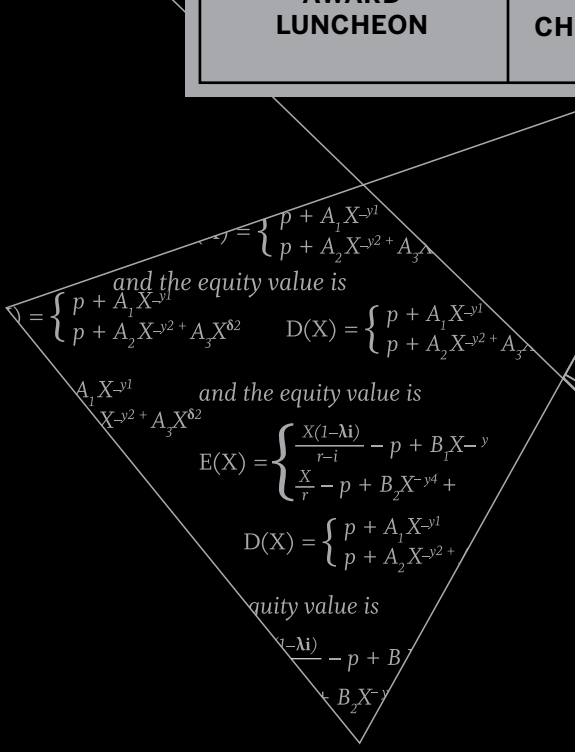
CME GROUP-MSRI

PRIZE *in* INNOVATIVE QUANTITATIVE APPLICATIONS

MODERATED SEMINAR
— and —
AWARD LUNCHEON

FEB 1 2016

CHICAGO, ILLINOIS



CME Group

MSRI
Mathematical Sciences Research Institute

CME GROUP-MSRI PRIZE

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.

CME Group, the world's leading and most diverse derivatives marketplace, launched the CME Center for Innovation in 2003. 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 showcases their application to a broad and diverse audience.

Partnering with CME Group in this initiative is the Mathematical Sciences Research Institute (MSRI). 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.

2015 PRIZE RECIPIENT

DOUGLAS W. DIAMOND

DOUGLAS DIAMOND specializes in the study of financial intermediaries, financial crises and liquidity. He is the **Fischer Black Visiting Professor of Financial Economics at the MIT Sloan School of Management, 2015–2016, and the Merton H. Miller Distinguished Service Professor of Finance at the University of Chicago's Booth School of Business**, where he has been a member of the faculty since 1979. Dr. Diamond is a research associate of the National Bureau of Economic Research and a visiting scholar at the Federal Reserve Bank of Richmond. He was president of the American Finance Association and the Western Finance Association, and is a fellow of the Econometric Society, the American Academy of Arts and Sciences and the American Finance Association. Diamond received the Morgan Stanley-American Finance Association Award for Excellence in Finance in 2012.He has taught at Yale University and was a visiting professor at the Hong Kong University of Science and Technology as well as the University of Bonn. Diamond earned a bachelor's degree in economics from Brown University in 1975. He earned master's degrees in 1976 and 1977 and a Ph.D. in economics from Yale University in 1980.

MODERATED SEMINAR

WELCOME

LEO MELAMED
Chairman Emeritus, CME Group

SEMINAR

NON-BANK RUNS AND FINANCIAL CRISES

Moderator

DAVID EISENBUD
Director, Mathematical Sciences Research Institute (MSRI)

Panelists

MARK FLANNERY
Director and Chief Economist, U.S. Securities and Exchange Commission, Bank of America Eminent Scholar Chair, Warrington College of Business, University of Florida

ITAY GOLDSTEIN
Joel S. Ehrenkranz Family Professor, Professor of Finance, Coordinator of Ph.D. Program, Wharton School of Business, University of Pennsylvania

GARY GORTON
Frederick Frank Class of 1954 Professor of Finance, Yale School of Management

ARVIND KRISHNAMURTHY
John S. Osterweis Professor of Finance, Lacob Family Faculty Fellow for 2015-2016, Stanford School of Business

LAWRENCE SCHMIDT
Assistant Professor in Economics and the College, University of Chicago

LUNCHEON AND AWARD CEREMONY

APPRECIATION OF THE LIFE AND WORKS OF DOUGLAS DIAMOND

GARY GORTON
Frederick Frank Class of 1954 Professor of Finance, Yale School of Management

KEYNOTE ADDRESS

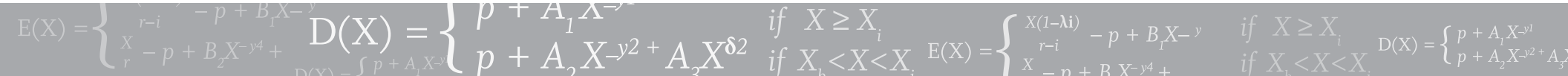
DOUGLAS DIAMOND
Fischer Black Visiting Professor of Financial Economics, MIT Sloan School of Management, 2015-2016 and Merton H. Miller Distinguished Service Professor of Finance, University of Chicago

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

LEO MELAMED
Chairman Emeritus, CME Group

DAVID EISENBUD
Director, MSRI

PROGRAM CONCLUSION



WELCOME ADDRESS

LEO MELAMED

Chairman Emeritus, CME Group

Leo Melamed has served as a member of the CME Group board of directors since 2001. He is the founder of financial futures and was instrumental in the creation of the CME Globex platform. He has served as CME Chairman Emeritus since 1997 and Chairman of our Strategic Steering Committee since 2001. He served as Chairman of our board from 1968 until 1973. He was founding Chairman of the International Monetary Market (IMM) from 1972 until its merger with our exchange in 1976, and then CME Chairman until 1977. Mr. Melamed served as a special advisor to the company in the role of Special Counsel to our board from 1977 to 1985 and then in the role of Chairman of its Executive Committee from 1985 until 1991. In 1992, Mr. Melamed became the founding Chairman of the Globex Corporation. 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 advisor to the National Futures Association, and a member 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 and on the advisory board of Vernon & Park Capital L.P. Mr. Melamed represents CME Group Foundation on the LEAP Innovations board of directors. Mr. Melamed is also a published author of a number of books pertaining to markets and the history of CME Group.

MODERATOR

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. Dr. 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

MARK FLANNERY

Director and Chief Economist, U.S. Securities and Exchange Commission, Bank of America Eminent Scholar Chair, Warrington College of Business, University of Florida

Mark Flannery serves as Director and Chief Economist for the U.S. Securities and Exchange Commission. He has held an Eminent Scholar Chair in Finance at the University of Florida since 1989. He teaches corporate finance and financial management of financial institutions in the graduate program at the Warrington College of Business. His current research focuses on the determinants of corporate leverage and the use of market information and stress tests in supervising large financial institutions. He has done research in the areas of government regulation of the financial sector, empirical corporate finance, financial management of financial institutions and asset pricing.

Dr. Flannery has served on the faculty of the University of Pennsylvania and the University of North Carolina, and as a visiting professor at the London Business School and the University of New South Wales. He has consulted with private banks and government agencies, including the Federal Reserve and the Federal Deposit Insurance Corporation, and served on the board of the Barnett Bank of Alachua County. He received a Ph.D. and master's degrees in economics from Yale University and a bachelor's degree in economics from Princeton University.

PANELIST

ITAY GOLDSTEIN

Joel S. Ehrenkranz Family Professor, Professor of Finance, Coordinator of Ph.D. Program, Wharton School of Business, University of Pennsylvania

Itay Goldstein is the Joel S. Ehrenkranz Family Professor in the Finance Department at the Wharton School of the University of Pennsylvania. He is also the coordinator of the Ph.D. program in Finance. He has been on the faculty of the Wharton School since 2004. Professor Goldstein earned his Ph.D. in Economics in 2001 from Tel Aviv University. He is an expert in the areas of corporate finance, financial institutions, and financial markets, focusing on financial fragility and crises and on the feedback effects between firms and financial markets. His research has been published in top academic journals, including the "American Economic Review," the "Journal of Finance," the "Journal of Financial Economics," the "Review of Economic Studies," and the "Review of Financial Studies." His research has also been featured in the popular press in the *Economist, Financial Times, Bloomberg, Forbes, National Public Radio*, and others. Professor Goldstein is an editor of the Review of Financial Studies. He has been an editor of the Finance Department in Management Science and an editor of the "Journal of Financial Intermediation." He has served as an academic advisor at the Federal Reserve Banks of New York, Philadelphia, and Richmond, the Bank of Canada, and the Committee for Capital Markets Regulation. He was the co-founder and the first president of the Finance Theory Group. He has taught various undergraduate, M.B.A., Ph.D., and executive education courses in finance and economics. Prior to joining Wharton, Professor Goldstein has served on the faculty of Duke University¿s Fuqua School of Business. He had also worked in the research department of the bank of Israel.

$$E(X) = \begin{cases} \dfrac{X(1-\lambda i)}{r-i} - p + B_1 X^{-y} & \text{if } X \geq X_i \\ X - p + B_2 X^{-y4} + & \text{if } X_b < X < X_i \end{cases} \qquad D(X) = \begin{cases} p + A_1 X^{-y1} & \\ p + A_2 X^{-y2} + A_3 X^{\delta 2} & \end{cases}$$

PANELIST

GARY GORTON

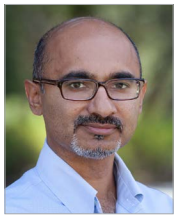
Frederick Frank Class of 1954 Professor of Finance,
Yale School of Management

Gary Gorton is the Frederick Frank Class of 1954 Professor of Finance at the Yale School of Management, which he joined in August 2008. Prior to joining Yale, he was the Robert Morris Professor of Banking and Finance at The Wharton School of the University of Pennsylvania, where he taught from 1983 to 2008. Dr. Gorton has done research in many areas of finance and economics, including both theoretical and empirical work. He is the author of *Slapped by the Invisible Hand: The Panic of 2007* (Oxford University Press) and *Misunderstanding Financial Crises* (Oxford University Press). Dr. Gorton has consulted for the U.S. Board of Governors of the Federal Reserve System, various U.S. Federal Reserve Banks, the Bank of England, the Bank of Japan, and the Central Bank of Turkey. He was a consultant to AIG Financial Products from 1996 to 2008. Dr. Gorton received his doctorate in economics from the University of Rochester. In the field of economics, he received master's degrees at the University of Rochester and Cleveland State University, and also received a master's degree in Chinese Studies from the University of Michigan.

PANELIST

ARVIND KRISHNAMURTHY

John S. Osterweis Professor of Finance, Lacob Family Faculty Fellow
for 2015-2016, Stanford School of Business



Arvind Krishnamurthy is a John S. Osterweis Professor of Finance at the Stanford Graduate School of Business and a Research Associate at the National Bureau of Economic Research. He formerly taught at the Kellogg School of Management at Northwestern University from 1998 to 2014. His research has focused on the causes and consequences of liquidity crises in emerging markets and developed economies, and the role of government policy in stabilizing crises. He has also conducted extensive research on liquidity effects in the U.S. Treasury bond market and the mortgage-backed securities market. Dr. Krishnamurthy has received numerous awards for his research, including the Smith Breeden Prize for best paper published in the "Journal of Finance," the Western Finance Association Corporate Finance Award and the Swiss Finance Institute's Outstanding Paper Award. He has written extensively on the causes and consequences of financial crises and is a leading scholar on the global financial crisis that began in 2007. Dr. Krishnamurthy's research on financial crises and monetary policy has received extensive national media coverage and been cited by central banks around the world. He received a Ph.D. in financial economics from MIT and a bachelor's degree from the University of Pennsylvania.

PANELIST

LAWRENCE SCHMIDT

Assistant Professor in Economics and the College, University of Chicago

Lawrence Schmidt joined the University of Chicago in 2015 as an assistant professor. His research is at the intersection of finance and macroeconomics, with a particular emphasis on asset pricing. He uses a unique combination of theory and applied econometrics to offer a richer picture of risks faced by financial market participants—households, institutional investors and financial intermediaries—and shed new light on underlying economic mechanisms linking financial markets with the real economy. A common thread in Dr. Schmidt's research agenda is the study of conditional distributions and higher moments, with an emphasis on the evolution of cross-sectional distributions over time in response to macroeconomic events. While the majority of empirical research emphasizes conditional means and variances, other moments of the distribution often reveal interesting asymmetries and nonlinearities which yield new insights about the propagation of aggregate shocks. Examples from his research consider the interaction between asset returns and idiosyncratic tail risk in the labor market, as well as the strategic behavior of investors during the money market panic of 2008. He received a Ph.D. in economics from the University of California, San Diego.

CME GROUP-MSRI PRIZE SELECTION COMMITTEE

DAVID EISENBUD

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

JOHN GOULD

Steven G. Rothmeier Professor and Distinguished Service Professor of Economics, Unversity of Chicago Booth School of Business

BENGT HOLMSTROM

Paul A. Samuelson Professor of Economics, Massachusetts Institute of Technology and 2013 recipient of the CME Group-MSRI Prize

LEO MELAMED

Chairman Emeritus, CME Group

ROBERT MERTON

School of Management Distinguished Professor of Finance, MIT Sloan School of Management.

THOMAS SARGENT

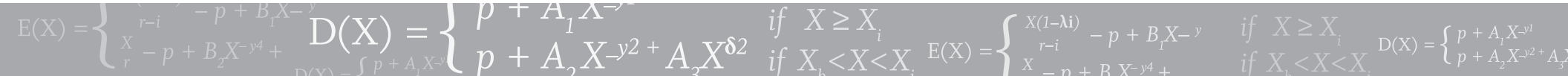
Nobel Laureate in Economic Sciences (2011), William R. Berkley Professor of Economics and Business, Stern School of Business, New York University, Senior Fellow at the Hoover Institution and 2011 recipient of the CME Group-MSRI Prize

MYRON SCHOLES

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

JEAN TIROLE

Nobel Laureate in Economic Sciences (2014), Scientific Director of Industrial Economics Institute, Member of the Toulouse School of Economics and 2010 recipient of the CME Group-MSRI Prize



PAST CME GROUP-MSRI PRIZE RECIPIENTS

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

2013 | BENGT HOLMSTROM
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 at the Hoover Institution

2010 | JEAN TIROLE
Nobel Laureate in Economic Sciences (2014), Scientific Director of the Industrial Economics Institute at the University of Toulouse Capitole, Member of the Toulouse School of Economics

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

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

2007 | DAVID KREPS
Adams Distinguished Professor of Management, Stanford University Graduate School of Business

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

"IT IS A GREAT HONOR TO BE RECOGNIZED BY CME GROUP AND MSRI FOR MY RESEARCH AND TO JOIN A TRULY OUTSTANDING GROUP OF PREVIOUS RECIPIENTS.

THEORETICAL WORK ON THE IMPORTANT LINKS BETWEEN FINANCIAL MARKETS AND INSTITUTIONS HAS PROVED TO BE IMPORTANT RECENTLY, AND I AM GRATEFUL THAT CME AND MSRI HAVE AGAIN RECOGNIZED WORK IN THIS AREA."

– 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, University of Chicago

$$D(X) = \begin{cases} p + A_1 X^{-y1} \\ p + A_2 X^{-y2} + A_3 X^{\delta 2} \end{cases} \qquad D(X) = \begin{cases} p + A_1 X^{-y1} \\ p + A_2 X^{-y2} + A_3 X^{\delta 2} \end{cases}$$

$$\begin{cases} p + A_1 X^{-y1} \\ p + A_2 X^{-y2} + A_3 X^{\delta 2} \end{cases}$$ *and the equity value is*

$$\begin{array}{ll} \textit{if} \quad X \geq X_i & \\ \textit{if} \quad X_b < X < X_i & \end{array} \qquad E(X) = \begin{cases} \frac{X(1-\lambda i)}{r-i} - p + B_1 X^{-y} \\ \frac{X}{r} - p + B_2 X^{-y4} + \end{cases}$$

$$D(X) = \begin{cases} p + A_1 X^{-y1} \\ p + A_2 X^{-y2} + A_3 X^{\delta 2} \end{cases}$$

$$D(X) = \begin{cases} p + A_1 X^{-y1} & \textit{if} \quad X \geq \\ p + A_2 X^{-y2} + A_3 X^{\delta 2} & \textit{if} \quad X_b < \end{cases}$$

and the equity value is

$$\frac{(1-\lambda i)}{i} - p + B_1 X^{-y3} - A_1 X^{-y1}$$

$$p + B_2 X^{-y4} + B_3 X^{\delta 4} - A_2 X$$

$$X) = \begin{cases} p + A_1 X^{-y1} \\ p + A_2 X^{-y2} \end{cases}$$

value is

$$i) - p +$$

$$+ B_2 X$$