The Impact of Imitation on Long Memory in an Order-Driven Market

| Symposium Article | Published: 02 November 2008

| Volume 34, pages 504–517, (2008) Cite this article

Eastern Economic Journal

Aims and scope →

Submit manuscript →

Blake LeBaron[1] & Ryuichi Yamamoto[2]

Abstract

Recent research has documented that learning and evolution are capable of generating many well-known features in financial times series. We extend the results of LeBaron and Yamamoto (2007) to explore the impact of varying amounts of imitation and agent learning in a simple order-driven market. We show that in our framework, imitation is critical to the generation of long memory persistence in many financial time series. This shows that imitation across trader behavior is probably crucial for understanding the dynamics of prices and trading volume.

Notes

1. We are grateful to four anonymous referees who provided useful suggestions and feedback. Barkley Rosser provided useful comments on the authors' earlier work that inspired the research questions addressed in this paper.

2. See LeBaron [2001b] for an example of how endogenously changing heterogeneity in investor strategies can impact observed market behavior.

3. See Khandani and Lo [2007] for information on how this situation might occur with quantitative hedge funds.

4. The use of k here represents a crude form of heterogeneous risk aversion in our population. Both buyers and sellers demand some premium beyond their risk neutral price. In this sense we are assuming that the actual risk of placing the order dominates any impact on the agents' portfolio. As a practical matter this also keeps traders from churning their portfolios at the same buy and sell prices. We model k as symmetric since we are not modeling any specific differences between buying and selling behavior. Also, there is some empirical evidence on the symmetry of order placement in Mike and Farmer [2008].

5. We have performed robustness checks on our mutation rate. For values of $p_m = 0, 0.08, 0.12, 0.16$ our results are unchanged. As the mutation rate gets very high, the selective impact of the GA is driven to zero, and the results will disappear for relatively large values of p_m. We have performed further robustness checks on other parameters used in our simulations. Specifically,

we have varied σ_1, the standard deviation of the fundamental forecasts from 0.5 to 1.5 from our original value of 1. We have also varied σ_2 the chartist forecasting component from 1 to 2 from the original value of 1.5, and the noise standard deviation, σ_n, from 0.3 to 0.7 from our original value of 0.5. Finally, we have adjusted k_{max}, the spread parameter length from 0.3 to 0.7. In all these cases we find that our results do no change significantly.

6. See Vriend [2000] for a general discussion.

7. It is beyond the scope of this paper to discuss long-memory processes. Interested readers should consult some recent surveys which include Baillie [1996], Robinson [2003], and Doukhan et al. [2003]. See also Parke [1999] for examples, intuition and discussion. Recent work in finance shows that volatility is a likely candidate for long memory even at longer horizons than intraday. For examples see Ding et al. [1993], Baillie et al. [1996], and Andersen et al. [2003].

8. The Lo test is one of many long memory tests, and is based on earlier R/S analysis. The test has been criticized in Teverosvsky et al. [1999] and Willinger et al. [1999]. Their Monte-Carlo experiments show that the test can accept the null of no long-range dependence as the bandwidth parameter is increased. We are concerned about this, but in most of our runs this low power problem is not an issue since we are rejecting the null hypothesis. We are also exploring the use of some other long-range diagnostics such as Giraitis et al. [2003a, 2003b].

9. We have also experimented with smaller order blocks, specifically 10 units. These blocks were not able to generate long memory in any of our time series. Obviously, there are many ways to implement order splitting, and we are continuing to explore the differences between these mechanisms, and our imitative framework.

References

Andersen, Torben G., Tim Bollerslev, Francis X. Diebold, and Paul Labys . 2003. Modeling and Forecasting Realized Volatility. Econometrica, 96: 579–625.

Article Google Scholar

Arthur, W.Brian, John Holland, Blake LeBaron, Richard Palmer, and Paul Tayler . 1997. Asset Pricing Under Endogenous Expectations in an Artificial Stock Market, in The Economy as an Evolving Complex System II, edited by W. Brian Arthur, Steven N. Durlauf, and David A. Lane, Reading, MA: Addison-Wesley, 15–44.

Google Scholar

Baillie, Richard T., T. Bollerslev, and H.-O. Mikkelsen . 1996. Fractionally Integrated Generalized Autoregressive Conditional Heteroskedasticity. Journal of Econometrics, 74: 3–30.

Article Google Scholar

Baillie, Richard T . 1996. Long Memory Processes and Fractional Integration in Econometrics. Journal of Econometrics, 73: 5–59.

Article Google Scholar

Bouchaud, Jean-Philippe, Yuval Gefen, Marc Potters, and Matthieu Wyart . 2004. Fluctuations and Response in Financial Markets: The Subtle Nature of ‘random’ Price Changes. Quantitative Finance, 4: 176–190.

Article Google Scholar

Chen, Shu-Heng, and Chia-Hsuan Yeh . 2001. Evolving Traders and the Business School with Genetic Programming: A New Architecture of the Agent-based Artificial Stock Market. Journal of Economic Dynamics and Control, 25: 363–394.

Article Google Scholar

Chiarella, Carl, and Giulia Iori . 2002. A Simulation Analysis of the Microstructure of Double Auction Markets. Quantitative Finance, 2: 346–353.

Article Google Scholar

Chiarella, Carl, Giulia Iori, and Josep Perello . 2004. The Impact of Heterogeneous Trading Rules on the Limit Order Book and Order Flows, Technical Report, Department of Economics, City University London.

Cohen, Kalman J., Steven F. Maier, Robert A. Schwartz, and David K. Whitcomb . 1983. A Simulation Model of Stock Exchange Trading. Simulation, 41: 181–191.

Article Google Scholar

Ding, Zhuanxin, Clive W.J. Granger, and Robert F. Engle . 1993. A Long Memory Property of Stock Market Returns and a New Model. Journal of Empirical Finance, 1: 83–106.

Article Google Scholar

Domowitz, Ian, and Jianxin Wang . 1994. Auctions as Algorithms: Computerized Trade Execution and Price Discovery. Journal of Economic Dynamics and Control, 18: 29–60.

Article Google Scholar

Doukhan, Paul, George Oppenheim, and Murad Taqqu . 2003. Theory and Applications of Long Range Depedence. Basel: Birkhauser.

Google Scholar

Farmer, J.Doyne, Paolo Patelli, and Ilija Zovko . 2005. The Predictive Power of

Zero Intelligence Models in Financial Markets. Proceedings of the National Academy of Sciences of the United States of America, 102: 2254–2259.

Article Google Scholar

Giraitis, Liudas, Piotr Kokosza, Remigijus Leypus, and Gilles Teyssiere . 2003a. Rescaled Variance and Related Tests for Long Memory in Volatility and Levels. Journal of Econometrics, 112: 265–294.

Article Google Scholar

Giraitis, Liudas, Piotr Kokosza, Remigijus Leypus, and Gilles Teyssiere . 2003b. On the Power of R/S Type Tests Under Contiguous and Semi-long Memory Aternatives. Acata Applicandae Mathematicae, 78: 285–299.

Article Google Scholar

Gode, Dhananjay K., and Shyam Sunder . 1993. Allocative Efficiency of Markets with Zero Intelligence Traders. Journal of Political Economy, 101: 119–137.

Article Google Scholar

Goettler, R., C.A. Parlour, and U. Rajan . 2005. Equilibrium in a Dynamic Limit Order Market. Journal of Finance, 60: 2149–2192.

Article Google Scholar

Granger, Clive W . 1980. Long Memory Relationships and the Aggregation of Dynamic Models. Journal of Econometrics, 14: 227–238.

Article Google Scholar

Khandani, Amir, and Andrew W. Lo . 2007. What Happened to the Quants in August 2007? Journal of Investment Management, 5: 29–78.

Google Scholar

Ladley, Dan, and Klaus R. Schenk-Hoppe . 2007. Do Stylized Facts of Order Book Markets Need Strategic Behavior, Technical Report, University of Leads.

LeBaron, Blake . 2001a. Evolution and Time Horizons in an Agent Based Stock Market. Macroeconomic Dynamics, 5 (2): 225–254.

Article Google Scholar

LeBaron, Blake . 2001b. Financial Market Efficiency in a Coevolutionary Environment, in Proceedings of the Workshop Simulation of Social Agents: Architectures and Institutions, edited by David Sallach and Thomas Wolsko, Argonne National Laboratories, Argonne, IL: pp. 33–51.

Google Scholar

LeBaron, Blake, and Ryuichi Yamamoto . 2007. Long-memory in an Order-driven Market. Physica A, 383: 85–89.

Article Google Scholar

Lillo, Fabrizio, and J. Doyne Farmer . 2004. The Long Memory of the Efficient Market. Studies in Nonlinear Dynamics and Econometrics, 8 (3): 1–32.

Google Scholar

Lillo, Fabrizio, Szabolcs Mike, and J. Doyne Farmer . 2005. Theory for Long Memory in Supply and Demand. Physica Review E, 7106: 287–297.

Google Scholar

Lo, Andrew W . 1991. Long-Term Memory in Stock Market Prices. Econometrica, 59: 1279–1314.

Article Google Scholar

Mike, Szabolcs, and J.Doyne Farmer . 2008. An Empirical Behavioral Model of Liquidity and Volatility. Journal of Economic Dynamics and Control, 32: 200–234.

Article Google Scholar

Parke, William R . 1999. What is Fractional Integration? Review of Economics and Statistics, 81 (4): 632–638.

Article Google Scholar

Robinson, Peter M . 1978. Statistical Inference for a Ranom Coefficient Autoregressive Model. Scandanavian Journal of Statistics, 5: 163–168.

Google Scholar

Robinson, Peter M . 2003. Long Memory Time Series, in Time Series with Long Memory, edited by Peter M. Robinson, Oxford: Oxford University Press.

Google Scholar

Teverosvsky, Vadim, Murad Taqqu, and Walter Willinger . 1999. A Critical Look at Lo's Modified R/S Statistic. Journal of Statistical Planning and Inference, 80: 211–227.

Article Google Scholar

Vriend, Nicolaas J . 2000. An Illustration of the Essential Difference Between Individual and Social Learning, and its Consequences for Computational Analysis. Journal of Economic Dynamics and Control, 24: 1–19.

Article Google Scholar

Willinger, Walter, Murad Taqqu, and Vadim Teverosvsky . 1999. Stock Market Prices and Long Range Dependence. Finance and stochastics, 3: 1–13.

Article Google Scholar

Author information

Authors and Affiliations

International Business School, Brandeis University, 415 South Street, Mailstop 32, Waltham, 02453-2728, MA, USA

Blake LeBaron

Department of International Business, National Chengchi University, 64 Sec.2, Zhi-Nan Road, Taipei, Taiwan

Ryuichi Yamamoto

Rights and permissions

About this article

Cite this article

LeBaron, B., Yamamoto, R. The Impact of Imitation on Long Memory in an Order-Driven Market. *Eastern Econ J* **34**, 504–517 (2008). https://doi.org/10.1057/eej.2008.32

Published	Issue date
02 November 2008	01 October 2008

DOI

https://doi.org/10.1057/eej.2008.32

Keywords

learning evolution market microstructure long memory

JEL Classifications

G12 G14 D83

Search

Search by keyword or author

Navigation

Find a journal

Publish with us

Track your research