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Buying on margin, selling short in an agent-based market model

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HIGHLIGHTS

- We study credit trading in financial market by an agent-based model.
- We explore leverage's effect on market indicators and individual wealth.
- Simulation results confirm price discovery function of credit trading.
- Leverage ratio has positive influence on price volatility and trading volume.

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ABSTRACT

Credit trading, or leverage trading, which includes buying on margin and selling short, plays an important role in financial markets, where agents tend to increase their leverages for increased profits. This paper presents an agent-based asset market model to study the effect of the permissive leverage level on traders' wealth and overall market indicators. In this model, heterogeneous agents can assume fundamental value-converging expectations or trend-persistence expectations, and their effective demands of assets depend both on demand willingness and wealth constraints, where leverage can relieve the wealth constraints to some extent. The asset market price is determined by a market maker, who watches the market excess demand, and is influenced by noise factors. By simulations, we examine market results for different leverage ratios. At the individual level, we focus on how the leverage ratio influences agents' wealth accumulation. At the market level, we focus on how the leverage ratio influences changes in the asset price, volatility, and trading volume. Qualitatively, our model provides some meaningful results supported by empirical facts. More importantly, we find a continuous phase transition as we increase the leverage threshold, which may provide a further prospective of credit trading.

1. Introduction

Leverage trading plays an important role in financial systems and has effects on many aspects of financial markets [1]. Investors tend to increase their leverages by buying on margin or selling short for increased profits, enlarging their trading amounts because of less wealth constraints. As a result, leverage trading contributes to the liquidity of the market. In addition, leverage also influences the price level and volatility [2–4] and therefore magnifies risk, which connects leverage with financial crises [5]. After the most recent global financial crisis, many countries took measures to adjust the regulations on leverage trading. Therefore, how does leverage trading, specifically the leverage ratio of traders, influence a financial market and traders' wealth? This is not only a fundamental topic for theoretical research but also a practical issue for the

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creation of reasonable regulations. To answer this question, in this paper, we focus on leverage's influence on the asset price level and volatility, trading volume, and traders' wealth.

There are numerous empirical studies related to how credit trading and leverage influence the financial market and wealth of traders (see Section 2). This paper, however, explores these issues by a theoretical market model. We adopt the agent-based modeling, which is an effective way to simulate trading activity in a financial market. There are two advantages of a computationally oriented agent-based model compared to a theoretically oriented one. First, computer simulation can link many behavioral aspects at the micro level with those at the macro level. Second, more realistic market features, including budget or wealth constraints, can be readily incorporated into the market microstructure. Therefore, in this paper, we incorporate traders' balance sheets and market dynamics into an agent-based model to study the trading leverage ratio's effect on both market price behavior and individual wealth evolution. According to the simulation results, at the individual level, we find that agents' wealth accumulation is amplified as the leverage ratio increases. At the market level, the results show that average price and final price converge more easily to the fundamental price as the leverage threshold value increases, which can be regarded as the price discovery function of credit trading. In addition, we also observe that stock price volatility and trading volume are magnified as the leverage ratio becomes larger. These results are consistent with most of the empirical data, and we can reveal some stylized facts of financial markets in the time series of returns. More importantly, by simulations we find a continuous phase transition as we increase the leverage threshold, which may provide further insight of credit trading.

This paper is organized as follows. In Section 2, we review the previous literature about credit trading. In Section 3, we introduce the agent-based market model with credit trading. In Section 4, we provide an analysis of the simulation results of the model and compare them with some observed empirical facts. Finally, in Section 5, we present our conclusion.

2. Literature review

Much of the extant literature has given attention to the effect of margin requirements, which determine the threshold of leverage, on market price volatility. One major reason why the Securities and Exchange Act (of the United States) created Federal Reserve margin requirements in 1934 was to reduce stock price volatility. The "pyramiding and anti-pyramiding" mechanism described by Bogen and Krooss [6] demonstrated the fact that margin loans would increase stock price variability. Luckett [7] explained that a rise in the margin requirement is a signal sent by the market regulator to indicate that the market is overheating and has excessive risks. This signal induces investors to reduce credit trading. Hardouvelis [2,3] examined the relationship between margin requirements and the volatility of stock prices in the cash market and concluded that increasing the margin requirements reduces market volatility. Hardouvelis and Theodossiou [8] found a negative association between margin requirements and stock volatility in the Japanese stock market and claimed that margin requirements represent an effective tool for influencing stock prices and market volatility. In addition, Hardouvelis and Peristiani [9] studied the effects of margin regulation in the Japanese stock market over the last 35 years and showed that higher margin requirements are associated with lower margin borrowing and lower volatility of daily returns. In further research, Hardouvelis and Theodossiou [10] also argued that the relationship between margin requirements and volatility across bull, normal, and bear periods is asymmetric. In other words, the negative relation is stronger in bull periods, but it disappears during bear periods. Moreover, Fortune [11] formulated a model of the distribution of stock prices to examine the relationship between the level of margin debt and stock returns during the period from 1975 to 2001, when no changes in Fed margins occurred, and also found that leverage trading can aggravate market volatility. Clearly, all these scholars supported the assertion that leverage has a positive effect on price volatility. However, in contrast, Moore [1] believed that high maintenance margins would bring about more margin calls; thus, a low maintenance margin would be a good way to eliminate much of the danger of forced sales. Afterwards, Officer [12] found that the decline of volatility in the stock market was not a result of the rise of margin requirements because margin requirements are changed after the variability in the market factor has already started to change. At the same time, Largay and West [13] found that the effects of margin requirement increases and decreases are asymmetric and inconspicuous. In a similar manner, the studies of Grube et al. [14], Schwert [15], Kupiec [16], Salinger [17], Hsieh [18], Lee and Yoo [19], and Kim and Oppenheimer [20] also revealed that public policies about margin requirements cannot control stock volatility. These findings imply that empirical works have not yet reached a consensus on leverage's effect on market price volatility.

The existing literature reveals that the effects of changing margin requirements for stock volatility can be illustrated in two ways. First, an increase in the margin requirement is a signal sent by the regulator of the market to indicate that the market is overheating and has excessive risks; this signal induces investors to reduce credit trading, which decreases volatility [7,21]. Kumar et al. called this the speculative effect. Second, some speculators may be discouraged and withdraw from the market due to the increase of margin requirements. Therefore, liquidity is decreased, and in turn, stock market volatility becomes larger, which is called the liquidity effect [21,22]. Because the two effects are opposites, markets under various conditions perform differently. The inconsistent results of empirical studies also reflect this. In our model, we mainly demonstrate the speculative effect.

As for price level, we focus on the discrepancy between the stock price and fundamental value. Galam [23] and Biondi et al. [24] found that the discrepancy existed and it even leads to the formation of bubbles and crashes, while some empirical works show that symmetrical credit trading can avoid this kind of overvaluation of stock price [4,25]. In terms of leverage's effect on trading volume, Hardouvelis [3] showed that higher margin requirements are associated with lower overall trading