



## UvA-DARE (Digital Academic Repository)

### Understanding the complex dynamics of financial markets through microsimulation

Qiu, G.

**Publication date**  
2011

[Link to publication](#)

#### **Citation for published version (APA):**

Qiu, G. (2011). *Understanding the complex dynamics of financial markets through microsimulation*.

#### **General rights**

It is not permitted to download or to forward/distribute the text or part of it without the consent of the author(s) and/or copyright holder(s), other than for strictly personal, individual use, unless the work is under an open content license (like Creative Commons).

#### **Disclaimer/Complaints regulations**

If you believe that digital publication of certain material infringes any of your rights or (privacy) interests, please let the Library know, stating your reasons. In case of a legitimate complaint, the Library will make the material inaccessible and/or remove it from the website. Please Ask the Library: <https://uba.uva.nl/en/contact>, or a letter to: Library of the University of Amsterdam, Secretariat, Singel 425, 1012 WP Amsterdam, The Netherlands. You will be contacted as soon as possible.

# Bibliography

- M. Alpert and H. Raiffa. A progress report on the training of probability assessors. *D. Kahneman, P. Slovic and A. Tversky, eds., Judgment Under Uncertainty: Heuristics and Biases, Cambridge University Press*, pages 294–305, 1982. 33
- C. Anteneodo and R. Riera. Additive-multiplicative stochastic models of financial mean-reverting processes. *Physical Review E*, 72:026106, 2005. 74
- W. B. Arthur. Inductive reasoning and bounded rationality. *American Economic Association Papers and Proceedings*, 84:406–411, 1994. 45
- R. Axelrod and L. Tesfatsion, editors. *A Guide for Newcomers to Agent-Based Modeling in the Social Sciences*. 2006. 40
- P. Bak, M. Paczuski, and M. Shubik. Price variations in a stock market with many agents. *Physica A*, 246:430–453, 1997. 46, 52, 74
- G. Bakshi, C. Cao, and Z. Chen. Empirical performance of alternative option pricing models. *The Journal of Finance*, 52(5):2003–2049, 1997. 13, 17, 20
- S. Bandini, S. Manzoni, A. Naimzada, and G. Pavesi. A CA approach to study complex dynamics in asset markets. *Proceedings of the 6th International Conference on Cellular Automata for Research and Industry*, pages 591–600, 2004. 58
- N. Barberis and R. Thaler. A survey of behavioral finance. *G.M. Constantinides, M. Harris and R. Stulz, eds., Handbook of the Economics of Finance, Elsevier*, pages 1051–1121, 2003. 33, 34

- M. Bartolozzi and A. W. Thomas. Stochastic cellular automata model for stock market dynamics. *Physical Review E*, 69:046112, 2004. 47, 52, 74
- W. J. Baumol. Speculation, probability, and stability. *The Review of Economics and Statistics*, 39(3):263–271, 1957. 68
- A. Beja and M. B. Goldman. On the dynamic behavior of prices in disequilibrium. *The Journal of Finance*, 35(2):235–248, 1980. 68
- A. K. Bera and M. L. Higgins. ARCH models: Properties, estimation and testing. *Journal of Economic Surveys*, 7(4):307–366, 1993. 19
- F. Black. Fact and fantasy in the use of options. *Financial Analysts Journal*, 31(4):36–72, 1975. 13
- F. Black and M. Scholes. The pricing of options and corporate liabilities. *Journal of Political Economy*, 81(2):637–654, 1973. 6, 13, 25, 76
- J. Black, N. Hashimzade, and G. Myles. *A Dictionary of Economics*. Oxford University Press, 2002. 26
- T. Bollerslev. Generalized autoregressive conditional heteroskedasticity. *Journal of Econometrics*, 31:307–327, 1986. 18
- J.-P. Bouchaud and M. Potters. *Theory of Financial Risks*. Cambridge University Press, Cambridge, UK, 2000. 28
- W. A. Brock and C. H. Hommes. A rational route to randomness. *Econometrica*, 65:1059–1095, 1997. 6
- M. Buchanan. This economy does not compute. *The New York Times*, 1, October, 2008. 30, 48
- M. Buchanan. Meltdown modeling: Could agent-based computer models prevent another financial crisis? *Nature*, 460:680–682, 2009. 48
- A. Buraschi and A. Jiltsov. Model uncertainty and option markets with heterogeneous beliefs. *The Journal of Finance*, 61(6):2841–2897, 2006. 44

- D. Challet and Y.-C. Zhang. Emergence of cooperation and organization in an evolutionary game. *Physica A*, 246:407–418, 1997. 45, 46
- R. Chatagny and B. Chopard. A microscopic model of the foreign exchange market. *Proceedings of the First Econophysics Workshop*, pages 106–121, 1997. 42
- S. Ciliberti, J.-P. Bouchaud, and M. Potters. Smile dynamics — a theory of the implied leverage effect. *Wilmott Journal*, 1(2):87–94, 2009. 13
- R. Cont. Empirical properties of asset returns: Stylized facts and statistical issues. *Quantitative Finance*, 1:223–236, 2001. 10
- R. Cont. Volatility clustering in financial markets: Empirical facts and agent-based models. *A. Kirman and G. Teyssiere, eds., Long Memory in Economics*, Springer, pages 289–310, 2005. 13, 19, 42, 49, 74
- R. Cont and J.-P. Bouchaud. Herd behavior and aggregate fluctuations in financial markets. *Macroeconomic Dynamics*, 4:170–196, 2000. 41, 52, 58
- R. Cont and J. da Fonseca. Dynamics of implied volatility surfaces. *Quantitative Finance*, 2:45–60, 2002. 13, 14, 77, 83, 89, 93
- R. Cont and P. Tankov. *Financial Modeling with Jump Processes*. Chapman & Hall/CRC, Boca Raton, Florida, 2004. 17
- J. C. Cox and S. A. Ross. The valuation of options for alternative stochastic processes. *Journal of Financial Economics*, 3:145–166, 1976. 20
- J. C. Cox and M. Rubinstein. *Options Markets*. Prentice Hall, Englewood Cliffs, 1985. 79, 80, 116
- R. H. Day and W. Huang. Bulls, bears and market sheep. *Journal of Economic Behavior and Organization*, 14:299–329, 1990. 68
- Z. Ding, C. W. J. Granger, and R. F. Engle. A long memory property of stock market returns and a new model. *Journal of Empirical Finance*, 1:83–106, 1993. 10

- J. Downes and J. E. Goodman. *Dictionary of Finance and Investment Terms*. Barron's Educational Series, Inc., 1998. 54
- L. H. Ederington and W. Guan. Why are those options smiling? *The Journal of Derivatives*, 10(2):9–34, 2002. 13, 17, 78, 80, 83, 102, 104, 120
- L. H. Ederington and J. H. Lee. The creation and resolution of market uncertainty: The impact of information releases on implied volatility. *Journal of Financial and Quantitative Analysis*, 31(4):513–539, 1996. 89
- E. Egenter, T. Lux, and D. Stauffer. Finite-size effects in Monte Carlo simulations of two stock market models. *Physica A*, 268:250–256, 1999. 63
- R. F. Engle. Autoregressive conditional heteroscedasticity with estimates of the variance of united kingdom inflation. *Econometrica*, 50(4):987–1007, 1982. 18
- E. F. Fama. Efficient capital markets: A review of theory and empirical work. *The Journal of Finance*, 25(2):383–417, 1970. 25
- J. D. Farmer. Physicists attempt to scale the ivory towers of finance. *Computing in Science and Engineering*, 1(6):26–39, 1999. 19, 25, 26, 27, 45, 49
- J. D. Farmer and D. Foley. The economy needs agent-based modeling. *Nature*, 460:685–686, 2009. 31, 48
- M. R. Fengler, W. K. Härdle, and C. Villa. The dynamics of implied volatilities: A common principal components approach. *Review of Derivatives Research*, 6(3):179–202, 2003. 13, 14, 16, 77, 83, 86, 93
- B. Fischhoff, P. Slovic, and S. Lichtenstein. Knowing with certainty: The appropriateness of extreme confidence. *Journal of Experimental Psychology: Human Perception and Performance*, 3:552–564, 1977. 33
- M. Friedman. *The Case of Flexible Exchange Rates*. Essays in Positive Economics. University Chicago Press, 1953. 34
- M. Gallegati, S. Keen, T. Lux, and P. Ormerod. Worrying trends in econophysics. *Physica A*, 370:1–6, 2006. 45

- J. Gatheral. *The Volatility Surface: A Practitioner's Guide*. John Wiley & Sons, 2006. 17
- H. Geman. *Commodities and Commodity Derivatives: Modeling and Pricing for Agriculturals, Metals and Energy*. John Wiley & Sons, 2005. 13, 89
- P. S. Goodman. Taking hard new look at a greenspan legacy. *The New York Times*, 9, October, 2008. 76
- J. M. Grandmont. On endogenous competitive business cycles. *Econometrica*, 53:995–1045, 1985. 5
- D. M. Guillaume, M. M. Dacorogna, R. R. Davé, U. A. Müller, R. B. Olsen, and O. V. Pictet. From the bird's eye to the microscope: A survey of new stylized facts of the intra-daily foreign exchange markets. *Finance and Stochastics*, 1: 95–125, 1997. 10
- P. S. Hagan, D. Kumar, A. S. Lesniewski, and D. E. Woodward. Managing smile risk. *Wilmott*, 1(8):84–108, 2002. 21, 24
- L. Harris and E. Gurel. Price and volume effects associated with changes in the S&P 500: New evidence for the existence of price pressure. *The Journal of Finance*, 41:851–860, 1986. 34
- C. H. Hommes. Heterogeneous agent models in economics and finance. *L. Tesfatsion and K.L. Judd, eds., Handbook of Computational Economics, Volume 2: Agent-Based Computational Economics, North-Holland*, 2006. 25, 26, 27, 29, 38
- C. H. Hommes and F. Wagener. Complex evolutionary systems in behavioral finance. *T. Hens and K.R. Schenk-Hoppé, eds., Handbook of Financial Markets: Dynamics and Evolution, Elsevier*, pages 217–276, 2009. 32
- J. C. Hull. *Options, Futures, and Other Derivatives*. Prentice Hall, Upper Saddle River, NJ, 2003. 3, 4, 13, 17, 23, 89, 96, 112
- J. C. Hull. *Fundamentals of Futures and Options Markets*. Prentice Hall, 2004. 2

- G. Iori. A microsimulation of traders activity in the stock market: The role of heterogeneity, agents' interactions and trade frictions. *Journal of Economic Behavior and Organization*, 49:269–285, 2002. 42, 52, 74
- N. F. Johnson, P. Jefferies, and P. M. Hui. *Financial Market Complexity: What Physics Can Tell Us about Market Behavior*. Oxford University Press, 2003. 2, 4, 13, 27, 28, 46, 78
- D. Kahneman and A. Tversky. Prospect theory: An analysis of decision under risk. *Econometrica*, 47(2):263–291, 1979. 33
- J. Lakonishok, L. Inmoo, N. D. Pearson, and A. M. Poteshman. Option market activity. *The Review of Financial Studies*, 20(3):813–857, 2007. 77, 92, 95
- M. Levy, H. Levy, and S. Solomon. *Microscopic Simulation of Financial Markets*. Academic Press, San Diego, 2000. 27, 43, 56, 110
- S. Lohr. In modeling risk, the human factor was left out. *The New York Times*, 4 November, 2008. 31
- C. Lord, L. Ross, and M. Lepper. Biased assimilation and attitude polarization: The effects of prior theories on subsequently considered evidence. *Journal of Personality and Social Psychology*, 37:2098–2109, 1979. 33
- T. Lux and M. Marchesi. Volatility clustering in financial markets: A microsimulation of interacting agents. *International Journal of Theoretical and Applied Finance*, 3:675–702, 2000. 81
- T. Lux and M. Marchesi. Scaling and criticality in a stochastic multi-agent model of a financial market. *Nature*, 397:498–500, 1999. 40, 52, 74
- J. D. Macbeth and L. J. Merville. An empirical examination of the Black-Scholes call option pricing model. *The Journal of Finance*, 34(5):1173–1186, 1979. 13
- B. Mandelbrot. The variation of certain speculative prices. *The Journal of Business*, 36:394, 1963. 10, 17

- R. N. Mantegna and H. E. Stanley. *An Introduction to Econophysics: Correlations and Complexity in Finance*. Cambridge University Press, 2000. 10, 19, 25, 26, 27, 29, 45, 46
- R. N. Mantegna and H. E. Stanley. Scaling behavior in the dynamics of an economic index. *Nature*, 376:46–49, 1995. 11
- A. Marshall. *Principles of Economics*. Macmillan & Co., London, 1890. 56
- P. Maymin. Prospect theory and fat tails. *Risk and Decision Analysis*, 1:187–195, 2009. 36
- G. McQueen and K. Vorkink. Whence GARCH? A preference-base explanation for conditional volatility. *The Review of Financial Studies*, 17(4):915–949, 2004. 36
- R. Mehra and E. C. Prescott. The equity premium: A puzzle. *Journal of Monetary Economics*, 15:145–161, 1985. 35
- R. W. Melicher and E. A. Norton. *Introduction to Finance: Markets, Investments, and Financial Management*. John Wiley & Sons, 2008. 2, 3
- R. C. Merton. Theory of rational option pricing. *The Bell Journal of Economics and Management Science*, 4(1):141–183, 1973. 6, 13, 25, 76
- U. A. Müller, M. M. Dacorogna, R. B. Olsen, O. V. Pictet, M. Schwarz, and C. Morgeneegg. Statistical study of foreign exchange rates, empirical evidence of a price change scaling law, and intraday analysis. *Journal of Banking and Finance*, 14:1189–1208, 1990. 11
- S. Natenberg. *Option Volatility and Pricing: Advanced Trading Strategies and Techniques*. McGraw-Hill, 1994. 77, 96
- A. Pagan. The econometrics of financial markets. *Journal of Empirical Finance*, 3:15–102, 1996. 10
- E. Platen and M. Schweizer. On feedback effects from hedging derivatives. *Mathematical Finance*, 8(1):67–84, 1998. 43



- G. Qiu, D. Kandhai, and P. M. A. Sloot. Understanding the complex dynamics of stock markets through cellular automata. *Physical Review E*, 75:046116, 2007. 49, 78
- G. Qiu, D. Kandhai, N. F. Johnson, and P. M. A. Sloot. Why do options markets smile? *Submitted*, 2010a. 77
- G. Qiu, D. Kandhai, and P. M. A. Sloot. Modeling options markets by focusing on active traders. *Procedia Computer Science: International Conference on Computational Science, ICCS 2010*, 1:2451–2456, 2010b. 77
- G. Qiu, D. Kandhai, and P. M. A. Sloot. Effects of heterogeneous speculative strategies on the volatility smile: A microsimulation study. *Working paper, University of Amsterdam*, 2010c. 95, 103
- M. Rabin. Psychology and economics. *Journal of Economic Literature*, 36:11–46, 1998. 35
- R. Rebonato. *Volatility and Correlation: The Perfect Hedger and the Fox*. John Wiley & Sons, Chichester, 2004. 13, 14, 17, 20, 22
- B. Rexhepi. The volatility smile dynamics implied by smile-consistent option pricing models and empirical data. *Master Thesis of the University of Amsterdam*, 2008. 14, 16, 22, 23, 24, 120
- D. Rickles. Econophysics and the complexity of financial markets. *J. Collier and C. Hooker, eds., Handbook of the Philosophy of Science, Elsevier*, pages 289–310, 2008. 30, 45
- M. Rubinstein. Displaced diffusion option pricing. *The Journal of Finance*, 38(1): 213–217, 1983. 20
- M. Rubinstein. Nonparametric test of alternative option pricing models using all reported trades and quotes on the 30 most active CBOE option classes from august 23, 1976 through august 31, 1978. *The Journal of Finance*, 40(2): 455–480, 1985. 13

- M. Rubinstein. Implied binomial trees. *The Journal of Finance*, 49(3):771–818, 1994. 89
- W. F. Sharpe. Capital asset prices: A theory of market equilibrium under conditions of risk. *The Journal of Finance*, 19(3):425–442, 1964. 25, 26
- H. Shefrin. *Behavioral Approach to Asset Pricing*. Academic Press, San Diego, 2008. 36, 37
- H. Shefrin. Irrational exuberance and option smiles. *Financial Analysts Journal*, November/December:91–103, 1999. 37, 94
- A. Shleifer. Do demand curves for stocks slope down? *The Journal of Finance*, 41:579–590, 1986. 34
- J. J. Siegel and R. H. Thaler. Anomalies: The equity premium puzzle. *The Journal of Economic Perspectives*, 11:191–200, 1997. 35
- H. A. Simon. The architecture of complexity. *Proceedings of the American Philosophical Society*, 106:467–482, 1962. 5
- J. D. Sterman. *Business Dynamics: Systems Thinking and Modeling for A Complex World*. McGraw-Hill, 2000. 30
- A. Subrahmanyam. Behavioral finance: A review and synthesis. *European Financial Management*, 14:12–29, 2007. 35
- D. Talia and P. M. A. Sloot. Cellular automata: Promise and prospects in computational science. *Future Generation of Computer Systems*, 16:v, 1999. 42
- L. Tesfatsion. Agent-based computational economics: Growing economies from the bottom up. *Artificial Life*, 8:55–82, 2002. 25, 26, 27, 29, 38, 110
- R. H. Thaler. The end of behavioral finance. *Financial Analysts Journal*, November/December:12–17, 1999. 35
- R. G. Tompkins. Implied volatility surfaces: Uncovering regularities for options on financial futures. *The European Journal of Finance*, 7:198–230, 2001. 13

- J. Voit. *The Statistical Mechanics of Financial Markets*. Springer-Verlag, 2003. 10, 29, 74
- Z. Wang. Microsimulation of financial markets. *Master Thesis of the University of Amsterdam*, 2005. 41, 42, 47
- N. D. Weinstein. Unrealistic optimism about future life events. *Journal of Personality and Social Psychology*, 39:806–820, 1980. 33
- E. C. Zeeman. The unstable behavior of stock exchange. *Journal of Mathematical Economics*, 1:39–49, 1974. 5