Curriculum Vita
Mark N. Broadie
November 2022

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Graduate School of Business
Columbia University
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Research Interests   Quantitative finance, risk analysis, and sports analytics

Education

1979–1983	Ph.D., Operations Research Stanford University, Stanford, California
1975–1979	B.S., OR/IE and Mathematics (with distinction) Cornell University, Ithaca, New York

Employment

2007–present	Carson Family Professor of Business, Columbia Business School
2012–2016	Vice Dean of Curriculum and Instruction, Columbia Business School
2000–2006	Professor, Columbia Business School
1988–1999	Associate Professor and Curriculum Specialist, Columbia University
1987–1988	Vice President, Lehman Brothers
1983–1987	Assistant Professor, Columbia Business School

Editorial

Editorial board	*Computational Management Science, International Journal of Golf Science, Springer-Finance, Cambridge University Press* (Mathematics, Finance and Risk), *Operations Research* (2000-2014), *Finance and Stochastics* (2007-2015), *SIAM Journal on Financial Mathematics* (2010-2013), *Review of Financial Studies* (2000-2003), *Management Science* (1999-2004), *Operations Research* (1999-2005), *Mathematical Finance* (1995-2003), and editor-in-chief *Journal of Computational Finance* (2003-2008).
Ad hoc reviewer	*Journal of Finance, Journal of Financial and Quantitative Analysis, Journal of Economic Dynamics and Control, Mathematical Finance, Journal of Derivatives, Review of Derivatives Research, Applied Mathematical Finance, Finance and Stochastics, RISK, Mathematics of Operations Research, Mathematical Programming*, and others.

Publications in Refereed Journals

Brennan, A., A. Ehlert, A., J. Wells, M. Broadie, D. Coughlan, A. Turner, and C. Bishop, 2022, "Monitoring Performance in Golf: More than just Clubhead Speed," *Strength and Conditioning Journal* (to appear). `tinyurl.com/yhmrsv75`

Shin, D., M. Broadie and A. Zeevi, 2021, "Practical Nonparametric Sampling Strategies for Quantile-based Ordinal Optimization," *INFORMS Journal on Computing*, `https://pubsonline.informs.org/doi/10.1287/ijoc.2021.1071`.

Shin, D., M. Broadie and A. Zeevi, 2018, "Tractable Sampling Strategies for Ordinal Optimization," *Operations Research*, Vol.66, No.6, 1693-1712. `https://doi.org/10.1287/opre.2018.1753`

Broadie, M. and W. Shen, 2017, "Numerical Solutions to Dynamic Portfolio Problems with Upper Bounds," *Computational Management Science*, `http://dx.doi.org/10.1007/s10287-016-0270-5`, 1-13.

Broadie, M. and W. Shen, 2016, "High-Dimensional Portfolio Optimization with Transaction Costs," *International Journal of Theoretical and Applied Finance*, Vol.19, No.4, 49 pages.

Broadie, M., Y. Du, and C. Moallemi, 2015, "Risk Estimation via Regression," *Operations Research*, Vol.63, No.5, September-October, 1077-1097.

Broadie, M., D. Cicek, and A. Zeevi, 2014, "Multidimensional Stochastic Approximation: Adaptive Algorithms and Applications," *ACM Transactions on Modeling and Computer Simulation*, Vol.24, No.1, 28 pages.

Broadie, M., and R. Rendleman, Jr., 2013, "Are the Official World Golf Rankings Biased?," *Journal of Quantitative Analysis and Sports*, Vol.9, No.2, 127-140.

Broadie, M., 2012, "Assessing Golfer Performance on the PGA TOUR," *Interfaces*, Vol.42, No.2, 146-165.

Broadie, M., D. Cicek and A. Zeevi, 2011, "General Bounds and Finite-Time Improvement for the Kiefer-Wolfowitz Stochastic Approximation Algorithm," *Operations Research*, Vol.59, No.5, 1211-1224.

Broadie, M., Y. Du and C. Moallemi, 2011, "Efficient Risk Estimation via Nested Sequential Simulation," *Management Science*, Vol.57, No.6, 1172-1194.

Asvanunt, A., M. Broadie and S. Sundaresan, 2011, "Managing Corporate Liquidity: Strategies and Pricing Implications," *International Journal of Theoretical and Applied Finance*, Vol.14, No.3, 369406.

Broadie, M., M. Chernov and M. Johannes, 2009, "Understanding Index Option Returns," *Review of Financial Studies*, Vol.22, No.11, 4493-4529.

Broadie, M. and A. Jain, 2008, "The Effect of Jumps and Discrete Sampling on Volatility and Variance Swaps," *International Journal of Theoretical and Applied Finance*, Vol.11, No.8, 761-797.

Broadie, M. and M. Cao, 2008, "Improved Lower and Upper Bound Algorithms for Pricing American Options by Simulation," *Quantitative Finance*, Vol.8, No.8, 845-861.

Broadie, M. and A. Jain, 2008, "Pricing and Hedging Volatility Derivatives," *Journal of Derivatives*, Vol.15, No.3, 7-24.

Broadie, M., M. Chernov and M. Johannes, 2007, "Model Specification and Risk Premia: Evidence from Futures Options," *Journal of Finance*, Vol.62, No.3, 1453-1490.

Broadie, M., M. Chernov and M. Sundaresan, 2007, "Optimal Debt and Equity Values in the Presence of Chapter 7 and Chapter 11," *Journal of Finance*, Vol.62, No.3, 1341-1377.

Broadie, M. and O. Kaya, 2007, "A Binomial Lattice Method for Pricing Corporate Debt and Modeling Chapter 11 Proceedings," *Journal of Financial and Quantitative Analysis*, Vol.42, No.2, 279-312.

Broadie, M. and O. Kaya, 2006, "Exact Simulation of Stochastic Volatility and other Affine Jump Diffusion Processes," *Operations Research*, Vol.54, No.2, 217-231.

Broadie, M. and Y. Yamamoto, 2005, "A Double-Exponential Fast Gauss Transform for Pricing Discrete Path-Dependent Options," *Operations Research*, Vol.53, No.5, 764-779.

Broadie, M. and J. Detemple, 2004, "Option Pricing: Valuation Models and Applications," *Management Science*, Vol.50, No.9 (September), 1145-1177.

Andersen, L. and M. Broadie, 2004, "A Primal-Dual Simulation Algorithm for Pricing Multi-Dimensional American Options," *Management Science*, Vol.50, No.9 (September) 1222-1234.

Broadie, M. and P. Glasserman, 2004, "A Stochastic Mesh Method for Pricing High-Dimensional American Options," *Journal of Computational Finance*, Vol.7, No.4, 35-72.

Broadie, M. and Y. Yamamoto, 2003, "Application of the Fast Gauss Transform to Option Pricing," *Management Science*, Vol.49, No.8, 1071-1088.

Broadie, M., J. Detemple, E. Ghysels, and O. Torres, 2000, "Nonparametric Estimation of American Option Exercise Boundaries and Call Prices," *Journal of Economic Dynamics and Control*, Vol.24, Nos.11-12, 1829-1857.

Broadie, M., J. Detemple, E. Ghysels, and O. Torres, 2000, "American Options with Stochastic Dividends and Volatility: A Nonparametric Investigation," *Journal of Econometrics*, Vol.94, 53-92.

Broadie, M., P. Glasserman, and S. Kou, 1999, "Connecting Discrete and Continuous Path-Dependent Options," *Finance and Stochastics*, Vol.3, No.1, 55-82.

Broadie, M., J. Cvitanić, and M. Soner, 1998, "Optimal Replication of Contingent Claims Under Portfolio Constraints," *Review of Financial Studies*, Vol.11, No.1, 59-79.

Broadie, M., P. Glasserman, and S. Kou, 1997, "A Continuity Correction for Discrete Barrier Options," *Mathematical Finance*, Vol.7, No.4, 325-349.

Broadie, M. and J. Detemple, 1997, "The Valuation of American Options on Multiple Assets," *Mathematical Finance*, Vol.7, No.3, 241-286.

Broadie, M., P. Glasserman, and G. Jain, 1997, "Enhanced Monte Carlo Estimates for American Option Prices," *Journal of Derivatives*, Vol.5, No.1 (Fall), 25-44.

Broadie, M., and P. Glasserman, 1997, "Pricing American-Style Securities Using Simulation," *Journal of Economic Dynamics and Control*, Vol.21, Nos.8-9, 1323-1352. Reprinted in *Options Markets (The International Library of Critical Writings in Financial Economics series)*, 2001, eds: G.M. Constantinides and A.G. Malliaris, Edward Elgar Publishing Limited, Cheltenham, UK.

Boyle, P., M. Broadie, and P. Glasserman, 1997, "Monte Carlo Methods for Security Pricing," *Journal of Economic Dynamics and Control*, Vol.21, Nos.8-9, 1267-1321. Reprinted as Chapter 2 in *Monte Carlo: Methodologies and Applications for Pricing and Risk Management*, 1998, ed: B. Dupire, RISK Books, London, 15-44, and as Chapter 6 in *Option Pricing, Interest Rates and Risk Management*, 2001, eds: E. Jouini, J. Cvitanić, and M. Musiela, Cambridge University Press, Cambridge, UK, 185-238, and in *Options Markets (The International Library of Critical Writings in Financial Economics series)*, 2001, eds: G.M. Constantinides and A.G. Malliaris, Edward Elgar Publishing Limited, Cheltenham, UK.

Broadie, M. and J. Detemple, 1996, "American Option Valuation: New Bounds, Approximations, and a Comparison of Existing Methods," *Review of Financial Studies*, Vol.9, No.4, 1211-1250.

Broadie, M. and P. Glasserman, 1996, "Estimating Security Price Derivatives Using Simulation," *Management Science*, Vol.42, No.2, 269-285.

Broadie, M. and J. Detemple, 1995, "American Capped Call Options on Dividend-Paying Assets," *Review of Financial Studies*, Vol.8, No.1, 161-191.

Broadie, M., 1993, "Computing Efficient Frontiers Using Estimated Parameters," *Annals of Operations Research: Financial Engineering*, Vol.45, 21-58.

Broadie, M. and D. Joneja, 1993, "An Application of Markov Chain Analysis to the Game of Squash," *Decision Sciences*, Vol.24, No.5, 1023-1035.

Broadie, M. and B.C. Eaves, 1987, "A Variable Rate Refining Triangulation," *Mathematical Programming*, Vol.38, 161-202.

Broadie, M., 1985, "An Introduction to the Octahedral Algorithm for the Computation of Economic Equilibria," *Mathematical Programming Study*, Vol.23, 121-143.

Broadie, M., 1985, "A Theorem about Antiprisms," *Linear Algebra and its Applications*, Vol.66, 99-111.

Broadie, M. and R.W. Cottle, 1984, "A Note on Triangulating the 5-Cube," *Discrete Mathematics*, Vol.52, 39-49.

Books, Chapters in Books and Other Journal Publications

Broadie, M. and W. Hurley, 2016, "Golf Analytics: Developments in Performance Measurement and Handicapping" chapter in the *Handbook of Statistical Methods for Design and Analysis in Sports*, Chapman & Hall, in the series CRC Handbooks of Modern Statistical Methods, eds: Jim Albert, Mark E. Glickman, Tim B. Swartz, Ruud H. Konig, `http://bit.ly/2jbjkvZ`.

Broadie, M., 2014, *Every Shot Counts*, Gotham Books (ISBN-10: 1592407501, ISBN-13: 978-1592407507), 288 pages, published March 2014. New York Times bestseller list in Sports.

Broadie, M., E. Derman, P. Glasserman, and S. Kou, 2012, "Financial Engineering at Columbia University," *Quantitative Finance*, Vol.12, No.1, 11-14.

Broadie, M., case studies in Winston and Albright, 2001, *Practical Management Science: Spreadsheet Modeling and Applications*, 2nd edition, Duxbury Press, Belmont, California.

Broadie, M., P. Glasserman, and Z. Ha, 2000, "Pricing American Options by Simulation Using a Stochastic Mesh with Optimized Weights," in *Probabilistic Constrained Optimization: Methodology and Applications*, ed: S. Uryasev, Kluwer Academic Publishers, Norwell, Massachusetts.

Broadie, M. and J. Detemple, 1999, "American Options on Dividend-Paying Assets," in *Topology and Markets*, ed: G. Chichilnisky, American Mathematical Society, Providence, RI, 69-98.

Broadie, M., case studies in Albright, Winston, and Zappe, 1999, *Data Analysis and Decision Making with Microsoft Excel*, Duxbury Press, Pacific Grove, California.

Broadie, M. and P. Glasserman, eds., 1998, *Hedging with Trees: Advances in Pricing and Hedging Complex Financial Instruments*, RISK Books, London, England.

Broadie, M. and P. Glasserman, 1998, "Monte Carlo Methods in Option Pricing and Risk Management," in *Risk Management and Analysis: Volume 1: Measuring and Modeling Financial Risk*, 2nd edition, ed: C. Alexander, John Wiley & Sons, Chichester, England, 173-208.

Broadie, M. and J. Detemple, 1997, "Recent Advances in American Option Pricing," in *Numerical Methods in Finance*, eds: L.C.G. Rogers and D. Talay, Cambridge University Press, Cambridge, 43-66.

Papers in Refereed Books and Conference Proceedings

Shin, D., M. Broadie and A. Zeevi, 2016, "Tractable Sampling Strategies For Quantile-Based Ordinal Optimization," Proceedings of the 2016 Winter Simulation Conference, eds: T.M.K. Roeder, P.I. Frazier, R. Szechtman, E. Zhou, T. Huschka, and S.E. Chick, 847-858.

Broadie, M., Y. Du and C. Moallemi, 2011, "Risk Estimation via Weighted Regression," Proceedings of the 2011 Winter Simulation Conference, eds: S. Jain, R.R. Creasey, J. Himmelspach, K.P. White, and M. Fu, Piscataway, New Jersey: Institute of Electrical and Electronics Engineers, Inc., 3859-3870.

Andersen, L. and M. Broadie, 2010, "Early Exercise Options: Upper Bounds," chapter in the *Encyclopedia of Quantitative Finance*, John Wiley and Sons.

Broadie, M. and S. Ko, 2009, "A Simulation Model to Analyze the Impact of Distance and Direction on Golf Scores," in *Proceedings of the 2009 Winter Simulation Conference*, eds: M.D. Rossetti, R.R. Hill, B. Johansson, A. Dunkin, and R.G. Ingalls, Piscataway, New Jersey: Institute of Electrical and Electronics Engineers, Inc., 3109-3120.

Broadie, M., D. Cicek and A. Zeevi, 2009, "An Adaptive Multidimensional Version of the Kiefer-Wolfowitz Stochastic Approximation Algorithm," in *Proceedings of the 2009 Winter Simulation Conference*, eds: M.D. Rossetti, R.R. Hill, B. Johansson, A. Dunkin, and R.G. Ingalls, Piscataway, New Jersey: Institute of Electrical and Electronics Engineers, Inc., 601-612.

Bansal, M. and M. Broadie, 2008, "A Simulation Model to Analyze the Impact of Hole Size on Putting in Golf," in *Proceedings of the 2008 Winter Simulation Conference*, eds: S.J. Mason, R.R. Hill, L. Mönch, O. Rose, T. Jefferson, J.W. Fowler, Piscataway, New Jersey: Institute of Electrical and Electronics Engineers, Inc., 2826-2834.

Broadie, M., 2008, "Assessing Golfer Performance Using Golfmetrics," in *Science and Golf V: Proceedings of the World Scientific Congress of Golf*, eds: D. Crews and R. Lutz, Energy in Motion Inc., Mesa, Arizona, 253-262.

Broadie, M., M. Han and A. Zeevi, 2007, "Implications of Heavy Tails on Simulation-Based Ordinal Optimization," in *Proceedings of the 2007 Winter Simulation Conference*, eds: S.G. Henderson, B. Biller, M.-H. Hsieh, J. Shortle, J.D. Tew, and R.R. Barton, The Society for Computer Simulation, 439-447.

Broadie, M. and O. Kaya, 2004, "Exact Simulation of Option Greeks under Stochastic Volatility and Jump Diffusion Models," in *Proceedings of the 2004 Winter Simulation Conference*, eds: R.G. Ingalls, M.D. Rossetti, J.S. Smith, and B.A. Peters, The Society for Computer Simulation, 1607-1615.

Acworth, P., M. Broadie, and P. Glasserman, 1998, "A Comparison of Some Monte Carlo and Quasi Monte Carlo Techniques for Option Pricing," in *Monte Carlo and Quasi-Monte Carlo Methods 1996*, eds: H. Niederreiter, P. Hellekalek, G. Larcher, P. Zinterhof, Lecture Notes in Statistics 127, Springer-Verlag, New York, 1-18.

Broadie, M. and P. Glasserman, 1997, "Monte Carlo Methods for Pricing High-Dimensional American Options: An Overview," *Net Exposure*, Issue 3 (December), 15-37. Reprinted as Chapter 16 in *Monte Carlo: Methodologies and Applications for Pricing and Risk Management*, 1998, ed: B. Dupire, RISK Books, London, 149-161.

Broadie, M. and P. Glasserman, 1995, "A Pruned and Bootstrapped American Option Simulator," in *Proceedings of the 1995 Winter Simulation Conference*, eds: Alexopoulos, Kang, Lilegdon, and Goldsman, The Society for Computer Simulation, San Diego, CA, 229-235.

Boyle, P., M. Broadie, and P. Glasserman, 1995, "Recent Advances in Simulation for Security Pricing," in *Proceedings of the 1995 Winter Simulation Conference*, eds: Alexopoulos, Kang, Lilegdon, and Goldsman, The Society for Computer Simulation, San Diego, CA, 212-219. This paper was selected in 2007 as a landmark paper in the four decades of the Winter Simulation Conference and reprinted in *Proceedings of the 2007 Winter Simulation Conference*, eds: S.G. Henderson, B. Biller, M.-H. Hsieh, J. Shortle, J.D. Tew, and R.R. Barton, The Society for Computer Simulation.

Publications in the Popular Press and Book Reviews

Broadie, M., July 2015, "Why Tiger's Consecutive Rounds Streak Might Be Better Than Joe DiMaggio's," *GOLF* magazine feature article. `http://www.golf.com/tour-and-news/tiger-woods-consecutive-rounds-streak-might-be-better-joe-dimaggios`

Monthly column in *GOLF* magazine since June 2014.

Broadie, M., 1996, "Shifty Pricing of Discrete Barrier Options," *Derivatives Week*, September 23.

Broadie, M., 1994, Review of the book *Portfolio Management: New Models for Successful Investment Decisions* by C. Kenneth Jones, *Journal of Finance*, Vol.49, No.1, 361-364.

Courses Taught

MBA level courses:
○ B8131: Sports Analytics
○ B6101: Business Analytics
○ B8835: Security Pricing: Models and Computation
○ B9801-18: Analytical Models in Finance
○ B6015: Decision Models
○ B8834: Decision Models II
○ B6014: Statistics

EMBA level courses:
○ B7311: Derivatives (previously titled Options Markets)
○ B7835: Security Pricing: Models and Computation

Ph.D. level courses:
○ Computational Finance
○ Computing for Business Research
○ Foundations of Optimization
○ Seminar in Fixed Point Methods

Cases written
○ Soccer Expected Goals (xG) (Columbia CaseWorks case id: 210205)
○ Clutch and Overall Performance in Major League Baseball (MLB) (Columbia CaseWorks case id: 210203)
○ Draft Analysis (Columbia CaseWorks case id: 210202)
○ Pandora Internet Radio (Columbia CaseWorks case id: 140202)
○ Evaluating the Legacy Distribution Process at Zara (Columbia CaseWorks case id: 140204)
○ Evaluating BOPS at Home and Kitchen (Columbia CaseWorks case id: 140205)
○ Tahoe Healthcare Systems (Columbia CaseWorks case id: 140206)

Grants and Awards

Golf Digest Research Award, best paper in the category of "The Golfer" at the World Scientific Congress of Golf, March 2012.

Dean's Award for Teaching Excellence, December 2010.

NSF Grant DMS-0914529 (2009-2013), Computational Methods in Risk Management and Financial Engineering (joint with Steve Kou and Paul Glasserman).

The paper "Recent Advances in Simulation for Security Pricing," co-authored with P. Boyle and P. Glasserman, was selected in 2007 as a landmark paper in the four decades of the Winter Simulation Conference.

United States Golf Association Grant 2007-2009.

Intel Corporation Grant: Acceleration of Financial Applications Through Hardware and Software Design (2007-2009).

JPMorgan Academic Outreach Program Grant (2007 and 2008).

Credit Suisse Grant (2007-2008).

NSF Grant DMS-0410234 (2004-2008), Computational Methods in Financial Engineering (joint with Steve Kou and Paul Glasserman).

Dean's Award for Innovation in the Curriculum, December 2001.

NSF Grant DMS-0074637 (2000-2003) Computational Methods in Financial Engineering (joint with Steve Kou and Paul Glasserman).

Finalist, 1996, 1997, 1998, 1999 Columbia University Presidential Teaching Award.

Institute for Quantitative Research in Finance research grant 1987 (joint with Suresh Sundaresan).

Outside Activities (Recent Five Years)

Consulting

Consultant for a major golf equipment manufacturer on the use of simulation and statistical analysis

Worked for Fox Sports and the USGA to analyze golf shot tracking data for the 2015-2018 U.S. Opens

Worked for Turner Broadcasting to analyze golf data for the Woods-Mickelson match

Sports analytics and data science consultant for SimpleBet

Speaking and Teaching Engagements

Speaker at many golf association meetings

Speaker at conference and industry workshops on quantitative methods in finance and risk management

Expert Witness

Gamecraft, LLC, v. Vector Putting, LLC, Case no. 6:12-cv-51-Orl-28-KRS (United States District Court, Middle District of Florida, Orlando Division)

Arbitration case involving a major investment bank (Michael-Shaked Group)

FINRA arbitration, Derivium Capital and Alan Grayson: report and arbitration testimony

Derivium Capital, LLC, Case no. 05-15042-JW (United States Bankruptcy Court, District of South Carolina): expert report, deposition testimony and trial testimony

Metromedia International Group, Inc., C.A. No. 3351-CC, C.A. No. 3389 (Court Of Chancery Of The State Of Delaware): expert report, deposition testimony and trial testimony

Other Activities

Academic advisory board member, Program for Financial Studies, Columbia Business School, 2009-present

Handicap research team member, United States Golf Association, 2003-present

Faculty advisor for Columbia University men's golf team

Visiting Professor of Mathematical Finance, Boston University, 2000