Analysis of Random Agents for Improving Market Liquidity Using Artificial Stock Market

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Abstract. Securing liquidity in a market is indispensable for the market mechanism to work efficiently. While there is a discussion that random agents have the effect to ensure the liquidity, the mechanism of this effect has not been clarified. We show that, using an artificial market system U-Mart, the random agents can improve the liquidity of a market by maintaining the balance of supply and demand. We also suggest that it is necessary for the random agents to manage their position in order to work as a market maker.

Keywords: Market Liquidity, Random Agent, Artificial Market, Institutional Design, Market Maker

1 Introduction

Extremely low liquidity in a stock market may cause severe problems of the market functions, since the market should serve as a place of fund collecting for every company and should be appropriately designed. We consider the market liquidity as the extent of contract without large price fluctuation and as a necessary condition for market stability. For example, in Osaka Securities Exchange that has only 1/40 volume of trading than Tokyo Stock Exchange, stock prices are sometimes not decided smoothly, and it may make the district economy sluggish. Shiozawa [1] calls such a market with low liquidity “thin market,” and discusses that a market maker must play an important role in order to avert the problems caused by the thinness. Ueki et al. [2] point out that those who decide order prices randomly around the latest price can improve the market liquidity and that such random agents have an effect of the market maker. The mechanism to ensure the liquidity, however, has not been clarified. In this paper, we study how the random agents increase the liquidity using an artificial market simulation.

2 Simulation

We considered how the random agents affect a stock market using an agent-based

artificial market simulator called "U-Mart" [3] (http://www.u-mart.org/). We conducted simulation experiments by changing the ratios of random agents to other agents, A_r, between 0% and 100%. The strategy of the random agents is to place orders at random around the latest price. We adopted the daily Nikkei Index that showed a downward trend as the spot price series given to the U-Mart system.

Firstly, we made sure that the contract rate increased with the ratios of the random agents (Fig. 1), as Ueki et al. [2] already showed. We also checked that the total trading volume also grew as the ratios of random agents became larger. Secondly, we measured the historical volatility. As indicated by the dashed line in Fig. 1, it decreased along with the ratios of the random agents. These evidences convinced us that the random agents affected the market to provide ample liquidity.

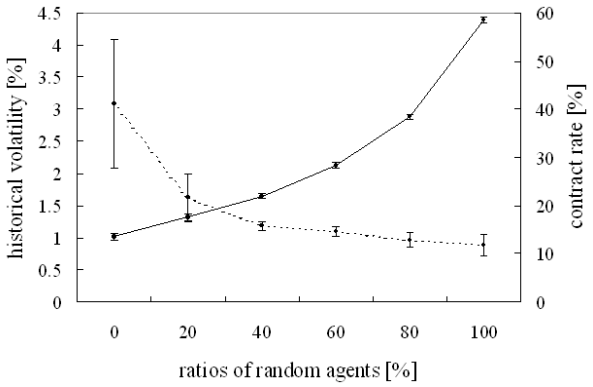

Fig. 1. The change of the contract rate (the solid line and the right vertical axis) and the historical volatility (the dashed line and the left vertical axis) related to the ratios of random agents. The error bars show the standard deviation of 100 runs of the simulation.

In order to clarify the mechanism to promote the liquidity by the random agents, we inquired into the way of ordering of both the random and the non-random agents (Fig .2). We found that, on the one hand, the non-random agents put the orders correlated with price changes. Namely, the buy orders are larger than the sell orders under positive price changes, and vice versa. Accordingly, the non-random agents are likely to skew supply and demand and to enhance trends. On the other hand, the random agents put the orders of both sell and buy irrespective to the price fluctuation. When the market is mainly occupied by the non-random agents, the left column of Fig. 2, the orders are not contracted, especially under the large price fluctuations. Although the random agents can potentially absorb such skewed orders, the volume is not enough. When the ratio of the random agents is large, the contract rate improves due to the balance between the order volumes by the non-random and the random agents, as shown in the right column of the Fig. 2.

In our simulations, the random agents often gained lower profit than the others and sometimes went bankrupt. In order for the random agents to efficiently work for providing liquidity, the agents with such function should exist in a market always. In order to do this, the agents should manage their position appropriately.

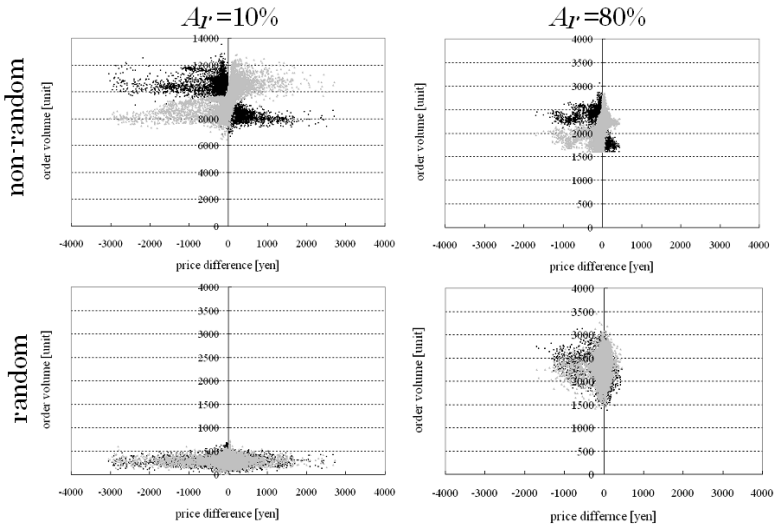

Fig. 2. The scatter diagram of order volume (the vertical axis) related to the price difference from the latest period (the horizontal axis). The left and the right columns are A_r =10% and 80%, respectively. The black and grey dots indicate the sell and buy orders, respectively. Note that the left upper graph has the larger scale of the vertical axis than the others.

3 Conclusion

We have showed that the random agents promote the liquidity in a stock market by improving the skewed state of the orders and maintaining the balance of the supply and demand. We think institutional design is essential for market with enough stability. Accordingly, the characteristics of the random agent should be taken into consideration as the institutional design to provide liquidity for a market. We should further study the strategy for the random agents capable of managing their position.

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