Physica A 407 (2014) 204–215

Contents lists available at ScienceDirect

Physica A

journal homepage: www.elsevier.com/locate/physa

Impact of information cost and switching of trading strategies in an artificial stock market

Yi-Fang Liu [a,b,c], Wei Zhang [a,b], Chao Xu [a,b,*], Jørgen Vitting Andersen [c], Hai-Chuan Xu [a,b]

[a] College of Management and Economics, Tianjin University, Tianjin 300072, China

[b] China Center for Social Computing and Analytics, Tianjin University, Tianjin 300072, China

[c] CNRS, Center d'Economie de la Sorbonne, Université Paris 1 Panthéon-Sorbonne, 106-112 Boulevard de l'Hôpital 75647 Paris Cedex 13, France

HIGHLIGHTS

- We designed a new type of agent-based model with pay-for-switch behavior.
- Switchers decide whether to pay for information to become informed before trading.
- The larger the percentage of switchers, the larger the volatility.
- But, when switchers paying for information increases, the effect becomes opposite.
- Pay-for-switch promotes the diffusion of information and stabilizes the market.

ARTICLE INFO

Article history:
Received 26 October 2013
Received in revised form 27 March 2014
Available online 12 April 2014

Keywords:
Agent-based model
Heterogeneity
Switching behavior
Market volatility

ABSTRACT

This paper studies the switching of trading strategies and its effect on the market volatility in a continuous double auction market. We describe the behavior when some uninformed agents, who we call switchers, decide whether or not to pay for information before they trade. By paying for the information they behave as informed traders. First we verify that our model is able to reproduce some of the stylized facts in real financial markets. Next we consider the relationship between switching and the market volatility under different structures of investors. We find that there exists a positive relationship between the market volatility and the percentage of switchers. We therefore conclude that the switchers are a destabilizing factor in the market. However, for a given fixed percentage of switchers, the proportion of switchers that decide to buy information at a given moment of time is negatively related to the current market volatility. In other words, if more agents pay for information to know the fundamental value at some time, the market volatility will be lower. This is because the market price is closer to the fundamental value due to information diffusion between switchers.

* Correspondence to: Rm. 713 Beiyang Science Building, College of Management and Economics, Tianjin University, Tianjin 300072, China. Tel.: +86 22 27891308.

E-mail addresses: yifang.0731@gmail.com (Y.-F. Liu), weiz@tju.edu.cn (W. Zhang), xuchao_201310@126.com (C. Xu), jorgen-vitting.andersen@univ-paris1.fr (J. Vitting Andersen), highchance.xu@gmail.com (H.-C. Xu).

http://dx.doi.org/10.1016/j.physa.2014.04.004
0378-4371/

1. Introduction

This paper addresses the question of how *pay-for-switch* behavior can affect financial markets in a continuous double auction mechanism. More precisely, we study how the percentage of switchers and the frequency of the switching are related to the volatility of the financial market. Franke and Westerhoff [1] have pointed out that there are indeed reasons that may result in the traders' switching, such as herding, and strategy fitness, i.e. pursuit of higher returns according to the past performance of the strategies. We introduce a new switching mechanism that uninformed traders can become informed by paying for certain information cost. Although the impacts of the switching based on some fitness function or performance measure along the Brock and Hommes framework have been studied [2,3], this paper is the first research considering *pay-for-switch* behavior in a limit order market model. We try to find the relationship between the switching and the volatility of a limit order market. Since the introduction of the idea of excess volatility [4,5], a large literature has been devoted to the topic. Behavioral finance tells us that the behavior of investors can affect the financial market, and switching is seen as one of the learning processes which could have some effect on the market volatility. Meanwhile, some scholars use switching to describe the learning behavior of investors in agent-based models and have studied its impact on the price dynamics. More recently, some researchers focus on agent-based models using heterogeneous information.

We initiate our research using an agent-based model in a continuous double auction market. The switching mechanism in our experiments is also based on heterogeneous information. There are four types of agents in our model: informed agents, uninformed agents, switchers and noise agents. We consider the pursuit of higher earnings according to the past performance as the reason for switching. At a given time a switcher considers whether he would have earned more if he paid for the information in the last time step. If so a switcher pays for the information and acts as an informed agent. Otherwise the switcher will not buy the information and acts as an uninformed agent. Next we study the stylized facts of our simulated market prices in order to test the validity of the model which are: fat tails of price returns, volatility clustering, no arbitrage (zero autocorrelation of returns) and long memory (slow decay of volatility autocorrelations) [6].

It has been proved that several parameters related to switching can affect the price dynamics of the market [2]. However, whether switching can aggravate or reduce the market volatility is still unknown. We therefore pose the question: Does the switching between different types of agents aggravate or reduce the market volatility, or exhibit different character under different market conditions? In our model, we consider the volatility of the market under different structures of agents. In other words, we validate whether the volatility is higher when there are more switchers in the market. Next we consider how, for a given fixed percentage ρ of switchers, does the market volatility depend on proportion γ of switchers *actively* buying information at a given instant of time? Our general findings show that the larger the percentage ρ of switchers the larger the volatility. However, the larger the percentage γ of switchers paying for information at a given time, the lower will be the market volatility. This is different from the story in Ref. [3]. In our paper, this is because the switchers promote the diffusion of information and stabilize the market. Similar results have been obtained by [7], which finds that an initial increase in switching reduces the price volatility, but the effect becomes opposite when the switching increases further.

2. Related literature

Ever since the first ASMs used to study financial markets, a growing literature now describes how to study the price dynamics of markets caused by the investors' behavior via agent-based models. In general, the behavior of the agents is time-varying and agents can choose different trading strategies according to some rules. Brock and Hommes [2] create an agent-based model where traders can switch between different types and found that the dynamics of market prices are caused by a change in the intensity of choice to switch predictors. Since its introduction several papers have elaborated on the model and studied relevant questions. Chiarella and He [8] conclude that the dynamics of pricing is affected by the relative risk attitudes of different types of investors (measured by the ratio of the relative risk aversion coefficients). Lux [9] designs a switching index that influences the probabilities with which the agents switch between different types. Lux and Marches [10] show that agents' switching between fundamentalist and chartist strategies is the main reason that leads to volatility clustering and the emergence of fat-tailed returns. Similar results are found in other models [3,11].

However, in general the agents in the afore-mentioned models are of the same two types: fundamentalists and chartists. The switching between different trading strategies can be considered for the following four reasons: predisposition as a behavioral bias, hypothetically differential wealth using the two different strategies over the past, herding, and a misalignment correctional mechanism [1].

In our model we design a new type of agent called switchers who behave as follows: if the switchers paid for information last time and thereby earned more, they will pay for the information this time and therefore act as an informed trader. To the contrary they will not pay for the information and will therefore try to predict the prices as uninformed agents. The interpretation of the behavior mentioned above can be seen as a decision on whether or not to buy analysts' reports in the real world. The viewpoint that research reports of securities and investment analysts can help the investors to get higher earnings has often been mentioned in the literature. For example, Dawson [12] finds that one can get excess earnings if you follow the analysts' report. Lee [13] considers that the value of analysts' reports is positively associated with the information in the reports. Further, Busse et al. [14] use the empirical data to show that some investors who indeed follow the analysts' reports thereby also change their behavior. That means some investors buy the reports and trade as the reports suggest.