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Q1 Investor structure and the price–volume relationship in a continuous double auction market: An agent-based modeling perspective

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HIGHLIGHTS

- An Artificial Continuous Double Auction Market is simulated.
- The price–volume relationship is investigated with MDH and SIAH.
- Results are held for SIAH when the number of informed investors is close to the number of uninformed investors.
- Results are held for MDH when informed investor dominates the market.
- Investor structure is a key factor in determining the price–volume relationship.

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ABSTRACT

This paper investigates the impact of investor structure on the price–volume relationship by simulating a continuous double auction market. Connected with the underlying mechanisms of the price–volume relationship, i.e., the Mixture of Distribution Hypothesis (MDH) and the Sequential Information Arrival Hypothesis (SIAH), the simulation results show that: (1) there exists a strong lead–lag relationship between the return volatility and trading volume when the number of informed investors is close to the number of uninformed investors in the market; (2) as more and more informed investors entering the market, the lead–lag relationship becomes weaker and weaker, while the contemporaneous relationship between the return volatility and trading volume becomes more prominent; (3) when the informed investors are in absolute majority, the market can achieve the new equilibrium immediately. Therefore, we can conclude that the investor structure is a key factor in affecting the price–volume relationship.

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1. Introduction

The relationship between price changes and trading volume (price–volume relationship) has long been the focus in econophysics and financial economics. The empirical study on the price–volume relationship varies from different perspectives, e.g., focusing on developed and emerging markets, employing different measurements of price changes and trading volume, and choosing different sample period. For example, previous researches include the investigation of the relationship between absolute values of price changes and trading volume from the daily data of the market indices [1,2],

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between price changes square and aggregated volume from the daily data of the cotton futures [3], between price changes variance and trading volume from four-day interval's and monthly data of 51 stocks [4], between price changes and trading volume from two-month interval's data of 17 future contracts [5], between absolute price value of price changes and trading volume from yearly data of individual common stocks [6], between high-frequency returns and trading volumes of stocks and indexes [7] as well as between returns and trading volumes of stocks at the transaction level [8–10].

Most of these studies document significant positive relationship between the price changes and trading volume. In the stock market, trading activity is driven by different types of investors receiving, processing and sending different kinds of information and thus results in the price reflecting all available information in both mass media and social media [11–16]. Therefore, scholars come up with different information related hypotheses to illustrate the mechanism of price–volume relationship, two of which arise more attentions recently. First is the hypothesis that return volatility and trading volume are correlated contemporaneously, which claims the new arrival information impels the changes in return volatility and trading volume simultaneously, based on the Mixture of Distribution Hypothesis (MDH) predicted by Clark [3] and Harris [17]. Evidence from SME PRICE INDEX and some actively traded stocks in CSI 300 index [18–20] by employing Baidu News as a proxy for information arrival alternatively supports the MDH. Second is that volume and return volatility are not related contemporaneously, where there is a lead-lag relationship implying a causal relationship between return volatility and trading volume, predicted by the Sequential Information Arrival Hypothesis (SIAH) of Copeland [21] and Smirlock and Starks [22]. The SIAH argues that not all investors receive and rationally react to the new arrival information at exactly the same time. The new equilibrium cannot be achieved immediately. It requires some time, producing a lead-lag relationship between the return volatility and trading volume during the equilibrium achieving procedure. The hypotheses are witnessed in Malaysia, the Philippines, Singapore and Thailand stock exchanges [23]. However, there are also situations contradicting to the two hypotheses. In the Greek future market [24], MDH is rejected. In the domestic and cross-country stock markets of New York, Tokyo and London [25], evidences are taken against the SIAH.

These discrepant testing results of two hypotheses lead us into reflections which factor affects the formation of the price–volume relationship. An intuitive thought is that the microstructure is extremely different in the different market and during the different period. Therefore, the dynamic process of price changes and trading changes are different, resulting in the forming price–volume relationship. In particular, O'Hara [26] states that market dynamic will be affected by the investors, especially by the present or absent of the informed investors, which is an important element in the microstructure models of the financial market. It leads us to deduce that the informed investors (number or ratio) in trading, by changing the microstructure of the financial market, effect on the mechanism of price–volume relationship. Research already abounds in the informed investors' behavior affecting on the financial market. An increase in the number of informed investors can affect the market behaviors, such as facilitating the process in the price discovery [27]. Therefore, we want to probe what kind of roles that the informed investors play in the price–volume relationship. We want to analyze the price–volume relationship in the market with different number (or ratio) of informed investor. However, it is difficult to identify the informed investors in a real market, let alone counting their numbers. Therefore, we simulate an artificial stock market based the continuous double auction model with changeable different investor structure. Here, we define investor structure is the ratio of the number of informed investors to the number of all the investors. While changing the investor structure, we validate the MDH and SIAH in causing the price–volume relationship each time. We contribute to the existing literature by including the investor structure as a factor affecting the price–volume relationship into consideration, which helps us have a better understanding of mechanism, efficiency and microstructure of the financial market.

The rest of this paper is organized as follows. Section 2 describes the model. Section 3 illustrates the stylized facts of the artificial market. Section 4 gives simulation results. Section 5 is the robustness test and Section 6 concludes.

2. Model descriptions

2.1. Financial environment

There are only two types of agents present in the artificial market: informed agents and uninformed agents. Uninformed agents can forecast the return of asset only by the public information. The public information and trading direction are exogenous variables. Informed agents can forecast the return of asset by their private information in addition to the public information. Compared to uninformed agents, the behavior of the informed agents can be very aggressive. To be more specific, if the informed agents forecast the return of asset to be positive, they will offer a higher price to buy more. If they forecast the return of asset to be negative, they will offer a lower price to sell more.

At the beginning, the agents who do not possess private information are the majority, while the agents who possess the private information are the minority. The percentage of informed investor is initially set as 10%. We assume the asset in trading is a single stock. The agents have sufficient wealth to buy the stock at any time. The orders issued by the agents are only based on their information. The trading cost is zero and therefore there is no friction in the market.

2.2. Continuous double auction market

There is an order book where all the orders are registered. The auction is called double: Traders can either place buy orders (bids) and/or sell orders (asks). The term “continuous” means that the orders could arrive at any time and be placed

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