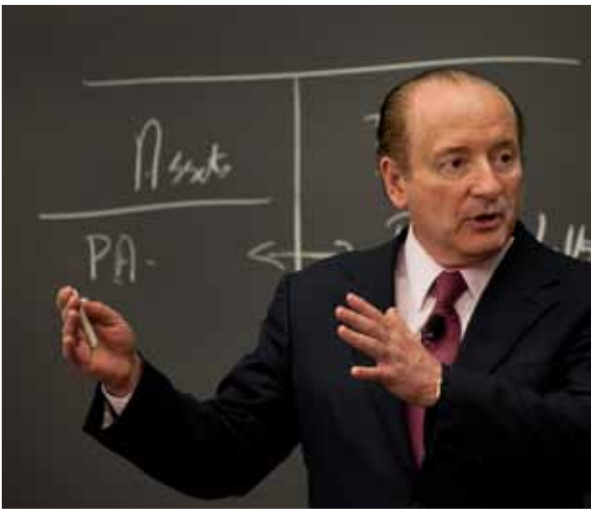
Perhaps Nobel laureate Robert C. Merton, PhD '70, coined it best when he stated that “finance is truly global; it doesn't have meaningful borders.” His comment is rooted in undeniable truth, as finance has become inextricably intertwined with commerce and economic growth, and financial innovation is a prerequisite for expansion and prosperity. As witnessed in recent years, a lack of financial expertise can also lead to disaster.

With the consequences of the world's financial crisis still reverberating, Merton and his colleagues within MIT Sloan's Finance Group teach and train students in the science and art of finance so they are prepared to lead in both the private and public sectors. At the same time, senior and junior faculty members continue MIT Sloan's proud legacy of financial expertise by conducting groundbreaking research with far-reaching global impact.

The MIT Sloan School of Management has been a pioneer in the scientific study of finance, beginning in the 1960s with Paul A. Samuelson's pathbreaking formulations of efficient markets, dynamic portfolio choice, and long-run risks. Over the past 40 years, faculty members in the Finance Group have pushed the frontiers of finance into many new areas, including corporate financial policy, real options, entrepreneurial finance, derivatives pricing, term structure models, financial regulation, banking and macro-finance, continuous-time general equilibrium theory, financial econometrics, and behavioral finance and neuroeconomics.

Today, the Finance Group consists of full-time and affiliated faculty members engaging in a broad array of research agendas aimed at deepening the understanding of the dynamics of the global financial system. The MIT Sloan Finance Group also offers the following educational programs:

- MBA Finance Track
- Master of Finance Program
- PhD Program in Finance
- Undergraduate Major and Minor in Finance
- Executive Education Programs in Finance



ROBERT C. MERTON
School of Management Distinguished Professor of Finance

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The landscape of retirement finance is undergoing dramatic changes because of large demographic transitions and institutional adjustments. Robert Merton's current research focus is on addressing the global challenge of retirement funding, including lifecycle investing, reverse mortgage design, funding and marketing, and enabling regulation; the dynamics of financial institutional change and financial innovation; improving the methods of measuring and managing macro-financial risk; financial policy issues such as "too big to fail" and contingent-capital instruments to avoid the dysfunctional impact of default on financial system customers.

The legacy of finance at MIT Sloan

The MIT Sloan Finance Group was founded in the late 1960s, long before many other business schools recognized finance as a distinct field of study. Thanks to the intellectual contributions of Paul A. Samuelson and the academic leadership of William Pounds (MIT Sloan Dean, 1966–80), the Finance Group coalesced into a small but influential collection of scholars with a common interest.

Pioneers of this academic unit became the pioneers of modern finance and have received an impressive collection of awards, including several Nobel Prizes. Thanks to the work of Fischer Black, John Cox, Robert Merton, Franco Modigliani, Stewart Myers, and Myron Scholes, many breakthroughs in financial economics are associated with MIT faculty, including: the Black-Scholes/Merton option-pricing model; the Modigliani-Miller theorems; continuous-time models of consumption and portfolio choice; applications of option-pricing theory to real investments, corporate finance, and other real options; equilibrium models of the term structure of interest rates; binomial option pricing; and the risk-neutral pricing kernel for pricing derivative securities. Peter Bernstein's lively accounts of the historical origins of modern financial economics—*Capital Ideas* and *Capital Ideas Evolving*—memorialize a number of these contributions, and some of the colorful personalities behind them.

The Finance Group today

Today, the MIT Sloan Finance Group consists of full-time tenure-track faculty, visiting faculty, adjunct faculty, and senior lecturers. Our research program is diverse, spanning all the sub-disciplines that financial economics has produced over the last four decades, including theory and empirical analysis; capital markets and corporate finance; financial institutions; macrofinance; risk management; financial regulation; and behavioral finance and neuroeconomics. Although expansive, the research agendas of our faculty share the common principles of scientific inquiry, with the goal of developing a systematic understanding of financial phenomena that will stand the test of time.

MIT Sloan Finance Forums

Continuing the MIT Sloan tradition of bringing new perspectives to modern finance, the School recently launched the MIT Sloan Finance Forum series. These events bring faculty presentations on cutting-edge research to alumni audiences around the world and focus on the role of MIT Sloan in defining the future of finance. Past forums have been held in many of the world's business centers, including New York, London, Shanghai, and Boston.

Each forum also includes a panel of alumni and friends of MIT Sloan who are leaders in their industry. Through moderated discussion, panelists have shared their perspectives on important and evolving topics in finance such as:

- Financing Innovation
- Financial Reform
- Growth of Emerging Markets
- Hedge Funds 2.0
- Systemic Risk





FELIPE SEVERINO, PhD '14
Assistant Professor, Tuck School of Business, Dartmouth College

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“MIT is the place where modern finance was born, being a student here was a life changing experience. The close interaction with scholars on the frontier of knowledge and the ability to learn from amazing peers is what makes MIT a unique and special place.”

Academic opportunities in finance

Like MIT itself, MIT Sloan draws its power from a paradox: it is a place for visionary pragmatists, for hands-on thinkers, for people who dream of changing the world and have the plan and the passion to make it happen. True to MIT's motto of *mens et manus* (“mind and hand”), MIT Sloan is the world leader in combining theory and practical application to both enhance careers and improve the world.

MIT Sloan has a global reputation for its commitment to balancing theory and practice. We offer unsurpassed management education to top students from around the world, including several avenues for those students desiring a focus on finance.



AJAMU KITWANA, MBA '12

Consumer Prosperity Program Manager, ESL Federal Credit Union

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"I became interested in the Finance Track at MIT Sloan as a prospective student researching MBA programs. As a career changer, I liked that the Finance Track offered a deep dive into finance that I could customize to my individual interest. The finance faculty is committed to meet the practical needs of MIT Sloan students, and the Track provides an introduction to finance recruiting, access to finance professionals, and real perspective on what to expect in finance careers. It provides the tools necessary to be successful short term in recruiting and long term in building a career in finance."

MBA Finance Track

Within MIT Sloan's MBA program, the Finance Group offers the Finance Track, which consists of required courses, electives, and extracurricular activities designed to prepare students for careers in the financial industry. Any MBA candidate may elect to participate in the Finance Track and, upon completion of the requirements, will receive a Certificate in Finance. The Finance Track aims to expose students to the institutions and practices of the financial world, ground students in the principles of finance theory and in the application of theory to real problems, and provide students with an overview of professional opportunities in finance.

An introductory seminar, Introduction to the Practice of Finance, is the gateway to the Finance Track, where students are exposed to some of the basic institutions and practices of the financial industry, including panel discussions with representatives from various financial organizations, MIT alumni currently working in financial services, and leading industry vendors.

For more information:

<http://mitsloan.mit.edu/finance/programs/mba.php>

The Practice of Finance Series

Financial economics is, by definition, an applied field of study in which industry practices and structure are important inputs to research and teaching activities. To ensure that our curriculum reflects the very best of both theory and practice, we have created a collection of courses called the Practice of Finance seminar series, in which leading practitioners provide our students with their unique business perspectives on a broad range of topics.

Practice of Finance seminars include:

- Advanced Corporate Risk Management
- Alternative Investments:
 - Private Equity and Hedge Funds
- Applied Credit Risk Modeling
- Corporate Boards:
 - Their Responsibilities and Functions
- Data Technologies for Quantitative Finance
- Managing Risk in the Banking System
- Perspectives on Investment Management
- Strategic Management of Financial Institutions

For more information: <http://mitsloan.mit.edu/group/finance/finance-seminars.php>



TRUDY PHAM, MFIN '15

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“Studying in the MFin program, I have had countless opportunities to interact with some of the most distinguished Finance professors in the field. I learn not only from their intellect and far-reaching contributions to academia, but also get inspired by their down-to-earth manner coupled with a serious passion to bridge the gap between finance theories and practice. To top the experience is the engaging diversity of the MFin cohort, exemplified by their collaboration, high caliber, and entrepreneurial spirit. Altogether, the MFin program has empowered me as I embark upon the next stage of my career in financial services.”

Master of Finance

The Master of Finance (MFin) program is designed to produce highly skilled finance professionals with the necessary theoretical and empirical training to make a difference in virtually every sector of industry and government. MFin provides students a comprehensive overview of finance as it applies to both the public and private sectors, while imparting an appreciation of the ethical implications of finance, including the profession's responsibility to society.

Designed to prepare students for careers in finance, this specialized program consists of required and elective courses and an optional master's thesis. As part of the School's commitment to action learning, MFin students also participate in a proseminar and finance research practicum where student teams work collaboratively on complex finance issues posed by external sponsors. These projects serve to strengthen new and existing partnerships with potential employers.

In addition to the traditional synergies among economics, finance, and accounting, the MFin takes advantage of intellectual ties between finance and mathematics, statistics, operations research, computer science, and engineering expertise at MIT.

For more information:
<http://mitsloan.mit.edu/academic/mfin/>

Leadership Development Program

One of the goals of the MFin program is to develop the next generation of global financial leaders. The Leadership Development Program (LDP) is a unique opportunity, created in collaboration with the MIT Leadership Center, designed to provide MFin students with appropriate leadership skills training and development. To complement the training, LDP provides opportunities for practical application experiences while at MIT to prepare them for future roles.



SAMAN MAJD, PHD '85
Former Vice Chairman, Deutsche Asset Management

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"Times change and new challenges crop up, but the one thing that remains constant is the way of thinking about problems that MIT Sloan has taught me. This, more than the technical training, is what I value most from my experience at MIT."

Doctoral Program in Finance

For individuals interested in research careers in academic finance, the MIT Sloan Finance Group offers a PhD program that provides students with an understanding of the theory on which the field is based, as well as the tools they need to conduct theoretical and applied research.

Once required coursework is completed, doctoral students in Finance are free to develop their programs of study and research with the guidance of faculty members. Often, the faculty offers students an opportunity to participate in and expand on faculty research interests.

As differentiators, students cite the smaller, personalized program; the outstanding faculty; and the opportunity to realize one's potential as a leading researcher in the area of finance. MIT Sloan's program is also unusual in that the required courses in the first two years are taken together with candidates in MIT's Economics PhD program, allowing a wide range of curricular choices while expanding cross-collaboration and peer interaction with other doctoral candidates. Additional advantages include the breadth of research interests within the Finance Group, the collaborative work with faculty on joint research projects, and the opportunities presented by the proximity of other leading universities and the National Bureau of Economic Research.

For more information:

<http://mitsloan.mit.edu/group/finance/finance-phd.php>

Undergraduate Program

MIT Sloan School of Management today offers an undergraduate major and minor in finance. Both programs delve into finance theory, the analytics of finance, and corporate financial accounting, among other offerings.

The Finance Group offers two laboratory courses that give undergraduate students the opportunity to work on team projects that emulate an experience typical of a finance summer internship.

- 15.417 Laboratory in Investments
- 15.418 Laboratory in Corporate Finance

For more information:

<http://mitsloan.mit.edu/undergrad/>



DEBORAH LUCAS
Sloan Distinguished Professor of Finance
Director, MIT Center for Finance and Policy

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Governments are the world's largest financial institutions, with investment and insurance operations that dwarf those of the largest private banks. Despite their central role in allocating capital and risk, surprisingly, little research has focused on government financial institutions and the unique challenges they face. Deborah Lucas and her co-authors are working to bridge that knowledge gap through research being conducted at the MIT Center for Finance and Policy. Her recent work on valuation practices by OECD governments finds a systematic bias in how governments evaluate their cost of capital, and illustrates the size of the resulting distortions. The analysis suggests methodologies and accounting changes that governments could adopt to increase transparency and improve the efficiency of their investment choices.

Labs and Centers

Center for Finance and Policy

The MIT Center for Finance and Policy (CFP) is an Institute-wide initiative, conceived by MIT Sloan's Finance Group. The CFP's mission is to serve as a catalyst for innovative financial research and educational initiatives that will positively impact policy and society. CFP initiatives will:

- Create incentives for top-notch scholars, both students and established researchers, to undertake innovative research, data collection and analyses that will lead to improved decision-making by policy-makers and regulators, and greater transparency of government financial institutions.
- Create new educational materials and curricula that make financial education relevant and accessible to students of public policy, employees of public institutions, and policymakers.

Research supported by the CFP is organized into three main tracks:

1. Evaluation and management of government financial institutions;
2. Regulation of financial markets and institutions; and
3. Measurement and control of systemic risk.

As part of its educational mission, the Center sponsors a Distinguished Speaker Series that brings top policymakers to campus to share their perspectives, and hosts periodic conferences that bring together academics, practitioners and policymakers.

Visit the CFP website for more information: <http://cfp.scripts.mit.edu/home/>



ANDREW LO
Charles E. and Susan T. Harris Professor
Director, MIT Laboratory for Financial Engineering

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Combining portfolio optimization and securitization techniques, Andrew Lo and his co-authors have proposed financial “megafunds” to fund biomedical innovation. They show that by pooling biomedical R&D projects into a single portfolio, risk can be reduced and the probability of at least one or two successes increased to attract larger pools of capital from insurance companies, mutual funds, pensions, and other institutional investors. Cancer and rare diseases provide two compelling cases for how such a private-sector megafund might work, while Alzheimer’s disease offers a contrasting case where a public-private partnership may be necessary.

Student Research Projects

A key component to the success of the LFE is its engagement of graduate and undergraduate students from across the Institute, each of whom brings great enthusiasm and unique skills to their particular research projects. At the LFE, they gain experience crafting research ideas from conception to publication, working with big data and various computational techniques, giving professional talks, and interacting with collaborators and sponsors, all of which helps to prepare them for their post-MIT endeavors.

MIT Laboratory for Financial Engineering

The MIT Laboratory for Financial Engineering (LFE) is a research center created as a partnership between academia and industry, designed to support and promote research in financial engineering and computational finance.

The principal focus of the LFE is the quantitative analysis of financial markets using mathematical, statistical, and computational models. The goal of the LFE is not only to spur academic advances in financial engineering, but also to reach out to students, industry professionals, regulators, and policymakers to support their applications of financial technology in practical settings.

LFE research projects fall into five distinct subject areas:

- Foundations of Investor Behavior and Adaptive Markets
- Risk Management and Systemic Risk
- Healthcare Finance
- Big Data and Financial Technology
- Hedge Funds and Asset-Market Dynamics

For more information: <http://lfe.mit.edu>



TAREK ELDIN
Head of Research, Geode Capital Management
Finance Research PracticumSM Project Sponsor

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“We have sponsored projects in the MIT Finance Research Practicum for the past three years, and the experience has far exceeded our expectations. The teams showed great enthusiasm and talent, and delivered more than we hoped for in a short amount of time. Some of their work became the basis of features we now use in our production models. As importantly, we are actively using the program for intern and analyst hires. Overall, the practicum is an excellent idea well executed.”

Action learning

A deep dive into finance

MIT Sloan serves as the leader in action learning in management education, with an approach that integrates theory, real-world practice, and personal reflection. The goal? To develop principled, innovative leaders who solve complex problems and produce systemic change in a global context. Within the Finance Group, several action learning opportunities are available, each of which offers a chance to work in teams on projects at MIT and on-site with partnering sponsors, giving students a rare firsthand look at a wide array of actual challenges facing organizations.

Proseminar in Capital Markets/ Investment Management

Students tackle original research problems in investment management that have been posed by leading experts from the financial community. These projects push students into a new frontier by introducing them to unsolved practical problems.

Proseminar in Corporate Finance/ Investment Banking

Students gain experience in the complex task of developing and communicating solutions to challenging financial problems facing businesses today by performing their own industry research and analysis on problem posed by company sponsors in corporate finance and investment banking.

Proseminar in Alternative Investments

Alternative assets present some of the most complex valuation and financial management challenges in finance, due to their illiquidity and greater information asymmetries. Students apply state of the art financial methods to practical problems formulated by professionals at leading alternative investment firms. The projects originate from partner firms focused on the following areas: venture capital, private equity, hedge funds, currency strategy and project finance.

Finance Research PracticumSM

Held over the Independent Activities Period (IAP) in January, the Practicum is a team-based finance course where students work on substantive projects proposed by external sponsors from both the private and public sector. The goal is to provide students with a meaningful opportunity to work with leading practitioners on important topical finance problems. The projects typically involve the use of one or more advanced technical skills, including financial econometrics, simulation, derivatives valuation, optimization, and related software and programming languages.



Selected student projects

A sampling of some of the hands-on projects that engage MIT Sloan students with partnering sponsors:

- Provide investment banking advice to a private equity-controlled chemical company, including valuation analysis and exit strategies.
- Conduct a valuation of two major home construction companies.
- Analyze the cost of trading foreign exchange for a major New York-based asset management firm.
- Analyze the history of commercialization of university-based research in the Boston area and identify common attributes of successful ventures.
- Construct a rainy day fund that will perform well when equity prices are falling, volatility is increasing, and credit spreads are widening for a significant Boston-based hedge fund.

Finance-related student clubs and conferences at MIT Sloan

- [Finance Club](#)
- [Financial Markets and Policy Club](#)
- [FinTech Club](#)
- [Investment Management Club](#)
- [Quantitative Finance Club](#)
- [Venture Capital Private Equity Club](#)
- [MIT Sloan CFO Summit](#)
- [MIT Sloan Energy Finance Forum](#)
- [MIT FinTech Symposium](#)
- [MIT Sloan Investment Conference](#)
- [MIT Sloan Private Equity Symposium](#)
- [MIT Sloan Venture Capital Conference](#)



JUDY LEWENT, SM '72
Former Executive Vice President & CFO, Merck & Co. Inc.

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"My finance education at MIT Sloan was distinguished by a faculty engaged in state-of-the-art research in all aspects of finance, who then brought that research into the classroom and translated it to practice. This educational experience provided me with a unique skill set that has been invaluable throughout my career."

Finance Group Advisory Board

The MIT Sloan Finance Group Advisory Board consists of academic and financial industry leaders who have agreed to meet regularly with the Finance Group to provide advice and guidance with respect to several initiatives. These initiatives include the MBA Finance Track, the Master of Finance program, the undergraduate program, executive education, and our ambitious research agenda. We are grateful to these individuals for their support and friendship:

- Armen Avanessians
- Robert Beckwitt
- Gary Bergstrom
- Vivek Bohra
- Paul Brewer
- Mariafrancesca Carli
- Philip Cooper
- Gifford Fong
- Diana Frazier
- Bennett Golub
- Peter Hancock
- Greg Hawkins
- Bernard Horn
- Dennis Kass
- Vikram Kirloskar
- Mark Kritzman
- Judy Lewent
- Shan Li
- Robert Litterman
- Saman Majd
- Harry Mamaysky
- John Mazzarino
- Stephen Memishian
- David Modest
- Laurence Nath
- Eric Rosenfeld
- Jackie Rosner
- Sadeq Sayeed
- Jeffrey Shames
- André Stern
- Tom Wilson
- Matthew Zames
- Tania Zouikin

Put-Call Parity for European Options

Non-dividend-Paying Underlying Security : [Put and call with the
Same E and T]

$$\text{Call Price} = S - EP(T-t) + \text{Put Price}$$

[$P(t) = \text{ZCB paying \$1 at maturity}$
 $S = S(t)$]

Black-Scholes European Put Price [$\sigma^2 = \text{constant}$
 $\rho = 0$]

$$\frac{1}{2} \sigma^2 S^2 \frac{\partial^2 F}{\partial S^2} + rS \frac{\partial F}{\partial S} + \frac{\partial F}{\partial t} - rF = 0$$

$$F(0, t) = Ee^{-r(T-t)}$$

$$F(S, T) = \max[0, E - S]$$

$$F(S, t; E, \sigma^2, r, T) = Ee^{-r(T-t)} \Phi(\chi_1) - S \Phi(\chi_2)$$

Pictured here are excerpts from Robert C. Merton's notes for course 15.438, Investment Banking. Based on work done at MIT Sloan, Merton and colleagues Myron S. Scholes and Fischer S. Black developed a pioneering formula to determine the value of derivatives.

Dividend-Paying Security (where dividends are known for certain over Options' Lives)

$$\left(\begin{array}{c} \text{European Call} \\ \text{Price} \end{array} \right) = S - EP(T-t) - PV(\text{dividend dividends}) + \left(\begin{array}{c} \text{European Put} \\ \text{Price} \end{array} \right)$$

$$\begin{aligned} PV(\text{dividends}) &\equiv \text{present value of dividend payments between } t \text{ and } T \\ &= \sum_{s=t}^T (\text{dividends at time } s) P(s) \end{aligned}$$

Dividend-Paying Security (where dividends are continuously-paid at constant proportional rate = ρ)

$$\left(\begin{array}{c} \text{European Call} \\ \text{Price} \end{array} \right) = Se^{-\rho(T-t)} - EP(T-t) + \left(\begin{array}{c} \text{European Put} \\ \text{Price} \end{array} \right)$$

$$\text{i.e., } PV(\text{dividends}) = [1 - e^{-\rho(T-t)}] S$$

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