

UNITED STATES DISTRICT COURT
SOUTHERN DISTRICT OF NEW YORK

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IN RE CREDIT DEFAULT SWAPS ANTITRUST	:	
LITIGATION	:	13 Md. 2476 (DLC)
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This Document Relates To: All Actions	:	
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DECLARATION OF DARRELL DUFFIE IN SUPPORT OF PLAINTIFFS’ MOTION FOR PRELIMINARY APPROVAL OF SETTLEMENT WITH ALL DEFENDANTS AND PRELIMINARY CERTIFICATION OF A SETTLEMENT CLASS

I, Darrell Duffie, hereby declare as follows:

1. Counsel for the plaintiff class in the above-captioned matter retained me in late 2014 as a testifying expert in *In re Credit Default Swaps Antitrust Litigation*, No. 13 MD 2476 (DLC) (S.D.N.Y.). I submit this declaration to explain why, in my view, this case was important; how its aggressive advancement and the publication of the proposed settlement has fostered beneficial changes in the Credit Default Swap (“CDS”) market; and the relevance of the behavioral remedies agreed to by Defendant International Swaps and Derivatives Association (“ISDA”) as part of the proposed settlement of this action.

Background

2. I am the Dean Witter Distinguished Professor of Finance at the Graduate School of Business, Stanford University, and Professor by Courtesy, Department of Economics, Stanford University. A substantial focus of my research, teaching, and policy-related work is the market for CDS, and more generally how alternative market structures and developments affect the CDS market.

3. In addition to a wide range of consulting work performed for regulators and market participants, I have written research papers, policy reports, and books that address CDS markets, swap markets, and the central clearing of swaps. My most recent books are: *Dark Markets: Asset Pricing and Information Transmission in Over-the-Counter Markets* (Princeton University Press, 2012), *Measuring Corporate Default Risk* (Oxford University Press, 2011) and *How Big Banks Fail* (Princeton University Press, 2010).

4. Among other appointments and activities, I serve on the Financial Advisory Roundtable of the Federal Reserve Bank of New York. I was elected the 2009 President of the American Finance Association, the leading U.S. and international academic organization of financial economists. In 2013-2014, I chaired the Market Participants Group (MPG), charged by the Financial Stability Board with recommending reforms to LIBOR, EURIBOR, and other interest-rate benchmarks used in over-the-counter swap markets.

5. My CV, which includes other relevant qualifications, is attached as Appendix A.

6. In this action, I analyzed the viability of CDS exchange trading in or around 2008 and the predominance of common issues and injury among class members in this action. In connection with my work, I examined, among other materials, hundreds of documents produced by Defendants and third parties, as well as dozens of deposition transcripts of current and former employees of Defendants and third parties.

Exchange Trading of CDS

7. I have written extensively about the migration of CDS from the over-the-counter (“OTC”) market to electronic and exchange trading and have long publicly stated that exchange trading would result in increased price transparency, more efficient pricing, and enhanced competition among dealers, and would thereby improve the efficiency of the CDS market.

8. Because this action sought to address the historical lack of price transparency and competition in the CDS market, I agreed to serve as an expert witness for the plaintiff class. Indeed, I believe that this action, and the aggressive manner in which the counsel for Plaintiffs have litigated it, has spurred important beneficial changes in the CDS market.

9. As a notable example, on August 31, shortly after I became aware that Plaintiffs and Defendants had reached a preliminary agreement to settle this case, the Intercontinental Exchange (“ICE”) announced that it plans to begin offering an anonymous, all-to-all trading platform for single-name CDS.¹ This platform was described as “exchange-like” and will feature many of the beneficial aspects of exchange trading that I have identified in my published works and describe above.²

10. That ICE has now announced an anonymous, all-to-all exchange trading platform—a transparent platform that Plaintiffs alleged in this action to have been blocked by Defendants—is a remarkable shift that I attribute, in part, to this litigation and its favorable resolution.

11. It is also my opinion that the licensing and related changes agreed to by ISDA as part of the proposed settlement will improve the CDS marketplace and benefit class members.

12. ISDA owns certain intellectual property, including the rights to the settlement prices generated by CDS auctions administered by ISDA (the “Final Price”), that are necessary for the operation of a viable CDS exchange trading platform. Plaintiffs alleged that ISDA, in collusion with Defendants, refused to grant such licenses to any exchange trading platforms. The changes to its licensing practices that ISDA has now agreed to adopt under the proposed

¹ See Mike Kentz, *ICE plans single-name CDS platform*, Reuters (Aug. 31, 2015), <http://www.reuters.com/article/2015/08/31/markets-derivatives-cds-idUKL1N1161A520150831>.

² *Id.*

settlement will make it much easier for parties to license ISDA's intellectual property for the exchange trading of CDS.

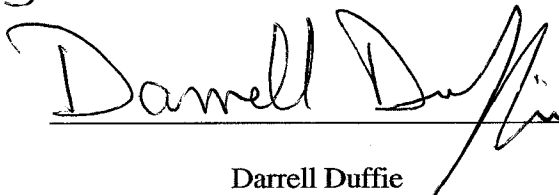
13. ISDA has also agreed to a number of measures that will make its licensing process more transparent and inclusive of class members. For example, as part of the proposed settlement, ISDA will ensure that its licensing decisions are made by a committee with equal buy-side representation. In addition, ISDA has agreed to broadcast its licensing meetings to the public via the internet and to publish licensing decisions related to CDS on its website, unless a proposed licensee objects. These measures should help ensure that ISDA's licensing process is fair and transparent.

14. Finally, ISDA has agreed to formally consider and vote on a proposal to make an official statement discouraging the post-trade disclosure of the identities of the counterparties to a CDS transaction—what is termed “name give-up”—and to support the implementation of Commodity Futures Trading Commission (“CFTC”) guidance related to the elimination of or placement of limitations on name give-up.³

15. I consider these and other terms of the proposed settlement agreement to be important changes that should make the CDS market more transparent, efficient, and competitive, and thereby benefit class members.

³ Anonymity is a critical component of exchange trading platforms because it allows entities to transact without disclosing their trading strategies to the wider market. The practice of name give-up, accordingly, deters buy-side firms from trading on platforms with exchange-like features. The elimination of the practice of name give-up would thus, in my view, significantly increase incentives for participation on new or existing CDS trading platforms with exchange-like features.

I declare under penalty of perjury under the laws of the United States of America that the foregoing is true and correct. Executed on this 13th date of October, 2015, at Lausanne, Switzerland.



Darrell Duffie

APPENDIX A

Curriculum Vitae of DARRELL DUFFIE

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UNIVERSITY
EDUCATION

Stanford University, Ph. D. (Engineering Economic Systems) (1984)

University of New England (Australia), Master of Economics (Economic Statistics) (1980)

University of New Brunswick (Canada), Bachelors of Science in Engineering (Civil Engineering) (1975)

AWARDS
AND
HONORS

1985-86 NSF Research Fellowship

1988-89 Batterymarch Fellowship

1990-92 NSF Research Grant

1992-93 Catalyst Institute Research Grant

1994-95 Q Group Research Award

1994-96 NSF Research Grant

Fellow, Econometric Society

1997, Smith-Breeden Distinguished Paper Prize, *Journal of Finance*2001, Graham and Dodd Award, *Financial Analysts Journal*

2002, NYSE Prize for equity research, Western Finance Association

2003, Distinguished teacher award, Doctoral Program, Graduate School of Business, Stanford University

2003, Financial Engineer of the Year, International Association of Financial Engineering

2004, Clarendon Lectures in Finance, Oxford University.

2007, Princeton Lectures in Finance.

2007, Elected Fellow of the American Academy of Arts and Sciences.

2008, 2011, Elected to the Council of the Econometric Society.

2008, Nash Lecture, Carnegie-Mellon University.

2009, Elected President of the American Finance Association.

2010, Tinbergen Institute Finance Lectures, Duisenberg Institute.

2011, Minerva Foundation Lectures, Columbia University.

EMPLOYMENT

1984-present: Graduate School of Business, Stanford University*Current Position:* Dean Witter Distinguished Professor of Finance*On leave:* Mathematical Sciences Research Institute, University of California, Berkeley; 1985-1986; Université de Paris, Dauphine; 1998. University of Lausanne; 2007-2008.RESEARCH
INTERESTS

Incomplete security markets; derivative security markets; market and credit risk management of banks and other financial institutions; asset pricing theory; preference theory under uncertainty, financial market innovation and security design; interest-rate modeling and fixed-income security pricing; options and other derivative security markets; credit risk; over-the-counter markets; financial market infrastructure, central banking.

BOOKS

- Security Markets: Stochastic Models*, Boston: Academic Press, 1988.
- Futures Markets*, Englewood Cliffs, New Jersey: Prentice-Hall, 1989. Japanese translation, Kinzai Publishing Company, 1994; Chinese translation, 1996.
- Dynamic Asset Pricing Theory*, Princeton University Press, 1992; Third Edition, 2001; French Translation, *Modèles Dynamiques d' Evaluation*, Paris: Presse Universitaire Française, 1993; Japanese Translation, Shinbun Press, 1998; portions appearing in Italian translation in *Il Principio di Arbitraggio*, edited by M. de Felice and E. F. Moriconi, Società Editrice Il Mulino, Bologna, 1996.
- Credit Risk: Pricing, Measurement, and Management*, with Kenneth J. Singleton, Princeton University Press, 2003.
- The Squam Lake Report: Fixing the Financial System*, co-authored with the Squam Lake Group, Princeton University Press, 2010.
- How Big Banks Fail — And What to Do About It*, Princeton University Press, 2010.
- Measuring Corporate Default Risk*, Oxford University Press, 2011.
- Dark Markets: Asset Pricing and Information Transmission in Over-The-Counter Markets*, Princeton University Press, 2012.

RESEARCH
PUBLICATIONS

- “Implementing Arrow-Debreu Equilibria by Continuous Trading of Few Long-Lived Securities,” (with Chi-fu Huang), *Econometrica*, vol. 53 (1985), pp. 1337-1356, forthcoming in reprinted form in *Continuous-Time Finance*, edited by Stephen Schaefer, London: Edward Elgar, 2000.
- “Competitive Equilibria in General Choice Spaces,” *Journal of Mathematical Economics*, vol. 14 (1986), pp. 1-23.
- “Stochastic Equilibria: Existence, Spanning Number, and the ‘No Expected Financial Gains From Trade’ Hypothesis,” *Econometrica*, vol. 54 (1986), pp. 1161-1184.
- “Predictable Representation of Martingale Spaces and Changes of Probability Measure,” *Séminaires de Probabilité XIX*, edited by J. Azéma and M. Yor, *Lecture Notes in Mathematics Number 1123*, (1985) Springer-Verlag: Berlin, pp. 278-285.
- “Multi-period Security Markets with Differential Information: Martingales and Resolution Times” (with Chi-fu Huang), *Journal of Mathematical Economics*, vol. 15 (1986), pp. 283-303.
- “Stochastic Equilibria with Incomplete Financial Markets”, *Journal of Economic Theory*, vol. 41 (1987), pp. 405-416. Corrigendum, vol. 49 (1989), p. 384.
- “Equilibrium in Incomplete Markets: I. A Basic Model of Generic Existence” (with Wayne Shafer), *Journal of Mathematical Economics*, vol. 13 (1985), pp. 285-300, forthcoming in reprinted form in *General Equilibrium Theory*, edited by Gérard Debreu, Edward Elgar Publishing, Cheltenham, England.

- “Equilibrium in Incomplete Markets: II. Generic Existence in Stochastic Economies” (with Wayne Shafer) *Journal of Mathematical Economics*, vol. 15 (1986), pp. 199-216, forthcoming in reprinted form in *General Equilibrium Theory*, edited by Gérard Debreu, Edward Elgar Publishing, Cheltenham, England.
- “Intertemporal Arbitrage and the Markov Valuation of Securities” (with Mark Garman), *Cuadernos Economicos de ICE*, vol. 49 (1991), pp. 37-60.
- “An Extension of the Black-Scholes Model of Security Valuation,” *Journal of Economic Theory*, Vol. 46 (1988), 194-204.
- “Optimal Hedging and Equilibrium in a Dynamic Futures Market” (with Matthew O. Jackson), *Journal of Economic Dynamics and Control*, Vol. 14 (1990), 21-33.
- “Optimal Innovation of Futures Contracts” (with Matthew O. Jackson) *Review of Financial Studies*, Vol. 2 (1989), pp. 275-296.
- “Money in General Equilibrium Theory,” Chapter 3, *Handbook of Monetary Economics*, Volume 1 (1990), edited by B. M. Friedman and F. H. Hahn, Elsevier Science Publishers, Amsterdam, pp. 81-100.
- “The Consumption-Based Capital Asset Pricing Model” (with Bill Zame), *Econometrica*, Vol. 57 (1989), pp. 1279-1298.
- “Transactions Costs and Portfolio Choice in a Discrete-Continuous Time Setting” (with Tong-Sheng Sun), *Journal of Economic Dynamics and Control*, Vol. 14 (1990), 35-51.
- “The Risk-Neutral Value of the Early Arbitrage Option”, *Advances in Futures and Options Research*, vol. 4 (1990), pp. 107-110.
- “Corporate Financial Hedging with Proprietary Information” (with Peter Demarzo), *Journal of Economic Theory*, Vol. 53 (1991), pp. 261-286.
- “From Discrete to Continuous Time Finance: Weak Convergence of the Financial Gain Process” (with Philip Protter), *Mathematical Finance*, Vol. 2 (1992), pp. 1-16.
- “Mean-Variance Hedging in Continuous Time” (with Henry Richardson), *Annals of Applied Probability*, Vol. 1 (1991), 1-15.
- “Pricing Continuously Resettled Contingent Claims” (with Richard Stanton), *Journal of Economic Dynamics and Control*, Vol. 16 (1992), pp. 561-574.
- “Stochastic Differential Utility,” (with Larry Epstein), *Econometrica*, Vol. 60 (1992), pp. 353-394.
- “PDE Solutions of Stochastic Differential Utility” (with P.-L. Lions) *Journal of Mathematical Economics*, Vol. 21 (1992). 577-606.

- “Asset Pricing with Stochastic Differential Utility” (with Larry Epstein), *Review of Financial Studies*, Vol. 5 (1992), pp. 411-436.
- “Simulated Moments Estimation of Markov Models of Asset Prices” (with Ken Singleton), *Econometrica*, Vol. 61 (1993), pp. 929-952.
- “Optimal Investment with Undiversifiable Income Risk” (with Thaleia Zariphopoulou), *Mathematical Finance*, Vol. 3 (1993), pp. 135-148.
- “Arbitrage Pricing of Russian Options and Perpetual Lookback Options” (with J. Michael Harrison), *Annals of Applied Probability*, Vol. 3 (1993), 641-651.
- “Asset Pricing in Incomplete Markets,” *Hitotsubashi Journal of Economics*, Vol. 34 (1993), 139-148.
- “Continuous-Time Security Pricing: A Utility Gradient Approach” (with Costis Skiadas), *Journal of Mathematical Economics*, Vol. 23 (1994), 107-132.
- “Efficient and Equilibrium Allocations with Stochastic Differential Utility,” (with Pierre-Yves Geoffard and Costis Skiadas), *Journal of Mathematical Economics*, Vol. 23 (1994), 133-146.
- “Stationary Markov Equilibria” (with John Geanakoplos, Andreu Mas-Colell, and Andy McLennan), *Econometrica*, Vol. 62 (1994), 745-782.
- “Volatility in Energy Prices,” with S. Gray and P. Hoang, in *Managing Energy Price Risk*, edited by Lou Pai and Peter Field, Risk Publications, 1995, revised for second edition, 1999, pp. 273-290.
- “Black’s Consol Rate Conjecture” (with Jin Ma and Jiongmin Yong), *Annals of Applied Probability*, Vol. 5 (1995), pp. 356-382.
- “Hedging in Incomplete Markets with HARA Utility” (with Wendell Fleming, Mete Soner, and Thaleia Zariphopoulou), *Journal of Economic Dynamics and Control* Vol. 21 (1997), pp. 753-782.
- “Efficient Monte Carlo Estimation of Security Prices” (with Peter Glynn), *Annals of Applied Probability* Vol. 5 (1996), pp. 897-905.
- “Corporate Incentives for Hedging and Hedge Accounting” (with Peter DeMarzo), *Review of Financial Studies*, Vol. 8 (1995), 743-772.
- “Special Repo Rates,” *Journal of Finance*, Vol. 51, (1996) 493-526.
- “Asset Pricing with Heterogeneous Consumers” (with George Constantinides), *Journal of Political Economy*, Vol. 104 (1996), pp. 219-240.
- “A Term Structure Model with Preferences for the Timing of the Resolution of Uncertainty” (with Mark Schroder and Costis Skiadas), *Economic Theory*, Vol. 9 (1997), pp. 3-22.

- “A Yield-Factor Model of Interest Rates” (with Rui Kan), *Mathematical Finance* Volume 6 (1996) pp. 379-406, reprinted in *The New Interest Rate Models*, London: Risk Books, 2000; and in *Options Markets*, edited by G. Constantinides and A. Malliaris, London: Edward Elgar, forthcoming.
- “Swap Rates and Credit Quality” (with Ming Huang), *Journal of Finance*, Volume 51 (1996) pp. 921-950.
- “Recursive Valuation of Defaultable Securities and the Timing of the Resolution of Uncertainty” (with Mark Schroder and Costis Skiadas), *Annals of Applied Probability*, Vol. 6 (1996) pp. 1075-1090.
- “An Econometric Model of the Term Structure of Interest Rate Swap Yields” (with Ken Singleton), *Journal of Finance*, Vol. 52, pp. 1287-1321, forthcoming in reprinted form in *Options Markets*, edited by G. Constantinides and A. Malliaris, London: Edward Elgar, 2000.
- “A Liquidity-Based Model of Security Design” (with Peter DeMarzo), *Econometrica*, Vol. 67 (1999), pp. 65-99.
- “Modeling Term Structures of Defaultable Bonds” (with Ken Singleton), *Review of Financial Studies*, Vol. 12 (1999), 687-720.
- “Credit Swap Valuation,” *Financial Analysts Journal*, January-February, 1999, pp. 73-87, reprinted in *Credit Risk: Models and Management*, edited by David Shimko, London: Risk Books, 1999, pp. 245-258, and to be reprinted in *International Securities*, edited by George Philippatos and Gregory Koutmos, The International Library of Critical Writings in Financial Economics, Senior Editor, Richard Roll, Edward Elgar Publishing, 2000.
- “Transform Analysis and Asset Pricing for Affine Jump-Diffusions,” (with Jun Pan and Ken Singleton), *Econometrica*, Vol. 68 (2000), pp. 1343-1376.
- “Floating-Fixed Credit Spreads,” (with Jun Liu), *Financial Analysts Journal*, May-June, 2001, pp. 76-87.
- “Term Structures of Credit Spreads with Incomplete Accounting Information,” (with David Lando), *Econometrica*, Vol. 69 (2001), pp. 633-664.
- “Analytical Value-at-Risk with Jumps and Credit Risk,” (with Jun Pan), *Finance and Stochastics*, Vol. 5 (2001), pp. 155-180.
- “Risk and Valuation of Collateralized Debt Obligations,” (with Nicolae Gârleanu), *Financial Analysts Journal*, January-February, 2001, pp. 41-62, winner, Graham and Dodd Scroll Award.
- “Universal State Prices and Asymmetric Information,” (with Rui Kan), *Journal of Mathematical Economics*, Vol. 38 (2002), pp. 191-196.
- “Securities Lending, Shorting, and Pricing,” (with Nicolae Gârleanu and Lasse Pedersen), *Journal of Financial Economics*, Vol. 66 (2002), pp. 307-339. (NYSE Award, Best Paper, Equity Analysis)

- “Liquidation Risk,” (with Alexandre Ziegler), *Financial Analysts Journal*, May-June 2003, pp 42-51.
- “Modeling Sovereign Yield Spreads: A Case Study of Russian Debt,” (with Lasse Pedersen and Ken Singleton), *Journal of Finance*, Vol. 58 (2003), pp. 119-159.
- “Affine Processes and Applications in Finance,” (with Damir Filipovic and Walter Schachermayer), *Annals of Applied Probability*, Vol. 13 (2003), 984-1053.
- “Market Pricing of Deposit Insurance,” (with Robert Jarrow, Amiyatosh Purnanandam, and Wei Yang) *Journal of Financial Services Research*, Vol. 24 (2003), 93-119.
- “Large Portfolio Losses,” (with Amir Dembo and Jean-Dominique Deuschel), *Finance and Stochastics*, Vol. 8 (2004), pp. 3-16.
- “Estimation of Continuous-Time Markov Processes Sampled at Random Times,” (with Peter Glynn), *Econometrica* Vol. 72 (2004), pp. 1773-1808.
- “Over-The-Counter Markets,” (with Nicolae Gârleanu and Lasse Pedersen), *Econometrica*, Volume 73 (2005), pages 1815-1847.
- “Multi-Period Corporate Default Prediction with Stochastic Covariates,” (with Leandro Saita and Ke Wang), *Journal of Financial Economics*, Volume, 83 (2007), 635-665.
- “Common Failings: How Corporate Defaults are Correlated,” (with Sanjiv Das, Nikunj Kapadia, and Leandro Saita), *Journal of Finance*, Volume 62 (2007), 93-117.
- “The Existence of Independent Random Matching,” (with Yeneng Sun), *Annals of Applied Probability*, Volume 17 (2007), 386-419.
- “Valuation in Over-The-Counter Markets,” (with Nicolae Gârleanu and Lasse Pedersen), *Review of Financial Studies*, 2007, Vol. 20, pp.1865-1900.
- “Information Percolation in Large Markets,” (with Gustavo Manso), *American Economic Review, Papers and Proceedings*, 2007, Vol. 97, pp. 203-209.
- “Systemic Dynamics in the Federal Funds Market,” (with Adam Ashcraft), *American Economic Review, Papers and Proceedings*, 2007, Vol. 97, pp. 221-225.
- “Frailty Correlated Default,” (with Andreas Eckner, Guillaume Horel, and Leandro Saita), *Journal of Finance*, 2009, Vol. 64, pp. 2089-2124.
- “Information Percolation,” (with Gaston Giroux and Gustavo Manso), *American Economics Journal: Microeconomics* 2010, Vol. 2, pp. 100-111.
- “Information Percolation with Equilibrium Search Dynamics,” (with Semyon Malamud and Gustavo Manso), *Econometrica* 2009, Vol. 77, pp. 1513-1574.

“The Relative Contributions of Private Information Sharing and Public Information Releases to Information Aggregation” (with Semyon Malamud and Gustavo Manso), *Journal of Economic Theory* 2010, Vol. 145, pp. 1574-1601.

“Asset Price Dynamics with Slow-Moving Capital,” Presidential Address, *Journal of Finance* 2010, Vol. 65, pp. 1238-1268.

“Does a Central Clearing Counterparty Reduce Counterparty Risk?” (with Haoxiang Zhu), *Review of Asset Pricing Studies* 2011, Vol. 1, pp. 74-95.

“The Exact Law of Large Numbers for Independent Random Matching” (with Yeneng Sun), *Journal of Economic Theory* 2012, Vol. 147, pp. 1105-1139.

“Capital Mobility and Asset Pricing” (with Bruno Strulovici), *Econometrica* 2012, Vol. 80, pp. 2469-2509.

“Information Percolation in Segmented Markets” (with Semyon Malamud and Gustavo Manso), *Journal of Economic Theory* 2014, Vol. 153, pp. 1-32.

“Central Clearing and Collateral Demand” (with Martin Scheicher and Guillaume Vuillemeys), forthcoming, *Journal of Financial Economics*, 2014.

OTHER
PUBLICATIONS

“Money in General Equilibrium Theory,” Chapter 3, *Handbook of Monetary Economics*, Volume 1 (1990), edited by B. M. Friedman and F. H. Hahn, Elsevier Science Publishers, Amsterdam, pp. 81-100.

“Arrow and General Equilibrium Theory” (with Hugo Sonnenschein), *Journal of Economic Literature*, Vol. 27 (1989), pp. 565-598.

“The Theory of Value in Security Markets,” *The Handbook of Mathematical Economics, Volume IV*, Chapter 31, edited by Werner Hildenbrand and Hugo Sonnenschein, North-Holland (1991), 1615-1682.

“Frontiers of Modern Financial Theory, Volume 1, Theory of Valuation, A Review,” *Review of Financial Studies*, Vol. 2 (1989), pp. 267-272.

“The Nature of Incomplete Security Markets,” *Advances in Economic Theory, Volume 2*, edited by Jean-Jacques Laffont, Cambridge University Press (1992), pp. 214-262.

“Intertemporal General Equilibrium: Comment,” *Value and Capital, Fifty Years Later*, edited by Lionel McKenzie and Stefano Zamagni, London: Macmillan (1991), 461-468.

“Spanning in Security Markets” in *The New Palgrave Dictionary of Money and Finance*, (1992) edited by P. Newman, M. Milgate, and J. Eatwell, London: The Macmillan Press.

- “The Modigliani-Miller Theorem,” in *The New Palgrave Dictionary of Money and Finance*, (1992) edited by P. Newman, M. Milgate, and J. Eatwell, London: The Macmillan Press.
- “Martingales, Arbitrage, and Portfolio Choice,” *Proceedings of The European Congress of Mathematics, Volume II, Invited Lectures*, edited by A. Joeseph and R. Rentschler, Boston: Birkhäuser Press, 1994, pages 3-21.
- “Asset Pricing in Incomplete Markets,” *Hitotsubashi Journal of Economics*, Vol. 34 (1993), 139-148.
- “Debt Management and Interest Rate Risk,” *Risk Management: Challenges and Solutions*, ed. W. Beaver and G. Parker, McGraw-Hill Publishing Company, 1994.
- “Incomplete Security Markets with Infinitely Many States: An Introduction” *Journal of Mathematical Economics*, Vol. 26 (1995), 1-8.
- “Multi-Factor Interest Rate Models,” with Rui Kan, *Philosophical Transactions of The Royal Society, Series A*, Volume 347 (1993), pp. 577-586, reprinted in *Mathematical Models in Finance*, Chapman and Hall, 1995.
- “Financial Market Innovation and Security Design” (with Rohit Rahi), *Journal of Economic Theory*, Vol. 65 (1995), pp. 1-42.
- “State-Space Models of the Term Structure of Interest Rates,” in H. Körezlioglu, B. Øksendal, and A. Üstünel, editors, *Stochastic Analysis and Related Topics V: The Silivri Workshop, 1994*, Boston: Birkhäuser, 1996, republished in *Vasicek and Beyond*, edited by Lane Hughston (RISK: London, 1997).
- “An Overview of Value at Risk,” (with Jun Pan), *Journal of Derivatives*, April, 1997, pp. 7-49, forthcoming in reprinted form in *Options Markets*, edited by G. Constantinides and A. G. Malliaris, London: Edward Elgar, 2000.
- “Black, Merton, and Scholes — Their Central Contributions to Economics,” *Scandinavian Journal of Economics*, Vol. 11 (1998), pp. 411-424.
- “Measuring and Marking Counterparty Risk,” (with Eduardo Canabarro), in, *ALM of Financial Institutions*, edited by Leo Tilman, Institutional Investor Books (2004), Chapter 9.
- “Intertemporal Asset Pricing Theory,” in *Handbook of Financial Economics*, edited by George Constantinides, Milt Harris, and René Stulz, Amsterdam, North-Holland Elsevier (2004), Chapter 11, pp. 639-742.
- “Credit Risk Modeling with Affine Processes,” *Journal of Banking and Finance*, Vol. 29 (2005), 2751-2802.
- “A Review of *Stochastic Calculus for Finance* by Steven E. Shreve, *Bulletin of the American Mathematical Society*, Vol. 46 (2009), pp. 165-174.

“Policy Issues Facing the Market for Credit Derivatives,” Chapter 8 of *The Road Ahead for the Fed* (2009), edited by John Corciari and John B. Taylor, pp. 123-136, Hoover Press.

”How Should We Regulate Derivatives Markets,” Briefing Paper Number 5, The Pew Financial Reform Project.

“A Contractual Approach to Restructuring Financial Institutions,” Chapter 6 of *Ending Government Bailouts as We Know Them*, edited by Kenneth Scott, George P. Schultz, and John B. Taylor, pp. 109-124, Hoover Press.

“Policy Perspectives on OTC Derivatives Market Infrastructure” (with Ada Li and Theo Lubke), Staff Report Number 424, Federal Reserve Bank of New York, January, 2010.

“Drawing Boundaries Around and Through the Banking System,” Chapter 1.2, in *World Economic Forum Financial Development Report*, October 31, 2012.

“Key Mechanics of the U.S. Tri-Party Repo Market” (with Adam Copeland, Antoine Martin, and Susan McLaughlin), *Economic Policy Review of the Federal Reserve Bank of New York*, October, 2012.

“Fixing the Flaw in Sovereign CDS” (with Mohit Thukral), *Risk Magazine*, July, 2012.

“Replumbing Our Financial System: Uneven Progress,” *International Journal of Central Banking* 2013, Volume 9, Supplement 1: 251-280.

Comment on “Risk Topography,” by Brunnermeier, Gorton, and Krishnamurthy, in *NBER Macroeconomics Annual 2011*, edited by Daron Acemoglu and Michael Woodford. Chicago: University of Chicago Press, 2012, pp. 177-183.

“A Dialogue on the Costs and Benefits of Automatic Stays for Derivatives and Repurchase Agreements” (with David Skeel) In *Bankruptcy Not Bailout: A Special Chapter 14*, edited by Kenneth E. Scott and John B. Taylor, Hoover Press, 2012.

“Challenges to A Policy Treatment of Speculative Trading Motivated by Differences in Beliefs,” forthcoming, *Journal of Legal Studies*, 2014.

”Systemic Risk Exposures: A 10-by-10-by-10 Approach,” in *Risk Topography: Systemic Risk and Macro Modeling*, edited by Markus K. Brunnermeier and Arvind Krishnamurthy, National Bureau of Economic Research and University of Chicago Press, 2014.

“Financial Market Infrastructure: Too Important to Fail,” in *Across the Divide: New Perspectives on the Financial Crisis*, edited by Martin Bailey and John Taylor, Hoover Institution and Brookings Institute, 2014.

“Replumbing Our Financial System Uneven Progress,” *International Journal of Central Banking* Volume 9, 2013, Supplement 1: 251-280.

WORKING
PAPERS

- “Diffusion Approximation in Arrow’s Model of Exhaustible Resources,” (with Michael Taksar) Technical Report Number 416, Stanford Institute for Mathematical Studies in The Social Sciences (Economics Series), Stanford University, August, 1983.
- “Price Operators: Extensions, Potentials, and the Markov Valuation of Securities”, Research Paper No. 813, Graduate School of Business, Stanford University, July, 1985.
- “Stochastic Production-Exchange Equilibria” (with Chi-Fu Huang), Research Paper, Graduate School of Business, Stanford University, May 1986.
- “Equilibrium and The Role of the Firm in Incomplete Markets” (with Wayne Shafer), Graduate School of Business, Stanford University, August, 1986.
- “A Liquidity-Based Model of Asset-Backed Security Design” (with Peter DeMarzo), Working Paper, Kellogg Graduate School of Management, Northwestern University, November, 1993.
- “Asymptotic Efficiency of Hansen-Scheinkman and Resolvent Estimators of Ornstein-Uhlenbeck Processes,” (with Qiang Dai and Peter Glynn), Working Paper, Graduate School of Business, Stanford University, 1997.
- “First-to-Default Valuation,” Working Paper, Université de Paris, Dauphine, and Graduate School of Business, Stanford University, 1998.
- “Defaultable Term Structure Models with Fractional Recovery of Par,” Working Paper, Graduate School of Business, Stanford University, 1998.
- “Simulating Correlated Defaults,” (with Ken Singleton), Working Paper, Graduate School of Business, Stanford University, 1998.
- “Reforming Money Market Funds,” January, 2011, The Squam Lake Group.
- “On the Clearing of Foreign Exchange Derivatives,” Graduate School of Business, Stanford University, May 2011. Comment on U.S. Treasury, “Determination of Foreign Exchange Swaps and Foreign Exchange Forwards under the Commodity Exchange Act,” April, 2011.
- “Market Making Under the Proposed Volcker Rule,” a report to the Securities Industry and Financial Markets Association and a submission to the Office of the Comptroller of the Currency, the Board of Governors of the Federal Reserve System, the Federal Deposit Insurance Corporation, and the Securities and Exchange Commission, January, 2012, Graduate School of Business, Stanford University.
- “A Sampling-Window Approach to Transactions-Based Libor Fixing” (with David Skeie and James Vickery), Federal Reserve Bank of New York Staff Report Number 513, February 2013.
- “Dynamic Directed Random Matching” (with Lei Qiao and Yeneng Sun), Working Paper, Graduate School of Business, Stanford University, June, 2014.

“Benchmarks in Search Markets” (with Piotr Dworczak and Haoxiang Zhu), Working Paper, Graduate School of Business, Stanford University, October, 2014.

“Reforming LIBOR and Other Financial-Market Benchmarks” (with Jeremy Stein), Working Paper, Graduate School of Business, Stanford University, September 2014.

“Market Participants Group on Reforming Interest Rate Benchmarks, Final Report” (with the Market Participants Group), Financial Stability Board, March 2014.

“Robust Benchmark Design” (with Piotr Dworczak), Working Paper, Graduate School of Business, Stanford University, September, 2014.

EDITORIAL

Management Science, May 1986 to March, 1989.

Journal of Mathematical Economics, July, 1988 to February, 1996.

BOARDS

Advances in Futures and Options Research, May, 1989 to May 1991.

Annals of Applied Probability, September, 1989 to May, 1994.

Economic Theory, December, 1989 to February, 1996.

Journal of Economic Theory, 1986 to 1999.

Mathematical Finance, October, 1989 to January, 2001.

Econometrica, July, 1990 to July, 2014.

Asia Pacific Financial Markets, August 1993 to 2006.

The Review of Derivatives Research, December, 1993 to 2007.

Finance and Stochastics, 1995 to 2002 (co-editor, 1998-2002).

Review of Finance, July, 1995 to 2012.

Journal of Computational Finance, February, 1997 to present.

Advances in Mathematical Economics, August, 1998 to present.

Stochastic Processes and Their Applications, July, 1999 to April, 2006.

Journal of Financial Economics. November, 2001 to present.

Journal of Bond Trading and Management. 2002 to 2003.

Journal of Banking and Finance. November, 2005, to 2008.

Mathematics and Financial Economics. April, 2007, to present.

AEJ: Microeconomics. May, 2007, to present.

International Journal of Central Banking. January, 2009, to present.

Stochastic Systems. January, 2009, to present.

Review of Asset Pricing Studies. June, 2010, to June 2014.

PROFESSIONAL

Council, Bachelier Society, 1996 to 1999.

International Association of Financial Engineers, Governing Board (1997 to 2000), Senior Fellow from 2005.

SERVICE

External Advisory Board, Institute for Computational Finance, University of Texas, Austin, 1996 to 2005.

Co-Director and Co-Developer, Stanford University Graduate School of Business Executive Education Courses on Market and Credit Risk for Financial Institutions, 1996 to 2005.

International Advisory Board, Centre for Financial Engineering, National University of Singapore.

Advisory Board, Financial Strategies Group, Graduate School of International Business Strategy, Hitotsubashi University, Tokyo, Japan.

Econometric Society, Fellow, Member of Council (2009-2012), Investments Committee (2009-present).

National Bureau of Economic Research, Research Associate.
 International Examinations Committee, The Association of Certified International Investment Analysts, Japan.
 NCCR FinRisk, International Scientific Council, Switzerland; 2005-2012.
 Organizing Committee, Quantitative Developments in Finance, Newton Institute, Cambridge University, 2005.
 American Finance Association, Executive Committee, 2007-2011; Vice-President, 2007-2008; President-Elect, 2008-2009; President, 2009-2010; Board of Directors, 2000-2003, 2007-2011.
 Banff International Research Station, Scientific Advisory Board, 2005 to 2010.
 The Chicago Mercantile Exchange-Mathematical Sciences Research Institute Prize Committee, 2005 to 2011.
 The Federal Reserve Bank of New York, Financial Advisory Roundtable, 2006 to present.
 Financial Economists Roundtable, 2007 to present.
 Pacific Institute of Mathematical Sciences, Board of Directors, 2007 to present.
 Stanford University, Working Group on Global Markets, Member, 2008 to present.
 Squam Lake Working Group, Member, 2008 to present.
 Stanford Institute of Economic Policy Research (SIEPR), Senior Fellow, 2009 to present.
 Society of Financial Econometrics (SoFiE), Council, 2009 to present.
 Swiss Finance Institute, Scientific Council, 2010 to present.
 Duisenberg Institute, Scientific Council, 2010 to present.
 Initiative on Global Markets (IGM), University of Chicago, Experts Panel, 2010-present.
 Stanford University, Financial Institution Resolution Group, 2009-present.
 SWIFT Institute Advisory Council, 2012-present.
 American Academy of Arts and Sciences, Fellow, and fellows nominating committee, 2010-present.
 Stanford University, Financial and Risk Modeling Institute, Co-director, 2012-present.
 Asian Bureau of Finance and Economics Research, Senior Academic Fellow.
 Bureau of Finance and Economics Research, Senior Academic Fellow.
 Member, World Economic Forum Global Agenda Council on the Global Financial System.
 World Economic Forum, The Role of Financial Services in Society, Steering Committee.
 Market Participants Group on Reference Rate Reform (chair), August 2013-present.
 P.R.I.M.E. Finance Foundation, Panel of Recognized International Market Experts in Finance. December, 2013-present.
 Institute for Global Finance, University of New South Wales, Senior Fellow.

CORPORATE
BOARDS

iShares Funds and Trusts, San Francisco, 2008-2011.
 Moody's Corporation, New York, October 2008 to present.

OTHER

Bank One and I.R.S., Chicago (expert testimony, valuation of swaps).
 Board of Directors, Affinium Fund, London.

COMPENSATED

International Monetary Fund, Washington, D.C. (credit risk).
 Citigroup, New York (economic capital).

ACTIVITIES
2003-2014

- Merrill Lynch, New York (risk management).
- Paloma Partners, Greenwich CT (risk management).
- Ixis, Paris (credit markets).
- Schering-Plough, Kenilworth NJ (asset valuation).
- MBIA, New York (credit risk management).
- Bombardier, Toronto (corporate debt valuation).
- Moody's, Academic Research and Advisory Committee, New York.
- Credit Suisse, New York (financial markets and risk management), New York.
- Quinn Emanuel, New York, (consulting and expert witness testimony, credit risk corporate debt valuation, credit derivatives).
- New York State Tax Authority (repurchase agreements), New York.
- Cantor Fitzgerald (inter-dealer broker markets), New York.
- Independent Health Care Trusts for UAW Retirees of General Motors Corporation and of Ford Motor Corporation, (exercise of equity options), Detroit.
- State Street Bank (speech to investor conference), Boston.
- PayNet Inc. (estimation of default probabilities), Chicago.
- Matterhorn Investment Management (global capital markets), London.
- Cantor Fitzgerald (interdealer brokerage of treasuries), New York.
- Public Prosecutor of Milan (valuation of swap agreements), Milan Italy.
- Federal Reserve Bank of Chicago (central clearing counterparties), Chicago.
- Kepos Capital (academic advisory board), New York.
- Lehman Estate (consultation on bankruptcy-related issues), New York.
- Incisive Media (public speaking).
- Rothwell, Figg, Ernst & Manbeck (consultation on intellectual property rights), Washington DC,
- Sansome Capital (consultation on global capital markets), San Francisco.

This curriculum vitae is current as of December, 2014.