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Information-driven trade and price–volume relationship in artificial stock markets

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HIGHLIGHTS

- Data from real stock market is incomplete.
- Tests found that informed agents can produce price–volume relationship.
- The trade style of aggressiveness impacts price–volume relationship.
- The trade style of trading more at one transaction impacts price–volume relationship.

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ABSTRACT

The positive relation between stock price changes and trading volume (price–volume relationship) as a stylized fact has attracted significant interest among finance researchers and investment practitioners. However, until now, consensus has not been reached regarding the causes of the relationship based on real market data because extracting valuable variables (such as information-driven trade volume) from real data is difficult. This lack of general consensus motivates us to develop a simple agent-based computational artificial stock market where extracting the necessary variables is easy. Based on this model and its artificial data, our tests have found that the aggressive trading style of informed agents can produce a price–volume relationship. Therefore, the information spreading process is not a necessary condition for producing price–volume relationship.

1. Introduction

The relation between stock price changes and trading volume (price–volume relationship) has drawn considerable attention among investors and researchers in the field of finance. As the old Wall Street adage asserts: "it takes volume to move prices". All books on technical analysis consider volume as important for predicting price. In the academic field, the empirical study of the relationship between price and volume has existed for more than 30 years. Most studies focus on two areas: the features of price–volume relationship and the causes of such relations.

As to the features of price–volume relationship, early empirical studies that focused on contemporaneous relation have demonstrated the positive relation between absolute returns and trading volume, which is acknowledged as one of the stylized facts. Studies then focused on dynamic relation, which is another interesting subject. Several Granger causality tests have indicated bidirectional causality between price and volume. However, other tests found a unilateral cause-and-effect relation that is sometimes volume Granger-causes price, sometimes price Granger-causes volume [1–4]. Subsequent

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studies have begun focusing on nonlinear Granger causality tests, most of which indicate bidirectional nonlinear Granger causality [5–7]. Recently, studies have extended to emerging markets and high-frequency data. For instance, Chen (2012) [8] found that "the stock return is capable of predicting trading volume in both bear and bull markets. However, the evidence for trade volume predicting returns is weaker". This finding indicates that bidirectional causality between price and volume does not exist.

Early researchers proposed several hypotheses on the causes of the price–volume relationship. In this article, we discuss two: the mixture of distribution hypothesis (MDH) and asymmetric information hypothesis (AIH). On the one hand, MDH asserts that the information flow influences price and volume simultaneously. Chen and Daigler (2008) [9] documented that this hypothesis highlighted a strong relationship between the information flow and market activities. Furthermore, Lamoureux and Lastrapes (1990) [10] noticed that persistence in volatility was reduced when volume was introduced in the conditional variance equation of the GARCH model, based on which, we could state that volume was driven by the same factors that generated the ARCH effects. We found similar results from other studies [11–14]. On the other hand, Louhichi (2011) [15] pointed out that MDH could not determine the component of trading volume that generates this relation between price and volume. In fact, trading volume is composed of two components: the number of trades and the size of trades. Louhichi (2011) [15] documented that the AIH has focused on the issue of whether the volume–volatility relationship is driven by either one of them or both. Several researchers (such as Xu and Wu (1999) [16], Chan and Fong (2000) [17]) supposed that (in a competitive market) informed investors prefer to trade large amounts in one transaction, and therefore price–volume relationship is driven by the size of trades. On the contrary, other researchers such as Giot et al. (2010) [18] and Louhichi (2011) [15] predicted that informed traders may camouflage their private information by splitting large trades into several small trades, and the number of trades will consequently generate the price–volume relationship. Therefore, no general consensus has been achieved regarding this issue.

The impossibility of determining the information-driven trade component of trading volume that generates price–volume relationship based on data gathered from the real stock market, the results of these empirical works on real data have impeded general consensus from being reached. Agent-based artificial stock markets enjoy the advantage of producing artificial data that researchers require, such as the information-driven component of trading volume. Artificial data also allow researchers to test price–volume relationship easily. Artificial stock market is also used to analyze various important issues, but has rarely been used in the context of price–volume relationship.

Chen and Liao (2005) [19] conducted a pioneering study in this field, building an artificial stock market to identify the consistent patterns between the macro-phenomena (e.g., the joint dynamics of prices and trading volume) and the micro-behavior of every heterogeneous agent, down to the details of their thought processes (e.g., the forecasting models or trading strategies that these agents use). The study found that when agents used volume to forecast price, the relations between prices and trading volume were sometimes noticeable and sometimes unnoticeable. On the contrary, when the relations appeared, agents rarely used volume to forecast price. The authors wondered whether it would be possible for the volume-to-price relation to finally emerge if no attempts to use the volume variable were made. In this paper, we present a simple artificial stock market and use it to explore the effect of information-driven trades on price–volume relationship. In our model, agents do not use volume to forecast price.

The rest of the paper is organized as follows: Section 2 defines the trade style of informed agents and proposes three hypotheses; Section 3 describes the model structure; Section 4 provides simulation parameters and shows descriptive statistic features of this artificial stock market; and Section 5 presents the simulation and tests the hypotheses on artificial data. Section 6 contains the concluding remarks.

2. Definitions of information-driven trade and hypothesis

Asymmetric information hypothesis proposes that information-driven trade generates the relations between volatility and volume. We must endow some agents with information-driven behaviors in order to test this hypothesis based on artificial data gathered from an agent-based model. We define trade styles of uninformed agents and informed agents as follows:

Uninformed agents: forecast the returns with common information. The information is an exogenous variable that belongs to an independent identical distribution. Agents trade because of the adjustment of their investment portfolio. The trade direction is also an exogenous variable that is uncorrelated with the forecast of return.

Informed agents: forecast returns with private information. Agents trade for risk-free extra profit, and thus, the trade direction is correlated with the forecast of return. If the prediction of return is positive, the agent will buy the stock; if the prediction of return is negative, the agent will sell the stock. In a competitive market, the trade style of agents who possess private information is aggressive because agents would aim to gain extra profits immediately before the private information spreads. Compared with the normal trading style, the aggressive trading style involves the following features: (a) taking a higher price to buy and a lower price to sell and (b) trading more for one transaction. We then formulate three hypotheses, as follows:

Hypothesis 1: Information-driven trading produces price–volume relationship;

Hypothesis 2: The trading style of taking a higher price to buy or a lower price to sell affects the price–volume relationship;

Hypothesis 3: The style of trading more at one transaction affects the price–volume relationship.