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Herd behaviour experimental testing in laboratory artificial stock market settings. Behavioural foundations of stylised facts of financial returns

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HIGHLIGHTS

- Evidence of more herding in a group of stocks.
- Herding does not exhibit the long-run mispricing of assets.
- Greater genetic diversity is leading to less herding.
- The market is more efficient in the presence of more agents.
- Enhanced genetic diversity means more heterogeneous rules.

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ABSTRACT

Many scholars express concerns that herding behaviour causes excess volatility, destabilises financial markets, and increases the likelihood of systemic risk. We use a special form of the Strongly Typed Genetic Programming (STGP) technique to evolve a stock market divided into two groups—a small subset of artificial agents called 'Best Agents' and a main cohort of agents named 'All Agents'. The 'Best Agents' perform best in term of the trailing return of a wealth moving average. We then investigate whether herding behaviour can arise when agents trade Dow Jones, General Electric, and IBM financial instruments in four different artificial stock markets. This paper uses real historical quotes of the three financial instruments to analyse the behavioural foundations of stylised facts such as leptokurtosis, non-IIDness, and volatility clustering. We found evidence of more herding in a group of stocks than in individual stocks, but the magnitude of herding does not contribute to the mispricing of assets in the long run. Our findings suggest that the price formation process caused by the collective behaviour of the entire market exhibit less herding and is more efficient than the segmented market populated by a small subset of agents. Hence, greater genetic diversity leads to greater consistency with fundamental values and market efficiency.

1. Introduction

The majority of investors actively trade stocks instead of buying and holding a market portfolio. Active trading may move asset prices around the intrinsic value of the stock and increase long-run price volatility. Analysing herd behaviour in financial markets is of particular interest, because it might offer an explanation of excess volatility and bubbles. Traders experience herd behaviour when the knowledge that others are investing changes their decision from not investing to making

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the investment. In other words, investors copy the behaviour of other investors, leading to changes in their decision-making process after observing others. Investors ignore to a certain degree their private opinions and follow the market, leading to a switch from non-trading to trading. Herding might cause changes in the magnitude of trading activity, the assets traders invest in, or even their valuation. Herding behaviour explains why profit-maximising individuals with similar information react similarly in terms of investing funds [1]. The financial crises of the 1980s and 1990 have highlighted herding as a possible reason for excess volatility and financial system fragility. The authors of [2–4] were among the first scholars to write about herd behaviour. They analyse herd behaviour under abstract conditions (in the context of fads, fashions, and customs) where privately informed individuals develop their decision-making process in sequence. These early research papers attempt to describe herding when a finite number of individuals have already chosen their actions and all following individuals abandon their own specific private information and herd. Devenow and Welch [5] suggest that agents disregard their prior beliefs and follow the actions of other agents, creating herding. Christie and Huang [6] assumed that herding is most pronounced when market returns are extreme. Their findings show that, when market agents abandon their own stock price forecasts in favour of the aggregate market behaviour, asset returns are very similar to the overall market return.

A few years later, Avery and Zemsky [7] investigated herd behaviour in real financial market settings with stock prices determined by a market maker according to the order flow. The authors conclude that the price mechanism prevents the development of informational cascades (a market condition in which traders disregard their own information and imitate previous traders' decisions, leading to herd behaviour).

They show that informational cascades are impossible because new information can reach the market at any time; thus, consistent with steady informational flow, prices do not deviate significantly from fundamental values. Moreover, according to their findings, herd behaviour does not cause excess volatility and the mispricing of assets in the long run.

Lakonishok, Shleifer, and Vishny [8] and Bikhchandani and Sharma [1] claim that there seems to be weaker evidence of herding behaviour in individual stocks than in groups of stocks. They stress that this does not exclude the possibility of more intensive herding in certain stocks such as stocks of a particular size or with particular performance records.

The Marginal Trader Hypothesis (MTH), proposed by Forsythe et al. [9], states that a small fraction of savvy individuals are capable of setting market prices and strive for market efficiency. Marginal traders are described as well-informed and active traders who are more capable of inferring true price and willing to explore those inferences. The authors argue that, when one removes those 'perfect' individuals from the pool of traders, prediction markets lose their accuracy. Prediction markets are markets established to generate knowledge and forecasts about the likelihood of future events. Forsythe et al. [9] analyse data from the Iowa Presidential Stock Market (IPSM), which was successfully created in 1988 and operated as a computerised double-action market in order to forecast the vote shares of the presidential candidates in elections held in the same year. They combined market design and incentive structures familiar from laboratory experiments to find out how the 1988 US presidentials would finish. The accuracy of prediction they achieved was very impressive.

However, it is difficult to test those theoretical assumptions directly. The literature related to herding behaviour in financial markets focuses primarily on statistical measures of clustering. The main difficulty from the empirical point of view comes from the fact that there is no database on the private information available to investors, and hence it is not possible to prove whether market agents strictly disregard their own information and imitate. This serious obstacle can be avoided in experimental settings such as an agent-based artificial stock market where the information possessed by traders can be controlled.

Under laboratory settings, researchers can observe the private information available to individuals for decision-making purposes, and therefore it is possible to test the presence of herding. In a market simulation model that we created using Altreva Adaptive Modeler, artificial traders receive information about the value of a real security and observe the history of past trades. Based on this information, they decide if they want to buy or sell one or more units of the security. By observing how artificial agents deal with the same piece of public information and react to the decisions of the previous agents, we can detect the possible presence of herding behaviour. The modelling software that we use provides a rich environment to examine herd behaviour as artificial traders make independent decisions creating a heterogeneous market structure (the market is populated by 10,000 boundedly rational artificial agents, each with different trading rules and behaviour). Traders' adaptive behaviour in our artificial stock market is modelled with an evolutionary computing technique called Strongly Typed Genetic Programming (STGP). The STGP evolves the trading rules at the micro level and co-evolves all agents through trading on the artificial market at the macro level.

In this paper, we evaluate the price series of a group of stocks modelled by the Dow Jones and individual stocks represented by General Electric and IBM generated using two main groups of artificial agents—'Best Agents' and 'All Agents'. We then use econometric evaluation to analyse the following topics.

(i) Do price series generated by artificial stock market agents exhibit herding behaviour in individual stocks as well as in a group of stocks?
(ii) Volatility analysis of price series generated by 'Best Agents' and 'All Agents'. Is the Virtual Market price based on the behaviour of all agents less volatile in comparison with a small subset of agents?
(iii) Artificial stock markets and the Efficient Market Hypothesis. Is the price series generated by 'Best Agents' more likely to conform to the Efficient Market Hypothesis, and therefore be more efficient?