

# Empirical regularities of order placement in the Chinese stock market

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## Abstract

Using ultra-high-frequency data extracted from the order flows of 23 stocks traded on the Shenzhen Stock Exchange, we study the empirical regularities of order placement in the opening call auction, cool period and continuous auction. The distributions of relative logarithmic prices against reference prices in the three time periods are qualitatively the same with quantitative discrepancies. The order placement behavior is asymmetric between buyers and sellers and between the inside-the-book orders and outside-the-book orders. In addition, the conditional distributions of relative prices in the continuous auction are independent of the bid–ask spread and volatility. These findings are crucial to build an empirical behavioral microscopic model based on order flows for Chinese stocks.

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## 1. Introduction

Stylized facts are common statistical characters observed from different stocks within different time periods and usually presented in a quantitative form. Concerning equity returns, the stylized facts contain the absence of autocorrelations, heavy tails, multifractality and intermittency, volatility clustering, leverage effect, and so on [1–3]. Many stylized facts in financial markets can be reproduced with microscopic models. If a microscopic model presents mock stylized facts in conformity with real ones, this model is believed to have caught some underlying regularities of financial markets. Based on how the price forms, there are two types of microscopic models for financial markets known as the agent-based models and order-driven models [3]. The price variations in agent-based models are

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determined by the imbalance of demand and supply, including percolation models [4–9], Ising models [10–15], minority games [16–23], and others [24,25]. The price in order-driven models changes based on the continuous double auction (CDA) mechanism [26–29]. Two fundamental ingredients of order-driven models are order placement and order cancelation [26]. The regularities governing the dynamical processes of order placement and cancelation can be determined empirically in some sense. In this way, very realistic behavioral models can be constructed.

Order placement plays a key role in the simulation of price formation in order-driven models, since the proportion of placed orders is much greater than that of canceled orders. When placing an order, the trader needs to determine its sign (“+1” for buys and “−1” for sells), size and price. In determining the order price, the trader faces a situation of dilemma and has to balance two contradictive factors, the certainty of execution on one hand and the potential benefit on the other hand. Patient traders possibly consider the fact of benefit more important than the other and place orders inside the limit-order book with a less aggressive price (high price for sellers and low for buyers). The situation is different for impatient traders who consider the factor of execution certainty in the first place. This kind of traders want to make a transaction as soon as possible and place the order outside the limit-order book with a more aggressive price (low for sellers and high for buyers). In this work, we focus on the prices of submitted orders.

Zovko and Farmer studied the unconditional distribution of relative limit prices defined as the distance from the same best prices for orders placed inside the limit-order book [30]. They merged the data from 50 stocks traded on the London Stock Exchange (August 1, 1998 to April 31, 2000) and found that the distribution decays roughly as a power law with the tail exponent  $\alpha = 1.5$  for both buy and sell orders. Bouchaud et al. analyzed the order books of three liquid stocks on the Paris Bourse (February 2001) and found that the relative price of new orders placed inside the book follows a power-law distribution with the tail exponent  $\alpha = 0.6$  [31]. Potters and Bouchaud investigated the relative limit price distributions for inside-the-book orders of three Nasdaq stocks (June 1 to July 15, 2002) and found that the distributions exhibit power-law tails with an exponent  $\alpha = 1$  [32]. Maskawa analyzed 13 rebuild order books of Stock Exchange Electronic Trading Service from July to December in 2004 on the London Stock Exchange and found that the limit prices for all orders inside the book are broadly distributed with a power-law tail whose exponent is  $\alpha = 1.5$  [33], which is consistent with the results of Zovko and Farmer [30]. He also presented the distribution in the negative part for more aggressive order outside the book and found that the negative part decays much faster than the positive part. Mike and Farmer focused on the stock named AZN and tested on 24 other stocks listed on the London Stock Exchange [26]. They found that the distribution of relative logarithmic prices can be fitted by a Student distribution with  $\alpha = 1.0 - 1.65$  degrees of freedom and the distribution is independent of bid–ask spread at least over a restricted range for both buy and sell orders.

There are also efforts to seek for factors influencing order placement. Using 15 stocks on the Swiss Stock Exchange, Rinaldo found that both bid–ask spread and volatility negatively relate to order aggressiveness [34]. Lillo analyzed the origin of power-law distribution of limit order prices considering the order placement as an utility maximization problem considering three factors: time horizon, utility function and volatility [35]. He found that the heterogeneity in time horizon is the proximate cause of the power-law distribution, while heterogeneity in volatility is hardly connected with the origin of power-law distribution.

The paper is organized as follows. In Section 2, we explain the data set analyzed and briefly introduce the trading rules of the Shenzhen Stock Exchange (SSE). Section 3 presents the unconditional probability distributions of relative prices in three periods: opening call auction, cool period, and continuous double auction. We then study in Section 4 the conditional probability distributions against bid–ask spread and volatility, respectively. The last section concludes.

## 2. Dataset

We analyze a huge database containing the order flows of 23 liquid stocks listed on the Shenzhen Stock Exchange in the whole year 2003 [36]. The order flow records ultra-high-frequency data whose time stamps are accurate to 0.01 second including details of every event. Each limit order can be identified by the order placement time. The logarithmic price of an order at time  $t$  is denoted as  $\pi(t)$ . The tick size of the quotation price of an order is RMB 0.01 yuan. As an emerging stock market, with the purpose of speculation limitation and healthy development, the Exchange imposes a daily price limit of 10% on trading of stocks, which means that the maximum price fluctuation on trading day  $T$  must be restricted to ten percent of the closing price  $p(T - 1)$  of the previous trading day. More details about the trading rules can be found in Ref. [37].

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