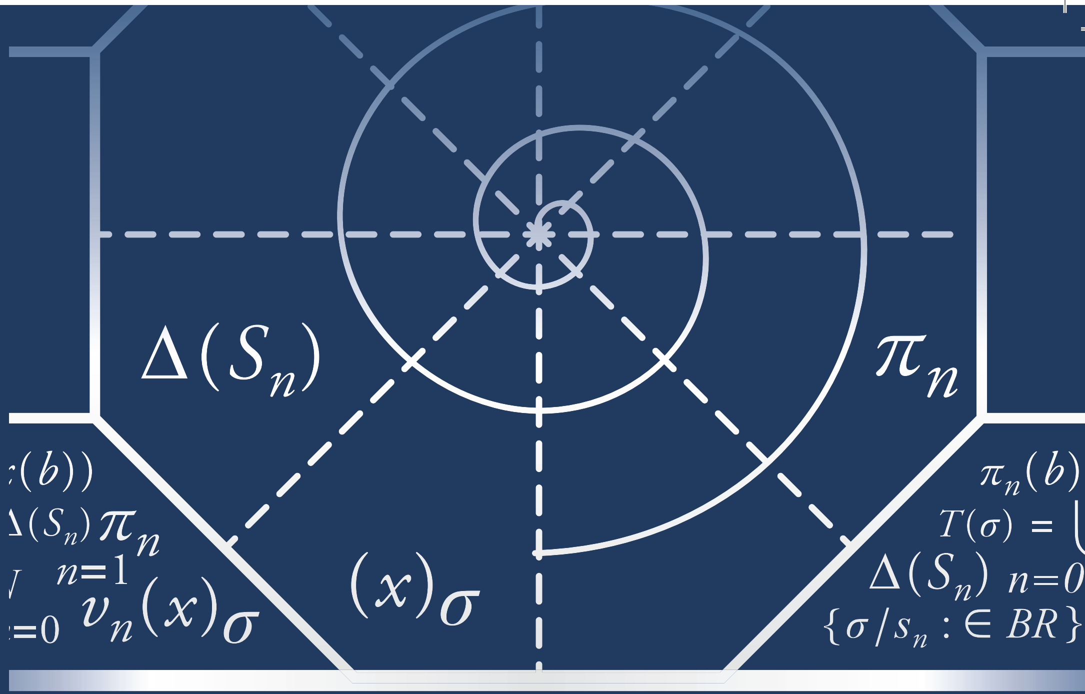


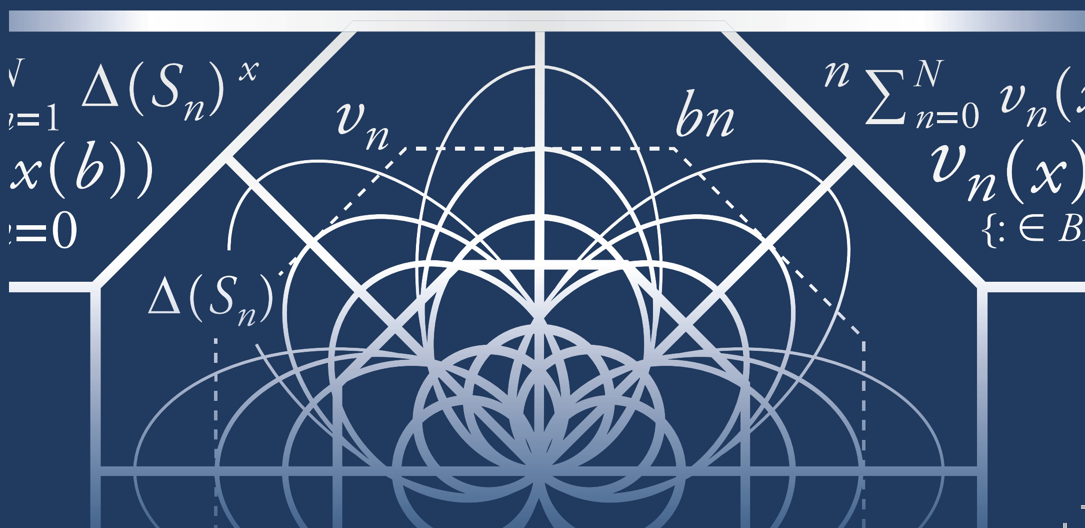
CME GROUP-MSRI

Prize in Innovative Quantitative Applications

Moderated Seminar and Award Luncheon | February 12, 2018 Chicago, Illinois

CME Group

MSRI Mathematical Sciences Research Institute



CME GROUP-MSRI PRIZE IN INNOVATIVE QUANTITATIVE APPLICATIONS

Awarded annually, the CME Group-MSRI Prize in Innovative Quantitative Applications rewards exemplary work in the field of mathematical sciences and recognizes the vital impact of quantitative research and its application to shaping global financial markets.

The prize was developed by the CME Center for Innovation, which was launched by CME Group in 2003. CME Group is the world's leading and most diverse derivatives marketplace. The Center creates and sponsors thought-provoking original programming that identifies and fosters examples of significant innovation and creative thinking across multiple industries. Each of the programs aims to explore the forces that drive innovation and showcase their application to a broad and diverse audience.

The Mathematical Sciences Research Institute (MSRI) partners with CME Group in this initiative. Based in Berkeley, California, MSRI exists to further mathematical research through broadly based programs in the mathematical sciences and closely related activities. Each year, approximately 2,000 mathematicians visit the Institute, which is funded primarily by the National Science Foundation, with additional support from other government agencies, private foundations, individual and corporate donors, and academic sponsors.

2017 PRIZE RECIPIENT

PAUL MILGROM

Shirley R. and Leonard W. Ely Professor of Humanities and Sciences
Department of Economics, Stanford University

PAUL MILGROM, a member of the National Academy of Sciences and the American Academy of Arts and Sciences, is the winner of the 2017 CME-MSRI prize in Innovative Quantitative Applications. He also won the 2012 BBVA Frontiers of Knowledge award and the 2008 Nemmers Prize in Economics.

Milgrom is best known for his contributions to the microeconomic theory, his pioneering innovations in the practical design of multi-item auctions, and the extraordinary success of his students and academic advisees. According to his BBVA Award citation, "Paul Milgrom has made seminal contributions to an unusually wide range of fields of economics including auctions, market design, contracts and incentives, industrial economics, economics of organizations, finance, and game theory." According to a count by Google Scholar, Milgrom's books and articles have received more than 80,000 citations.

MODERATED SEMINAR

FRONTIERS OF RESEARCH IN MARKET DESIGN

WELCOME

LEO MELAMED
Chairman Emeritus
CME Group

DAVID EISENBUD
Director
Mathematical Sciences Research Institute (MSRI)

MODERATOR

PRESTON McAFEE
Corporate Vice President and Chief Economist
Microsoft Corporation

PANELISTS

MOHAMMAD AKBARPOUR
Assistant Professor of Economics
Graduate School of Business, Stanford University

PIOTR DWORCZAK
Research Fellow
Becker Friedman Institute, University of Chicago

SHENGWU LI
Junior Fellow of the Society of Fellows
Department of Economics, Harvard University

ELLEN MUIR
Ph.D. Student
Department of Economics, Stanford University

PAST CME GROUP-MSRI PRIZE RECIPIENTS

2016 | ROBERT WILSON
Adams Distinguished Professor of Management, Emeritus, Stanford Graduate School of Business

2015 | DOUGLAS DIAMOND
Fischer Black Visiting Professor of Financial Economics, MIT Sloan School of Management, 2015-2016, and Merton H. Miller Distinguished Service Professor of Finance, Booth School of Business, University of Chicago

2014 | JOSÉ SCHEINKMAN
Charles and Lynn Zhang Professor of Economics, Columbia University and Theodore A. Wells '29 Professor of Economics Emeritus, Princeton University

2013 | BENGT HOLMSTRÖM
Nobel Laureate in Economic Sciences (2016), Paul A. Samuelson Professor of Economics, Massachusetts Institute of Technology

2012 | ROBERT SHILLER
Nobel Laureate in Economic Sciences (2013), Sterling Professor of Economics, Yale University, and Professor of Finance and Fellow at the International Center for Finance, Yale School of Management

2011 | THOMAS SARGENT
Nobel Laureate in Economic Sciences (2011), William R. Berkley Professor of Economics and Business, Stern School of Business, New York University, and Senior Fellow, Hoover Institution

2010 | JEAN TIROLE
Nobel Laureate in Economic Sciences (2014), Chairman, Toulouse School of Economics, and Chairman of the Executive Committee, Institute for Advanced Study in Toulouse

2009 | SANFORD GROSSMAN
Chairman and President, Quantitative Financial Strategies, Inc.

2008 | LARS PETER HANSEN
Nobel Laureate in Economic Sciences (2013), David Rockefeller Distinguished Service Professor in Economics, Statistics and the Booth School of Business, University of Chicago

2007 | DAVID KREPS
Adams Distinguished Professor of Management, Professor of Economics (by courtesy), School of Humanities and Sciences, and the Winnick Family Faculty Fellow for 2016-2017, Stanford University Graduate School of Business

2006 | STEPHEN ROSS
Franco Modigliani Professor of Financial Economics, MIT Sloan School of Management

CME GROUP-MSRI PRIZE SELECTION COMMITTEE

DAVID EISENBUD
Prize Committee Chair, Director, Mathematical Sciences Research Institute (MSRI)

LARS PETER HANSEN
Nobel Laureate in Economic Sciences (2013), David Rockefeller Distinguished Service Professor in Economics, Statistics and the Booth School of Business, University of Chicago, and 2008 Recipient of the CME Group-MSRI Prize in Innovative Quantitative Applications

BENGT HOLMSTRÖM
Nobel Laureate in Economic Sciences (2016), Paul A. Samuelson Professor of Economics, Massachusetts Institute of Technology, and 2013 Recipient of the CME Group-MSRI Prize in Innovative Quantitative Applications

PRESTON MCAFEE
Corporate Vice President and Chief Economist, Microsoft Corporation

LEO MELAMED
Chairman Emeritus, CME Group

ROGER MYERSON
Nobel Laureate in Economic Sciences (2007), Glen A. Lloyd Distinguished Service Professor of Economics, University of Chicago

MAUREEN O'HARA
Robert W. Purcell Professorship of Management and Professor of Finance, SC Johnson College of Business, Cornell University

MYRON SCHOLES
Nobel Laureate in Economic Sciences (1997), Frank E. Buck Professor of Finance, Emeritus, Stanford Graduate School of Business

HUGO SONNENSCHEIN
Charles L. Hutchinson Distinguished Service Professor Emeritus, University of Chicago

JEAN TIROLE
Nobel Laureate in Economic Sciences (2014), Chairman, Toulouse School of Economics, and Chairman of the Executive Committee, Institute for Advanced Study in Toulouse, and 2010 Recipient of the CME Group-MSRI Prize in Innovative Quantitative Applications

LUNCHEON AND AWARD CEREMONY

WELCOME

BRYAN DURKIN
President
CME Group

APPRECIATION OF THE LIFE AND WORK OF PAUL MILGROM

ROGER MYERSON
Nobel Laureate in Economic Sciences (2007)
Glen A. Lloyd Distinguished Service Professor of Economics
University of Chicago

KEYNOTE ADDRESS

PAUL MILGROM
Shirley R. and Leonard W. Ely Professor of Humanities and Sciences
Department of Economics, Stanford University

PRESENTATION OF THE CME GROUP-MSRI PRIZE IN INNOVATIVE QUANTITATIVE APPLICATIONS

LEO MELAMED
Chairman Emeritus
CME Group

DAVID EISENBUD
Director
Mathematical Sciences Research Institute (MSRI)

PROGRAM CONCLUSION

> I am honored to accept this prize on behalf of myself and my collaborators, they have helped me both to conduct my most important research and to bring my ideas into practice. Bob Wilson, who won this prize last year, was my teacher who guided my first research efforts and collaborated with me on my first real-world auction design. Another past winner, Dave Kreps, was also an early collaborator, as was Nobel Laureate Bengt Holmstrom. It is hard to go wrong with collaborators like those! Or with Evan Kwerel, Ilya Segal, Kevin Leyton-Brown, John Roberts, Robert Weber, Larry Glosten and Nancy Stokey, all of whom played crucial roles in bringing our work to fruition.

– PAUL MILGROM

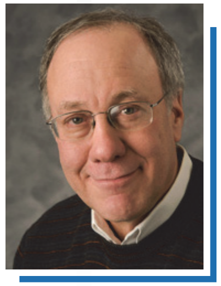
Shirley R. and Leonard W. Ely Professor of Humanities and Sciences
Department of Economics, Stanford University

LUNCHEON REMARKS

APPRECIATION OF THE LIFE AND WORKS OF PAUL MILGROM

ROGER MYERSON

Nobel Laureate in Economic Sciences (2007)
Glen A. Lloyd Distinguished Service Professor of Economics
University of Chicago



Roger Myerson studied applied mathematics at Harvard University, earning his bachelor's degree in 1973 and his Ph.D. in 1976. From 1976 to 2001, he was professor of managerial economics and decision sciences at Northwestern University, in the Kellogg School of Management. Since 2001, he has been at the University of Chicago where he is the Glen A. Lloyd Distinguised Service Professor in Economics. He is a fellow of the American Academy of Arts and Sciences and the National Academy of Sciences.

He is author of two books, *Game Theory* (1991) and *Probability Models for Economic Decisions* (2005), and many professional articles on game theory, information economics and political economics. In particular, he has written about bargaining problems with incomplete information, refinements of Nash's equilibrium concept, optimal auction design, incentive constraints in economic systems and game-theoretic models of politics.

In 2007, he shared the Nobel Prize in Economic Sciences, in recognition of his contributions to mechanism design theory, which analyzes rules for coordinating economic agents efficiently when they have different information and difficulty trusting each other.

LUNCHEON REMARKS

BRYAN DURKIN

President
CME Group

Bryan T. Durkin serves as president of CME Group. In this role, he is responsible for overseeing the company's technology, global operations, market technology and data services and international businesses. He also is president of GFX Corp., a wholly owned subsidiary of CME Group that provides liquidity in foreign exchange futures.

Previously, he served as chief commercial officer since 2014 and as chief operating officer since 2007. As part of his responsibilities, he led the global integrations following CME's merger with the Chicago Board of Trade (CBOT) in 2007 and CME Group's acquisition of the New York Mercantile Exchange (NYMEX) in 2008.

Before joining CME Group, Durkin served as executive vice president and chief operating officer of the CBOT.

Durkin is a member of the COMEX governors committee and the Commodity Futures Trading Commission's technology advisory committee and energy and environmental markets advisory committee. He also serves on the board of directors of the CME Group Community Foundation and the board of advisors of Misericordia.

Durkin holds a bachelor's degree in business administration and an MBA from Lewis University. He has been an adjunct faculty member of Lewis University's MBA program, teaching courses in organizational behavior and management.

WELCOME ADDRESS

LEO MELAMED

Chairman Emeritus
CME Group

Leo Melamed is acknowledged as the father of financial futures. He led in the creation of our FX, interest rate and stock index futures contracts. He served as CME chairman of the Board from 1968 until 1973. Upon founding the International Monetary Market (IMM), he was its chairman from 1972 until its merger with the CME in 1976. He then served as chairman of the merged exchange until 1977. He has served as CME chairman emeritus since 1997 and chairman of our strategic steering committee since 2001.

Melamed was special counsel to our board from 1977 to 1985 and then chairman of its executive committee from 1985 until 1991. He was instrumental in the creation and launch of the CME Globex electronic trading platform and served as its founding chairman in 1992. From 1993 to 2001, he served as chairman and CEO of Sakura Dellsher, Inc., a former clearing firm of CME, and currently serves as chairman and CEO of Melamed & Associates, a global consulting group. He is founder and a permanent special advisor to the National Futures Association, and an advisor of the International Advisory Council of the CSRC in China.

He serves on the board of overseers of the Becker Friedman Institute of the University of Chicago. Melamed is a director of The Chicago Council on Global Affairs and senior advisor to LEAP Innovations. He also is a published author of a number of books pertaining to markets and the history of CME Group.

WELCOME ADDRESS

DAVID EISENBUD

Director
Mathematical Sciences Research Institute (MSRI)

David Eisenbud served as director of MSRI from 1997 to 2007, and began a new term in 2013.

He received his Ph.D. in mathematics in 1970 at the University of Chicago under Saunders MacLane and Chris Robson, and was on the faculty at Brandeis University before coming to Berkeley, where he became professor of mathematics in 1997. He served from 2009 to 2011 as director for mathematics and the physical sciences at the Simons Foundation, and is currently on the board of directors of the Foundation. He has been a visiting professor at Harvard, Bonn and Paris. Eisenbud's mathematical interests range widely over commutative and non-commutative algebra, algebraic geometry, topology and computer methods. Eisenbud is chair of the editorial board of the "Algebra and Number Theory" journal, which he helped found in 2006, and serves on the board of the "Journal of Software for Algebra and Geometry," as well as Springer-Verlag's book series *Algorithms and Computation in Mathematics*.

Eisenbud was president of the American Mathematical Society from 2003 to 2005. He is a director of Math for America, a foundation devoted to improving mathematics teaching. He has been a member of the board of Mathematical Sciences and their Applications of the National Research Council, and is a member of the U.S. National Committee of the International Mathematical Union. In 2006, Eisenbud was elected a fellow of the American Academy of Arts and Sciences.

PANELIST

ELLEN MUIR

Ph.D. Student
Department of Economics, Stanford University

Ellen Muir is currently a first-year Ph.D. student in economics at Stanford University. She previously was a research fellow in the School of Mathematics and Statistics at the University of Melbourne, Australia and a member of the Australian Research Council Centre of Excellence for Mathematical and Statistical Frontiers.

Muir holds a Ph.D. in mathematics, which was completed in 2017 at the University of Melbourne under the supervision of Professor Simon Loertscher and Professor Peter Taylor. Her research interests include microeconomic theory, market design, dynamic mechanism design, matching, probability theory and stochastic processes.

PANELIST

SHENGWU LI

Junior Fellow of the Society of Fellows
Department of Economics, Harvard University

Shengwu Li studies economic theory and behavioral economics. His recent work investigates mechanism design under bounded rationality and under partial commitment. Shengwu graduated with a Ph.D. in economics from Stanford University in 2016, and is a junior fellow at the Harvard Society of Fellows. He was invited to the 2016 Review of Economic Studies Tour, and was awarded the 2017 Aliprantis Prize by the Society for the Advancement of Economic Theory. The first chapter of his Ph.D. dissertation was published as the lead article of the American Economic Review in November 2017.

MODERATOR

PRESTON McAFEE

Corporate Vice President and Chief Economist
Microsoft Corporation

R. Preston McAfee, corporate vice president and chief economist of Microsoft, is an economist who has worked extensively in pricing, auctions, antitrust, business strategy, market design, computational advertising and machine learning applied to exchanges. He is the author of more than 100 refereed articles, seven patents and three books.

McAfee received a B.A. in economics from the University of Florida in 1976, as well as an M.S. in mathematics and economics, both in 1978, and a Ph.D. in economics in 1980, from Purdue University. He has taught at the University of Western Ontario, the University of Texas, MIT, the University of Chicago and Caltech, where he was executive officer for the social sciences. He joined Yahoo in 2007 as chief economist, moved to Google in 2012, and joined Microsoft in his current role in 2014.

Working with colleague John McMillan in the 1980s, McAfee developed research that showed how auctions could be designed to improve government procurement and sales. For this work, McAfee was awarded a Golden Goose award in 2014.

In 1995, McAfee, McMillan and Stanford professors Paul Milgrom and Robert Wilson formed a company, Market Design, Inc., that provided auction advice and expertise in many countries.

In 2006, McAfee finished Introduction to *Economic Analysis*, a textbook covering both introductory and intermediate microeconomics. He won the Association of Research Libraries' SParc Innovator award in 2009.

PANELIST

MOHAMMAD AKBARPOUR

Assistant Professor of Economics
Graduate School of Business, Stanford University

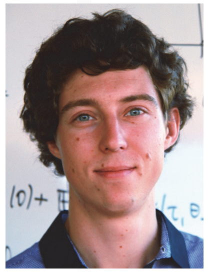
Mohammad Akbarpour is an assistant professor of economics at Stanford Graduate School of Business, where he teaches MBA and Ph.D. courses on the economics of marketplaces and market design. His research bridges computer science and economic theory, and is focused on marketplace design, social and economic networks, and the economics of organ markets.

Mohammad received his Ph.D. in economics from Stanford University in 2015 and his B.Sc. in electrical engineering from Sharif University of Technology in Iran. He has held research positions at Auctionomics and Microsoft Research, where he worked on designing auction markets for spectrum and online advertising. He has also been an instructor at Khan Academy Farsi, teaching game theory, physics, calculus, and macroeconomics through hundreds of video-lectures.

PANELIST

PIOTR DWORCZAK

Research Fellow
Becker Friedman Institute, University of Chicago



Stanford Ph.D. Piotr Dworczak studies mechanism and information design, with interests in auction design, matching theory and information in financial markets.

In particular, his research examines design problems that arise when a mechanism is embedded in a larger market that influences agents' continuation payoffs.

In work with Darrell Duffie and Haoxiang Zhu, he has studied the role and appropriate design of financial benchmarks, addressing concerns arising from recent scandals involving manipulation of LIBOR and foreign exchange benchmarks. One of the papers was awarded the 2017 Amundi Smith Breeden First Prize.

Another strand of his work considers classical topics in matching theory. This work in algorithms was honored as the best paper with a student lead author at the 2016 Conference on Economics and Computation.

He is currently a research fellow at the Becker Friedman Institute at the University of Chicago, and will join the Northwestern University economics faculty as assistant professor in 2018.

Before seeking his Ph.D. at Stanford, he earned a bachelor's degree in mathematics at the University of Warsaw and one in economics at the Warsaw School of Economics.