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The virtues and vices of equilibrium and the future of financial economics

J. Doyne Farmer, John Geanakoplos

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Abstract

The use of equilibrium models in economics springs from the desire for parsimonious models of economic phenomena that take human reasoning into account. This approach has been the cornerstone of modern economic theory. We explain why this is so, extolling the virtues of equilibrium theory; then we present a critique and describe why this approach is inherently limited, and why economics needs to move in new directions if it is to continue to make progress. We stress that this shouldn't be a question of dogma, and should be resolved empirically. There are situations where equilibrium models provide useful predictions and there are situations where they can never provide useful predictions. There are also many situations where the jury is still out, i.e., where so far they fail to provide a good description of the world, but where proper extensions might change this. Our goal is to convince the skeptics that equilibrium models can be useful, but also to make traditional economists more aware of the limitations of equilibrium models. We sketch some alternative approaches and discuss why they should play an important role in future research in economics. © 2008 Wiley Periodicals, Inc. Complexity, 2009

REFERENCES

1 Arrow, K. J.; Debreu, G. Existence of an equilibrium for a competitive economy. *Econometrica* 1954, **22**, 265–290.

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4 D. Kahneman; A. Tversky, Eds. *Choices, Values, and Frames*; Cambridge University Press: Cambridge, 2000.

Google Scholar

5 Brock, W. A.; Hommes, C. H. Models of complexity in economics and finance. In: *System Dynamics in Economic and Financial Models*; C. Hey; J. Schumacher; B. Hanzon; C. Praagman, Eds.; Wiley: New York, 1997; pp 3–41.

Web of Science® Google Scholar

6 Brock, W. A.; Hommes, C. H. Heterogeneous beliefs and routes to chaos in a simple asset pricing model. *J Econ Dynam Control* 1998, **22**, 1235–1274.

Web of Science® Google Scholar

7 Brock, W. A.; Hommes, C. H. Rational animal spirits. In: *The Theory of Markets*; P. Herings; G. van der Laan; A. Talman, Eds.; North Holland: Amsterdam, 1999; pp 109–137.

Google Scholar

8 Schleifer, A. *Clarendon Lectures: Inefficient Markets*; Oxford University Press: Oxford, 2000.

Google Scholar

9 Delong, J. B.; Schleifer, A.; Summers, L. H.; Waldmann, R. J. Positive feedback and destabilizing rational speculation. *J Finance* 1990, **45**, 379–395.

Web of Science® Google Scholar

10 Sargent, T. J. *Bounded Rationality in Macroeconomics*; Oxford University Press: Oxford, 1993.

Google Scholar

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Google Scholar

13 Spence, A. *Market signaling: Informational transfer in hiring and related screening processes*; Harvard University Press: Cambridge, 1974.

Google Scholar

14 Stiglitz, J. Credit rationing in markets with imperfect information. *Am Econ Rev* 1981, **71**, 393–410.

Web of Science® Google Scholar

15 Dubey, P.; Geanakoplos, J.; Shubik, M. Default and punishment in general equilibrium. *Econometrica* 2005, **73**, 1–37.

Web of Science® Google Scholar

16 Geanakoplos, J. Promises, promises. In: *The Economy as an Evolving Complex System, II*; W. B. Arthur; S. N. Durlauf; D. H. Lane, Eds.; Addison-Wesley: Reading, 1997; pp 285–320.

Google Scholar

17 Geanakoplos, J. Liquidity, default, and crashes: Endogenous contracts in general equilibrium. In: Advances in Economics and Econometrics: Theory and Applications, Eighth World Congress, Vol. **3**; M. Dewatripont; L. P. Hansen; S. J. Turnovsky, Eds.; Cambridge University Press: Cambridge, 2003; pp 170–205.

Google Scholar

18 Arrow, K. J. An extension of the basic theorems of classical welfare economics. In: *Proceedings of the Second Berkeley Symposium on Mathematical Statistics*; University of California Press: Berkeley, 1951; pp 507–532.

Google Scholar

19 Debreu, G. The coefficient of resource utilization. *Econometrica* 1951, **19**, 273–292.

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21 Geanakoplos, J.; Polemarchakis, H. Existence, regularity, and constrained suboptimality of competititve allocations when the asset market is incomplete. In: Essays in Honor of Kenneth J. Arrow; Uncertainty, Information and Communication, Vol. **3**; W. P. Heller; R. M. Starr; D. A. Starrett, Eds.; Cambridge University press: Cambridge, 1986, pp. 65–96.

Google Scholar

22 Fama, E. F. Efficient capital markets: A review of theory and empirical work. *J Finance* 1970, **25**, 383–417.

Web of Science® | Google Scholar

23 Fama, E. F. Efficient capital markets: II. *J Finance* 1991, **46**, 1575–1617.

Web of Science® | Google Scholar

24 Roll, R. Orange juice and weather. *Am Econ Rev* 1984, 861–880.

Web of Science® | Google Scholar

25 Ross, S. *Neoclassical Finance*; Princeton University Press: Princeton, NJ, 2004.

Google Scholar

26 Lucas, R. E. *Econometric policy evaluation: A critique, Carnegie Rochester Conf Series Public Policy* 1976, vol. **1**, 19–46.

Web of Science® | Google Scholar

27 Sims, C. A. Macroeconomics and reality. *Econometrica* 1980, **48**, 1–48.

CAS | Web of Science® | Google Scholar

28 Berns, G.; Laibson, D.; Loewenstein, G. Intertemporal choice – toward and integrative framework. *Tends Cogn Sci* 2007, **11**, 482–488.

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30 Thaler, R. *Advances in Behavioral Economics*; Russel Sage Foundation: New York, 2005.

Google Scholar

31 Fisher, F. M. *Disequilibrium Foundations of Equilibrium Economics*; Cambridge University Press: Cambridge, 1983.

Google Scholar

32 Ijiri, Y.; Simon, H. A. *Skew Distributions and the Sizes of Business Firms; Studies in Mathematical Economics*; North-Holland: Amsterdam, 1977.

Google Scholar

33 Brown, S.; Goetzmann, W. N.; Ross, S. Survival. *J Finance L* 1995, **3**, 853–873.

Web of Science® Google Scholar

34 Markowitz, H. Portfolio selection. *J Finance* 1952, **7**, 77–91.

Web of Science® Google Scholar

35 Tobin, J. Liquidity preference as behavior towards risk. *Rev Econ Studies* 1958, **25**, 65–86.

Web of Science® Google Scholar

36 Lintner, J. The valuation of risky assets and the selection of risky investments in stock portfolios and capital budgets. *Rev Econ Stat* 1965, **47**, 13–37.

Web of Science® Google Scholar

37 Sharpe, W. F. Capital asset prices: A theory of market equillibrium under conditions of risk. *J Finance* 1964, **19**, 425–442.

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Accept All

Reject Non-Essential

39 Sebenius, J. K.; Geanakoplos, J. Dont bet on it—Contingent agreements with asymmetric information. *J Am Stat Assoc* 1983, **78**, 424–426.

Web of Science® | Google Scholar

40 Shiller, R. J. Do stock prices move too much to be justified by subsequent changes in dividends? *Am Econ Rev* 1981, **71**, 421–436.

Web of Science® | Google Scholar

41 Shiller, R. J. *Market Volatility*; MIT Press: Cambridge, 1997.

Google Scholar

42 Odean, T. Do investors trade too much? *Am Econ Rev* 1999, **89**, 1279–1298.

Web of Science® | Google Scholar

43 Cutler, D. M.; Poterba, J. M.; Summers, L. H. What moves stock prices? *J Portfolio Manage* 1989, **15**, 4–12.

Web of Science® | Google Scholar

44 French, K.; Roll, R. Stock return variances: The arrival of information and the reaction of traders. *J Financial Econ* 1986, **17**, 5–26.

Web of Science® | Google Scholar

45 Engle, R.; Rangel, J. The spline GARCH model for unconditioanl volatlity and its global macroeconomic causes, Tech. rep., NYU and UCSD, 2005.

Google Scholar

46 Engle, R. F. Autoregressive conditional heteroscedasticity with estimates of the variance of United Kingdom inflation. *Econometrica* 1982, **50**, 987–1007.

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Reject Non-Essential

48 Mandelbrot, B. B. A subordinated stochastic process model with finite variance for speculative prices: Comment. *Econometrica* 1973, **41**, 157–59.

Web of Science® | Google Scholar

49 Clark, P. K. Subordinated stochastic process model with finite variance for speculative prices. *Econometrica* 1973, **41**, 135–155.

Web of Science® | Google Scholar

50 Ane, T.; Geman, H. Order flow, transaction clock, and normality of asset returns. *J Finance* 2000, **55**, 2259–2284.

Web of Science® | Google Scholar

51 Gillemot, L.; Farmer, J. D.; Lillo, F. There's more to volatility than volume. *Quant Finance* 2006, **6**, 371–384.

Web of Science® | Google Scholar

52 Newman, M. E. J. Power, laws, pareto distributions and zipf's law. *Contemp Phys* 2005, **46**(5), 323–351.

Web of Science® | Google Scholar

53 Farmer, J. D.; Geanakoplos, J. Power laws in economics and elsewhere, Tech. rep., Santa Fe Institute, 2005 Unfinished manuscript. www.santafe.edu/~jdfpapers/powerlaw3.pdf.

Google Scholar

54 Pareto, V. *Cours d'Economie Politique*; Droz: Geneva, 1896.

Google Scholar

55 Fama, E. F. The behavior of stock-market prices. *J Business* 1965, **38**, 34–105.

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Reject Non-Essential

Google Scholar

58 Koedijk, K. G.; Schafgans, M. M. A.; de Vries, C. G. The tail index of exchange rates. *J Int Econ* 1990, **29**(1/2), 1–197.

Google Scholar

59 Loretan, M.; Phillips, P. C. B. Testing the covariance stationarity of heavy-tailed time series: An overview of the theory with applications to several financial datasets. *J Empirical Finance* 1994, **1**, 211–248.

Google Scholar

60 Mantegna, R. N.; Stanley, H. E. Scaling behavior in the dynamics of an economic index. *Nature* 1995, **376**, 46–49.

CAS | Web of Science® | Google Scholar

61 Longin, F. M. The asymptotic distribution of extreme stock market returns. *J Business* 1996, **69**, 383–408.

Web of Science® | Google Scholar

62 Lux, T. The stable paretian hypothesis and the frequency of large returns: An examination of major german stocks. *Appl Financial Econ* 1996, **6**, 463–475.

Google Scholar

63 Muller, U. A.; Dacorogna, M. M.; Pictet, O. V. Heavy tails in high-frequency financial data. In: *A Practical Guide to Heavy Tails: Statistical Techniques and Applications*; R. J. Adler; R. E. Feldman; M. S. Taqqu, Eds.; Springer-Verlag: Berlin, 1998; pp 55–78.

Google Scholar

64 Plerou, V.; Gopikrishnan, P.; Amaral, L. A. N.; Meyer, M.; Stanley, H. E. Scaling of the distribution of price fluctuations of individual companies. *Phys Rev E Part A* 1999, **60**, 6519–6529.

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66 Goldstein, M. L.; Morris, S. A.; Yen, G. G. Problems with fitting to the power-law distribution. *Eur Phys J B* 2004, **41**, 255–258.

CAS | Web of Science® | Google Scholar

67 Gopikrishnan, P.; Plerou, V.; Gabaix, X.; Stanley, H. E. Statistical properties of share volume traded in financial markets. *Phys Rev E Part A* 2000, **62**, R4493–R4496.

CAS | Web of Science® | Google Scholar

68 Lillo, F.; Mike, S.; Farmer, J. D. Theory for long memory in supply and demand. *Phys Rev E* 2005, **7106**, 066122.

Web of Science® | Google Scholar

69 Ding, Z.; Granger, C. W. J.; Engle, R. F. A long memory property of stock returns and a new model. *J Empirical Finance* 1993, **1**, 83–106.

Web of Science® | Google Scholar

70 Breidt, F. J.; Crato, N.; de Lima, P. J. F. Modeling long-memory stochastic volatility, Journal of Econometrics, Vol. **83**, issues 1–2, March–April 1998 pp. 325–346.

Google Scholar

71 Harvey, A. C. Long-Memory in Stochastic Volatility, Working paper; London School of Economics, 1993.

Google Scholar

72 Baillie, R. T. Long-memory processes and fractional integration in econometrics. *J Econometrics* 1996, **73**, 5–59.

Web of Science® | Google Scholar

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75 Bouchaud, J.-P.; Mezard, M.; Potters, M. Statistical properties of the stock order books: Empirical results and models. *Quant Finance* 2002, **2**, 251–256.

Google Scholar

76 Zovko, I.; Farmer, J. D. The power of patience; a behavioral regularity in limit order placement. *Quant Finance* 2002, **2**, 387–392.

Google Scholar

77 Mike, S.; Farmer, J. An empirical behavioral model of liquidity and volatility. *J Econ Dynam Control* 2008, **32**, 200–234.

Web of Science® | Google Scholar

78 Bouchaud, J.-P.; Gefen, Y.; Potters, M.; Wyart, M. Fluctuations and response in financial markets: The subtle nature of "random" price changes. *Quant Finance* 2004, **4**, 176–190.

Web of Science® | Google Scholar

79 Bouchaud, J.-P.; Kockelkoren, J.; Potters, M. Random walks, liquidity molasses and critical response in financial markets. *Quant Finance* 2006, **6**, 115–123.

Web of Science® | Google Scholar

80 Lillo, F.; Farmer, J. D. The long memory of the efficient market. *Studies Nonlinear Dynam Econometrics* 2004, **8**, 1226.

Google Scholar

81 Farmer, J.; Gerig, A.; Lillo, F.; Mike, S. Market efficiency and the long-memory of supply and demand: Is price impact variable and permanent or fixed and temporary? *Quant Finance* 2006, **6**, 107–112.

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84 Plerou, V.; Amaral, L. A. N.; Gopikrishnan, P.; Meyer, M.; Stanley, H. E. Similarities between growth dynamics of university research and of competitive economic activities. *Nature* 1999, **400**, 433–437.

CAS | Web of Science® | Google Scholar

85 Lillo, F.; Farmer, J. D.; Mantegna, R. N. Master curve for price impact function. *Nature* 2003, **421**, 129–130.

CAS | PubMed | Web of Science® | Google Scholar

86 Durlauf, S. N. Complexity in economics. Working paper 03-02-014; Santa Fe Institute, 2003.

Google Scholar

87 Calvet, L.; Fisher, A. Forecasting multifractal volatility. *J Econometrics* 2002, **105**, 27–58.

Web of Science® | Google Scholar

88 Calvet, L.; Fisher, A. How to forecast long-run volatility: Regime-switching and the estimation of multifractal processes. *J Finan Econometrics* 2004, **2**, 49–83.

Google Scholar

89 Embrechts, J. P.; Kluppelberg, C.; Mikosch, T. *Modeling Extremal Events for Insurance and Finance*; Springer-Verlag: Berlin, 1997.

Google Scholar

90 Clauset, A.; Shalizi, C.; Newman, M. Power law distributions in empirical data, Tech. Rep. 07-12-049, Santa Fe Institute, 2007.

Google Scholar

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93 Khandani, A.; Lo, A. What happened to the quants in august 2007? Tech. rep., MIT, 2007.

Google Scholar

94 Fostel, A.; Geanakoplos, J. Emerging markets in an anxious global economy, Tech. Rep. 1646, Cowles Foundation Discussion Paper, 2008.

Google Scholar

95 J. H. Kagel; A. E. Roth, Eds. *The Handbook of Experiemental Economics*; Princeton University Press: Princeton, NJ, 1995.

Google Scholar

96 Shefrin, H. Behavioral Finance, Volumes **I-III**; Edward Elgar: Northampton, MA, 2001.

Google Scholar

97 Shefrin, H. *A Behavioral Approach to Asset Pricing*; Elsevier: Amsterdam, 2005.

Web of Science® Google Scholar

98 Krugman, P. What economists can learn from evolutionary theorists. a talk given to the European Association for Evolutionary Political Economy 1996, posted at http://www.pkarchive.org.

Google Scholar

99 Helbing, D. Traffic and related self-driven many-particle systems. *Rev Mod Phys* 2001, **73**, 1067–1141.

Web of Science® Google Scholar

100 Nagel, K.; Wagner, P.; Woesler, R. Still flowing: Approaches to traffic flow and traffic jam modeling. *Operat Res* 2003, **51**, 681–710.

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102 Dragulescu, A.; Yakovenko Victor, M. Exponential and power-law probability distribution of wealth and income in the united kingdom and the united states. *Physica A* 2001, **299**(1/2), 213–221.

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103 Yakovenko, V. Statistical mechanics approach to econophysics. In: *Springer Encyclopedia of Complexity and System Science*; Springer Verlag: Berlin, 2007.

Google Scholar

104 Champernowne, D. A model of income distribution. *Econ J* 1953, **63**, 318–351.

Web of Science® | Google Scholar

105 Simon, H. A. On a class of skew distribution functions. *Biometrika* 1955, **42**(3/4), 425–440.

Web of Science® | Google Scholar

106 Malcai, O.; Biham, O.; Solomon, S. Power-law distributions and Levy-stable intermittent fluctuations in stochastic systems of many autocatalytic elements. *Phys Rev E* 1999, **60**, 1299–1303.

PubMed | Web of Science® | Google Scholar

107 Sornette, D.; Cont, R. Convergent multiplicative processes repelled from zero: Power laws and truncated power laws. *J de Physique I* 1997, **7**, 431–444.

Web of Science® | Google Scholar

108 Levy, M. Market efficiency, the pareto wealth distribution, and the distribution of stock returns. In: *The Economy as an Evolving Complex System III*; S. N. Durlauf; L. E. Blume, Eds.; Oxford University Press: Oxford, 2005.

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111 Gabaix, X. Zipf's law for cities: An explanation. *Quart J Econ* 1999, **114**, 739–768.

Web of Science® | Google Scholar

112 Axtell, R. L. The emergence of firms in a population of agents: Local increasing returns, unstable Nash equilibria, and power law size distributions, Tech. Rep. 03-019-99, Santa Fe Institute, 1999.

Google Scholar

113 Axtell, R. Zipf distribution of U. S. firm size. *Science* 2001, **293**, 1818–1820.

CAS | PubMed | Web of Science® | Google Scholar

114 Glosten, L. R.; Milgrom, P. R. Bid, ask and transaction prices in a specialist market with heterogeneously informed traders. In: *Financial Intermediaries*; M. K. Lewis, Ed.; Edward Elgar: Aldershot, UK, 1995; pp 174–203.

Google Scholar

115 Sandas, P. Adverse selection and comparative market making:empirical evidence from a limit order market. *Rev Financial Studies* 2001, **14**, 705–734.

Web of Science® | Google Scholar

116 Becker, G. Irrational behavior and economic theory. *J Pol Econ* 1962, **70**, 1–13.

Web of Science® | Google Scholar

117 Gode, D. K.; Sunder, S. Allocative efficiency of markets with zero-intelligence traders: Market as a partial substitute for individual rationality. *J Pol Econ* 1993, **101**, 119–137.

Web of Science® | Google Scholar

118 Mendelson, H. Market behavior in a clearing house. *Econometrica* 1982, **50**, 1505–1524.

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120 Domowitz, I.; Wang, J. Auctions as algorithms: Computerized trade execution and price discovery. *J Econ Dynam Control* 1994, **18**, 29–60.

Web of Science® | Google Scholar

121 Bak, P.; Paczuski, M.; Shubik, M. Price variations in a stock market with many agents. *Physica A-Stat Mechan Appl* 1997, **246**, 430–453.

Web of Science® | Google Scholar

122 Bollerslev, T.; Domowitz, I.; Wang, J. Order flow and the bid-ask spread: An empirical probability model of screen-based trading. *J Econ Dynam Control* 1997, **21**, 1471–1491.

Web of Science® | Google Scholar

123 Eliezer, D.; Kogan, I. I. Scaling laws for the market microstructure of the interdealer broker markets, Tech. rep., available at: http://www.arxiv.org/abs/cond-mat/9808240, 1998.

Google Scholar

124 Maslov, S. Simple model of a limit order-driven market. *Physica A-Stat Mechan Appl* 2000, **278**(3/4), 571–578.

Web of Science® | Google Scholar

125 Slanina, F. Mean-field approximation for a limit order driven market model. *Phys Rev E* Part 2, **64** 2001, article no.056136.

Web of Science® | Google Scholar

126 Challet, D.; Stinchcombe, R. Analyzing and modeling 1+1d markets. *Physica A* 2001, **300**,(1/2) 285–299.

Web of Science® | Google Scholar

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Reject Non-Essential

Google Scholar

129 Smith, E.; Farmer, J. D.; Gillemot, L.; Krishnamurthy, S. Statistical theory of the continuous double auction. *Quant Finance* 2003, **3**, 481–514.

Web of Science® | Google Scholar

130 Farmer, J. D.; Patelli, P.; Zovko, I. The predictive power of zero intelligence in financial markets. *Proc Nal Acad Sci U S A* 2005, **102**, 2254–2259.

CAS | PubMed | Web of Science® | Google Scholar

131 Wyart, M.; Bouchaud, J.-P.; Kockelkoren, J.; Potters, M.; Vettorazzo, M. Relation between bid-ask spread, impact and volatility in double auction markets, Tech. rep., 2006.

Google Scholar

132 Grossman, S. J.; Stiglitz, J. E. On the impossibility of informationally efficient markets. *Am Econ Rev* 1980, **70**, 393–408.

Web of Science® | Google Scholar

133 Geanakoplos, J.; Milgrom, P. A theory of hierarchies based on limited managerial attention. *J Japan Int Econ* 1991, **5**, 205–225.

Web of Science® | Google Scholar

134 LeBaron, B. Agent-based computational finance: suggested readings and early research. *J Econ Dynam Control* 2000, **24**(5–7), 679–702.

Web of Science® | Google Scholar

135 Tesfatsion, L. Agent-based computational economics: A brief guide to the literature, Tech. rep., 1999.

Google Scholar

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138 Brock, W. A.; LeBaron, B. A dynamic structural model for stock return volatility and trading volume. *Rev Econ Stat* 1996, **78**, 94–110.

Web of Science® | Google Scholar

139 Caldarelli, G.; Marsili, M.; Zhang, Y.-C. A prototype model of stock exchange. *Europhys Lett* 1997, **40**, 479–484.

CAS | Web of Science® | Google Scholar

140 Chiarella, C. The dynamics of speculative behavior. *Ann Operat Res* 1992, **37**, 101–123.

Google Scholar

141 Chiarella, C.; He, X. Asset price and wealth dynamics under heterogeneous expectations. *Quant Finance* 2001, **1**, 509–526.

Google Scholar

142 Day, R. H. Bulls, bears and market sheep. *J Econ Behav Organ* 1990, **14**, 299–329.

Web of Science® | Google Scholar

143 Farmer, J. D.; Joshi, S. The price dynamics of common trading strategies. *J Econ Behav Organ* 2002, **49**, 149–171.

Web of Science® | Google Scholar

144 Kirman, A. Epidemics of opinion and speculative bubbles in financial markets. In: *Money and Financial Markets*; M. Taylor, Ed.; Blackwell: Oxford, 1991; pp 354–368.

Google Scholar

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Reject Non-Essential

147 Lux, T. The socio-economic dynamics of speculative markets: Interacting agents, chaos, and the fat tails of return distributions. *J Econ Behav Organ* 1998, **33**, 143–165.

Web of Science® | Google Scholar

148 Lux, T.; Marchesi, M. Scaling and criticality in a stochastic multi-agent model of a financial market. *Nature* 1999, **397**, 498–500.

CAS | Web of Science® | Google Scholar

149 Rieck, C. Evolutionary simulation of asset trading strategies. In: *Many-agent Simulation and Artificial Life*; E. Hillebrand; J. Stender, Eds.; IOS Press: Amsterdam, 1994; pp 112–136.

Google Scholar

150 Arthur, W. B.; Holland, J. H.; LeBaron, B.; Palmer, R.; Tayler, P. Asset pricing under endogenous expectations in an artificial stock market. In: *The Economy as an Evolving Complex System II*; W. B. Arthur; S. N. Durlauf; D. H. Lane, Eds.; Addison-Wesley: Redwood City, 1997; pp 15–44.

Google Scholar

151 Challet, D.; Marsili, M.; Zhang, Y.-C. *Minority Games*; Oxford University Press: Oxford, 2005.

Google Scholar

152 Giardina, I.; Bouchaud, J.-P. Bubbles, crashes and intermittency in agent based market models. *Eur Phys J B* 2003, **31**, 421–437.

CAS | Web of Science® | Google Scholar

153 Johnson, N. F.; Jeffries, P.; Hui, P. M. *Financial Market Complexity*; Oxford University Press: Oxford, 2003.

Google Scholar

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155 LeBaron, B. Empirical regularities from interacting long and short memory investors in an agent-based financial market. *IEEE Trans Evolution Comp* 2001, **5**, 442–455.

Web of Science® | Google Scholar

156 LeBaron, B. Calibrating an agent-based financial market, Tech. rep., Brandeis Economics Dept., 2003.

Google Scholar

157 Lux, T. The Markov-switching multifractal model of asset returns: Estimation via GMM estimation and linear forecasting of volatility. *J Business Econ Stat* 2008, **26**(2), 194–210.

Web of Science® | Google Scholar

158 Alfarano, S.; Lux, T.; Wagener, F. Empirical validation of stochastic models of interacting agents: A maximally skewed noise trader model. *Eur J Phys-Condensed Matter* 2007, **55**(2), 183–187.

Web of Science® | Google Scholar

159 Thomas, B. Alfred marshall on economic biology. *Rev Pol Econ* 1991, **3**, 1–14.

Google Scholar

160 Foster, J. Economics and the self-organization approach: Alfred marshall revisited? Econ J 1993, **103**, 975–991.

Google Scholar

161 Nelson, R. R.; Winter, S. G. *An Evolutionary Theory of Economic Change*; Harvard University Press: Cambridge, 1982.

Web of Science® | Google Scholar

162 R. England, Ed. *Evolutionary Concepts in Contemporary Economics*; University of Michigan: Ann

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164 Farmer, J. D.; Lo, A. W. Frontiers of finance: Evolution and efficient markets. *Proc Natl Acad Sci U S A* 1999, **96**, 9991–9992.

CAS | PubMed | Web of Science® | Google Scholar

165 Lo, A. Market efficiency from an evolutionary perspective, Tech. rep., MIT, 2005.

Google Scholar

166 Keim, D. B.; Madhavan, A. Anatomy of the trading process: Empirical evidence on the behavior of institutional traders. *J Financ Econ* 1995, **37**, 371–398.

Web of Science® | Google Scholar

167 Menkhoff, L. The noise trading approach—Questionnaire evidence from foreign exchange. *J Int Money Finance* 1998, **17**, 547–564.

Web of Science® | Google Scholar

168 Lillo, F.; Moro, E.; Vaglica, G.; Mantegna, R. Specialization of strategies and herding behavior of trading firms in a financial market, Tech. rep., University of Palermo 2007.

Google Scholar

169 Zovko, I.; Farmer, J. D. Correlations and clustering in the trading of members of the London Stock Exchange. In: *Complexity, Metastability and Nonextensivity: An International Conference*; S. Abe; T. Mie; H. Herrmann; P. Quarati; A. Rapisarda; C. Tsallis, Eds.; AIP Conference Proceedings; Springer, 2007.

Google Scholar

170 Friedman, M. *Essays in Positive Economics*; University of Chicago Press: Chicago, 1953.

Google Scholar

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