



An empirical analysis of non-execution and picking-off risks on the Tokyo Stock Exchange

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ABSTRACT

This paper investigates how the state of the order-book economy influences non-execution and picking-off risks. We utilize data from the limit order book and transactions in individual stocks on the Tokyo Stock Exchange. We demonstrate that, on the one hand, the risk of non-execution increases, while the risk of being picked off, on the other hand, decreases when: 1) the depth on the incoming investor's side becomes thicker, 2) the bid-ask spread becomes narrower, 3) volatility declines, and 4) the depth on the opposite side to the incoming investor becomes thicker. In addition, we report asymmetric determinants of non-execution and picking-off risks between buy and sell limit orders, as well as among our sample firms. We interpret the asymmetry to be attributed to differences in transaction volume and order book thickness between buy and sell sides of the order book as well as among the firms. More transactions lead to higher quote competitions among limit order traders, increasing the thickness of the order book inside of the spread. It then decreases the rate of executions and of being picked off for limit orders existing outside of the spread. Our results suggest that real-time information on order book and transactions is highly valuable to stock investors, who trade individual securities and manage a portfolio of individual stocks, such as ETFs. Our findings assist real stock investors in reducing the monitoring cost, making more profitable order choices among market and limit orders and exposing/hiding/canceling/revising limit orders, and understanding the price formation process in an order-driven market. They are crucial for investors for better risk management in actual stock markets.

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1. Introduction

Electronic trading systems have been proliferated to modern stock exchanges for trading equity securities. They offer an automatic clearing mechanism by which investors place either market or limit orders. Market orders are executed immediately at the best available prices. Limit orders are transacted only when an individual hits the orders, in accordance with a pre-specified number of shares at the limit price at which they are willing to trade. Thus, in contrast with trading according to market orders, limit order traders can avoid the cost of a bid-ask spread by placing the orders at favorable limit prices, but they face the risks of non-execution and of being picked off. On the one hand, the risk of non-execution arises precisely because limit orders are executed solely when someone hits the limit orders, and the order of execution is determined by price and time priority rules. Limit orders have a higher price priority to be executed if placed at prices closer to the best quotes. Orders that were submitted at the same prices but that were placed prior to the incoming limit order trader have a higher time priority to be traded than the order by the incoming trader. Thus, the time and price priority rules may cause limit orders to fail the executions.

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On the other hand, a limit order trader faces the picking-off risk as the market price may cross his/her limit price. If a limit order is posted to the order book and the order is not cancelled, someone can “pick off” his/her order and make money, resulting in a loss for the limit order trader. For example, suppose that a trader places a limit buy order at the best bid and the order is not cancelled. When the best ask falls below his/her limit price due to a drop in the asset's intrinsic value, other investors can make money by picking off the limit order at the best bid (selling the shares to limit order traders at his/her limit price) and then buying shares at the best ask, which is lower than the price at which the shares were sold. The limit order trader incurs a loss because the price at which he/she bought the shares is higher than the market price at which investors can actually buy the shares. Therefore, due to the risks of non-execution and of being picked off, optimal order choices between market and limit orders involve quantitative evaluation of these two risks.

The present paper makes a unique contribution to the field of market microstructure by quantifying the determinants of both the risks of non-execution and of being picked off simultaneously. Our study provides important insights into the following four issues. First, as discussed in details by [Handa and Schwartz \(1996\)](#), the risk of picking off concerns with “permanent price change” due to the arrival of information, while the risk of non-execution can be due to both temporary and permanent price change. Strictly speaking, orders are not picked off if they are traded against liquidity traders and price change is always temporary. Thus, the sources of the two risks involve whether the fundamental information arrives to the market or not. When the fundamental information arrives to the market, both of the two risks arise. When the information does not arrive so that the price change is temporary, non-execution risk possibly appears, while picking-off risk does not. Therefore, we are able to clarify the timing of the information arrivals by quantifying the determinants of the two risks simultaneously.

Second, several theoretical and empirical studies examine traders' order choice between market and limit orders that involves trade-off between immediate execution and favorable transaction price.¹ Since non-execution and picking-off risks significantly influence traders' order choice between market and limit orders, an econometric analysis to quantify these two risks also offers a better understanding of dynamic order-submission strategies that actual stock investors use. Third, when stock investors attempt to reduce the risks of non-execution and of being picked off, they must monitor the market closely and revise or cancel the orders if necessary. However, they may reduce the monitoring cost, if they have certain ideas regarding determinations of the risks. Thus, our investigation assists real stock investors by contributing to better risk management. Fourth, as the optimal choice of strategies constitutes traders' fundamental decision problem, the study in the present paper offers additional insight into the price formation process and how order-driven markets work.

We conduct this analysis by utilizing an order book and transaction data on individual stocks listed on the Nikkei 225 from September 1, 2006 to August 31, 2007, distributed by Nikkei Media Marketing, Inc., an information vendor in the Nikkei Group. We demonstrate that, on the one hand, the risk of non-execution increases, while the risk of being picked off, on the other hand, decreases when: 1) the depth on the incoming investor's side becomes thicker, 2) the bid-ask spread becomes narrower, 3) volatility decreases, and 4) the depth on the opposite side to the incoming investor becomes thicker. As discussed in [Handa and Schwartz \(1996\)](#), picking-off risk increases when the fundamental information cause the price to change permanently so that the best prices cross the limit price, while non-execution risk arises due to both temporary and permanent price changes. Our results imply that the fundamental information impacted the Japanese stock market during our sample periods, influencing both of the two risks.

In addition, we report asymmetric determinations of non-execution and picking-off risks between buy and sell limit orders, as well as among our sample firms. We interpret the asymmetry to be attributed to differences in transaction volume and order book thickness. For example, more transactions on the sell side of the order book for certain stocks lead to higher quote competition among limit order traders on the sell side, increasing the thickness of the order book inside of the spread. It then decreases the rate of executions and of being picked off for limit orders on the sell side existing outside of the spread. Our results are robust for a different one-year period, covering from September 1, 2005 to August 31, 2006, in which volatility is higher, possibly adding extra risk to dynamic strategies, implying a higher risk premium. Our findings suggest that real-time information on order book and transactions is highly valuable to stock investors, and will assist investors in making profitable order choices about placing a limit or a market order.

Although our most significant contribution is that we measure both non-execution and picking-off risks and analyze their determinants on the Tokyo Stock Exchange, this paper makes another significant contribution with our size-stratified analyses of the Tokyo Stock Exchange. We relate the non-execution and picking-off risks to the states of the order book and transactions over individual stocks, which have not been sufficiently examined in past empirical studies. [Duong et al. \(2009\)](#) empirically explore the determinants of the order choice between market and limit orders by institutional and individual traders on the Australian Stock Exchange. They imply that picking-off activity by institutional investors tends to be prevalent and that the risk is thus exacerbated in large-sized stocks in comparison with mid- and small-cap stocks. In addition, since the number of transactions is usually lower for mid- and small-cap stocks than for large stocks, the non-execution risk may be larger for mid- and small-sized stocks than for large stocks. [Liu \(2009\)](#) theoretically and empirically analyzes the determinants of order cancellation/revision. By utilizing the dataset on the Australian Stock Exchange, [Liu \(2009\)](#) shows that non-execution and picking-off risks increase order cancellation/revision for actively traded stocks, and that there are more order cancellations/revisions for larger stocks. Thus, the results suggest that both the non-execution and the picking-off risks increase for larger stocks. However, direct evidence, which demonstrates empirical determinants of the non-execution and the picking-off risks using the order book and transaction data for individual stocks on the Tokyo Stock Exchange, is still lacking. Moreover, our approach investigating the two risks for individual stocks assists certain types of traders by contributing to better risk

¹ With regard to theoretical studies of order choice, [Parlour \(1998\)](#) constructs a one-tick model showing that order aggressiveness depends on the market depth of the order book. For empirical studies, see, for example, [Aitken et al. \(2007\)](#); [Beber and Caglio \(2005\)](#); [Biais et al. \(1995\)](#); [Duong et al. \(2009\)](#); [Griffiths et al. \(2000\)](#); [Hall and Hautsch \(2006\)](#); [Handa et al. \(2003\)](#); [Rinaldo \(2004\)](#); and [Wald and Horigan \(2005\)](#).

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