Chapter IV

Minimal Intelligence Agents in Double Auction Markets with Speculators

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ABSTRACT

This chapter explores the minimal intelligence conditions for traders in a general double auction market with speculation activities. Using an agent-based model, it is shown that when traders and speculators play together under general market curve settings, zero-intelligent plus (ZIP) is still a sufficient condition for market prices to converge to the equilibrium. At the same time, market efficiency is lowered as the number of speculators increase. The experiments demonstrate that the equilibrium of a double auction market is an interactive result of the intelligence of the traders and other factors such as the type of the players and market conditions. This research fills in an important gap in the literature, and strengthens Cliff and Bruten’s (1997) declaration that zero is not enough for a double auction market.
INTRODUCTION

The double auction is a multilateral process in which the buyers and sellers can freely enter orders (bids or asks) and accept orders (asks or bids) entered by others. Many major stock markets, currency markets, commodity markets, and the derivative markets are organized as a form of double auctions; some over-the-counter (OTC) markets are also de facto double auction markets. In a double auction market, buyers can enter bids for an asset or raise existing bids. Sellers can enter offers or lower existing offers. A match or cross of bids and offers implements a transaction. Specifically, buyer $i$ who is given a redemption value of $\lambda_i$ for a certain asset shouts a bid price $b_i$, with a potential profit of $\lambda_i - b_i$; seller $j$ who is given a cost of $\lambda_j$ to obtain the asset shouts an offer price $s_j$, with a potential profit of $s_j - \lambda_j$. The redemption value $\lambda_i$ and the cost $\lambda_j$ of the asset are the private information for the buyer or the seller accordingly (Gibbons, 1992). The success of a trade depends on whether the trader’s shout is accepted or not. Furthermore, if the current market has a bid $b_i$, a new bid shout will replace this market bid only when this new bid is higher than the old one; if the current market has one offer $s_j$, a new offer shout will replace this market offer only when this new offer is lower than the existing one. This is the basic structure of the double auction market.

Smith (1962) was one of the first to apply an experimental method to the double auction market. He studied the market equilibrium and convergence with a method of Walrasian competitive equilibrium. Note that for historical reasons, Smith’s experiments were limited by the small sample size of traders, in relation to actual double auction markets. At the same time, the physical conditions of his experiments, such as the round time, and the traders’ quantities, were also different from real world double auction markets, which further weakened the comparison power. In recent years, the development of the computational tools and especially agent-based models has stimulated extensive studies in many directions. Agent-based models help overcome some limitations of human experiments. For example, once a model is constructed, it is quite easy to adjust the parameters with little cost. Therefore, this modeling method is increasingly being used today for addressing a range of research questions in diverse fields from economics and finance to sociology and engineering (Chan, LeBaron, Lo & Poggio, 1999; LeBaron, 2000). A research stream pertaining to double auction markets studies strategies used by the traders in a game theoretic sense. For example, Chen (2000) studied variant “bargaining strategies” in the double auction market. Hsu and Soo (2001) compared the performance of traders with different trading strategies and that of traders with a Q-learning ability. Some studies have also extended to examine interactions between the software traders and the human traders. For example, Das, Hanson, Kephart and Tesauro (2001) compared the performance of software agents and human traders. Grossklags and Schmidt (2003) studied the influence of software agents to the market performance of the human traders in the market. Another research direction has been the study of the influence of the trader’s intelligence on the market. For example, Chen and Tai (2003) studied the effect of the intelligence of the traders on the market efficiency by exerting limits on the spaces where the traders can shout their bid and ask offers.

This chapter addresses the minimal intelligence needed for traders in the context of double auction markets convergence to equilibrium. There have been a number of studies on this topic. Gode and Sunder (1993) were the first to examine this problem. Using
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