ESSAYS ON MARKET DESIGN AND MARKET QUALITY

Dong Zhang
To my family and friends
Acknowledgement

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Introduction

O’Hara (2000) refers to market microstructure as “the study of the process and outcomes of exchanging assets under a specific set of rules”. As a collection of four market microstructure articles, this thesis examines how different structures of the financial market affect market quality. Harris (2003) describes market structures as the trading rules and the trading systems that determine who can trade; what and how they can trade. Trading rules and systems determine the price formation mechanism and how market participants trade in practice.

Market structure issues are related to the functions of the financial markets, which are important to the economy. Mishkin (2004) claims that “well-functioning financial markets are a key factor in producing high economic growth, and poorly performing financial markets are one reason that many countries in the world remain desperately poor”. The function of financial markets includes allocating resources to productive projects, facilitating price discovery and providing means for risk management.

Harris (2003) suggests that the defining characteristic of a market’s structure is the trading system that decides the procedures for matching buyers and sellers. Markets with different trading systems mainly differ in how buy and sell orders are matched and whether there exists designated market makers. There are three main categories of markets classified after their trading systems: quote-driven market, order-driven market and hybrid market. In a pure quote-driven market, market makers supply liquidity to the market by quoting prices at which they will buy or sell. Market makers can trade among themselves, but other investors must trade with market makers. One example of quote-driven market is the foreign exchange market. Pure order-driven markets, or limit order markets, allow investors to trade with each other without the intervention of market makers. Buy and sell orders sent by investors are matched directly in the market. The Shanghai Stock Exchange market is an example of such market. Hybrid market combines the quote-driven and order-driven protocols. Investors are able to trade with each other directly. At the same time, some market makers are designated to offer liquidity when the market is not liquid. Market makers are required to send buy and sell orders to the market when no one else does so voluntarily. Many exchanges today adopt a hybrid market execution system, e.g., the New York Stock Exchange, the London Stock Exchange and NASDAQ OMX Stockholm (NOMX).
A common definition for liquidity is that it measures the ability to buy or sell a large amount of a financial instrument with a low cost in a short time period. In a liquid market, a small change of supply or demand for a financial instrument does not cause a large price change. Higher liquidity makes it possible for investors to implement their trading strategies with lower costs. Resources can be allocated more efficiently. A more liquid market also helps exchanges to attract more investors. Kyle (1985) points out that there are several dimensions of liquidity: width, depth and resiliency. Width refers to the trading cost of turning around a buy or sell position over a short time period. It is often measured as the bid-ask spread, i.e., the difference between the highest buy and the lowest sell prices. Depth is the sensitivity of prices to trading volume. It can be measured as the volume available to trade on the given buy or sell prices. Resiliency refers to the speed at which prices revert back to the former level after uninformed large buy or sell trading activities.

Harris (2003) states that liquidity is the most important characteristic of well-functioning market. It is relevant not only to investors who trade financial instruments, but also to firms and general consumers. First, investors prefer to trade liquid securities because it is cheaper and faster than to trade illiquid securities. If liquidity is low and transaction costs are high, trading activity decreases. Informed traders are less motivated to collect information because it is costly for them to use the information to buy or sell assets. The market price consequently reflects less the information. Investors rely on prices that accurately reflect information to make investment decisions. Second, as investors prefer liquid securities with lower transaction costs, firms whose securities are traded in a more liquid market can have higher prices, and consequently higher company valuation and lower cost of capital. Accordingly, consumers can benefit more from these firms’ products and services.

Articles I and IV investigate the impact of employing market makers. It is relevant to the financial markets’ function of resource allocation, which refers to channelling capital from individuals or organizations that have saved surplus funds to those who need capital for production activities. For example, when individuals invest their savings to buy stocks issued by firms that need funds for development, market makers act as trading intermediaries in the process and move funds from buyers to sellers. Market makers are employed with the purpose to supply liquidity to the market, reduce transaction costs, and consequently enhance the efficiency of resource allocation.

Except for contracted market makers, any market participant can supply liquidity in a hybrid market structure by submitting buy and sell orders. Article III in this dissertation examines the order submission strategies of the market-making high frequency traders (MM-HFTs), other HFTs and non-HFTs. With the development of information technology, some HFTs can use automated trading algorithms and act as market makers. HFTs are able to
reduce the latency by locating their trading systems directly at the exchange site and use computer algorithms to trade. HFTs who use the colocation service are often questioned for whether they gain unfair advantages over other slower investors. Until today, there is not an unambiguous conclusion about the exact effects of high frequency traders. However there is no doubt about the fact that they are a non-trivial market participant. The Wall Street Journal (2009) shows that high frequency trading accounts for at least half of the stock trading volume in the US. All HFTs do not only use the same trading strategy. Hagströmer and Nordén (2013) suggest that as one group of HFTs, MM-HFTs engage actively in supplying liquidity. Different from contracted market makers who are obliged to supply liquidity, MM-HFTs supply liquidity voluntarily.

Another important market quality measurement is volatility, which describes the variation in the price of financial instruments. It is often measured by the variance of price changes. Volatility arises when the price changes in response to new information (fundamental volatility) or liquidity demand from uninformed traders (transitory volatility).

Market participants are concerned with excessive volatility, which often indicates that the financial market is not functioning well. Under excessive volatility, informed traders are less able to secure the profits from trading with their information. Uninformed traders are likely to experience high transaction costs and lose confidence in the market. Liquidity suppliers become more reluctant or demand higher compensation to supply liquidity when volatility is high. Consequently, liquidity becomes worse. One example of an excessive volatility event is the “flash crash” on May 6, 2010, when the stock indexes in the US plunged and regained very rapidly.

The second function of the financial market is to facilitate price discovery, which refers to the process through which information is incorporated into the price. The concept of price discovery is linked to volatility. When prices change to reflect new information, fundamental volatility is formed in the market. Informed traders collect information and trade on it, which causes prices to move towards levels with full information. In an efficient market, prices reflect all available information and transactions are made at fair value.

Article II investigates price discovery on a relatively new futures market, the Chinese gold futures market, which was established in 2008. Price discovery is related to financial markets’ function of resource allocation. Harris (2003) claims that informative prices are essential to efficient production and allocation decisions. For example, the value of gold mining companies is linked to the gold prices. Return for the gold mining companies in relation to the cost determines whether more resources will be allocated to gold mining industries. Uninformative gold prices lead to unfair valuation for the gold mining companies, and consequently mislead recourse allocation.
Article II is the first to investigate the price discovery function of the Chinese gold futures market in relation to the US market. China’s gold supply and demand volume has recently become world’s largest. The Chinese gold prices therefore can be informative if they reflect the large supply and demand volume. However, the US gold futures market is a traditional popular market where the most of the trading activities occur for gold futures contracts.

As the third function of the financial markets, the futures market provides means for investors to manage risk. A futures contract is an agreement between two parties to buy or sell an asset at a certain time in the future for a certain price. Futures contracts guarantee a transaction price in the future time, and they can be used by market participants to control their risk exposure.

The futures market can attract hedgers, speculators and arbitrageurs to participate in the market. Hedgers take positions in the futures market to reduce their exposure to the future price movements. With more certain cash flows, hedger companies are able to increase their capital efficiency, lower the cost of capital and ultimately benefit consumers. Speculators are able to use the leverage from the futures market and bet the future price changes to make profits. Excessive speculation activities are likely to increase the transitory volatility. However, informed speculators can make the price informative and enhance the market efficiency. Arbitrageurs also contribute to the market efficiency by trading on the price discrepancies between the same or related assets traded in different market places.

The trading of the futures contracts can have a negative impact on the underlying market. For example, Stein (1987) suggests that futures trading can destabilize the spot market through trading activities between hedgers and poorly informed speculators. Therefore, the possibility of using futures markets to manage risk may enter with a cost of the deteriorated quality in the underlying market. Article I examines the effect of introducing futures contracts on the underlying stocks in Thailand. Market makers were employed in the futures market several months after the futures contracts were introduced in the Thai market. The staggered events provide a good material for empirical investigation on the impact of introducing futures contracts and market makers in the futures market.

Summary of the thesis

This dissertation consists of four articles in which various market structures are studied and evaluated in terms of how they affect market quality or investors’ trading activities. Article I investigates the impact of introducing futures contracts on the underlying stocks. Article II studies price discovery in the gold futures markets. Article III examines the trading activities of high
frequency traders, and article IV studies the effects of introducing designated market makers to the stock market.

Article I

Futures contracts provide a cost-efficient way for market participants to gain access to the financial market. Hedgers, speculators and arbitrageurs enter the futures market for various purposes. Stein (1987) and Subrahmanyam (1991) suggest that futures trading can have impact on the underlying assets. In Article I, “Effects of the introduction of stock index futures on the underlying stocks: the role of futures market makers”, the aim is to examine the stock market’s reaction in response to the introduction of futures contracts.

Introducing derivatives markets can change multiple-market participants’ activities, and the effect of this on the underlying market is a complex issue. In a model proposed by Stein (1987), two types of investor are present in the markets: hedgers and speculators. The hedgers maintain inventory positions while the speculators do not. The futures markets have a negative effect and destabilize (increase the price variability of) the underlying asset prices if the speculators possess noisy information. In this case, the hedgers react to the noisy signals from the speculators and transmit them to the spot markets. However, if the speculators have perfect information or do not have information at all, there should be no destabilizing effect on the underlying market.

In Subrahmanyam (1991), there are also two types of market participants: informed and liquidity traders. Informed traders use their private information to trade, whereas liquidity traders’ activities are determined by factors outside the market. He suggests that liquidity traders experience lower costs when they trade index futures than when they trade individual stocks. As liquidity traders leave the spot market for the index futures market, liquidity decreases for individual stocks.

On April 28, 2006, the Thailand Futures Exchange (TFEX) introduced the SET 50 stock index futures contracts. The SET 50 index consists of the 50 largest companies on the Stock Exchange of Thailand. The futures contracts are organized as a pure limit order market. However, on September 18, 2006, designated market makers were introduced to the futures market to provide liquidity. After that, the TFEX is operated under a hybrid market structure.

Article I, written jointly with Lars Nordén, studies the effects of introducing the SET 50 futures on liquidity, trading activity and volatility of the SET 50 stocks in the spot market. We focus not only on the effects from the futures introduction event per se, but also from the subsequent event of introducing market makers to the futures market. Market makers take positions
on both the futures and the stock markets, and are likely to have impact on
the stock market. Previous studies focus only on the introduction of the fu-
tures contracts. The case of the SET 50 futures provides an excellent oppor-
tunity for studying the impacts from both the futures introduction itself and
the introduction of futures market makers.

The impact of introducing market makers in the futures market on the
spot market is not obvious. SET (2008) shows that the designated futures
market makers are also active in the spot market in Thailand. Market makers
are often considered uninformed and they make profit from trading at the
bid-ask spread. In this case, the trading cost (adverse selection cost) decrea-
eses and liquidity increases in the spot market. In contrast, market makers in
the futures market potentially decrease adverse selection costs for investors
in the futures market. As Subrahmanyam (1991) predicts, lower adverse
selection cost in the futures market attracts liquidity traders on the spot mar-
ket to migrate to the futures market. Consequently, liquidity can also de-
crease in the spot market.

The main contribution of this paper is related to the unique structure of
the Thai financial market. First, the Thai futures contracts and designated
market makers are introduced in different times with almost five months in
between. The market event provides a good chance to study the impact of
designated market makers, which have not been the focus of previous studies.
Second, unlike markets in developed countries, where institutional investors
are often the major market participants, the Thai financial market is domi-
nated by local retail investors. Institutional investors are generally consid-
ered as informed investors, and retail investors are considered as uninformed
ones. Bohl, Salm and Wilfling (2011) point out that institutional investor
dominated markets are not suitable to study whether the futures market de-
stabilizes the spot market. A solution in empirical studies is to investigate
markets where uninformed investors are active. Last, this article uses a vec-
tor auto-regression (VAR) framework to treat the liquidity, volatility and
trading volume variables endogenous. Volatility, liquidity and trading vol-
ume are often found related to one another. However, most previous studies
on the impact of the futures market on the spot market treat them separately.

The results show a lower liquidity for the underlying index stocks after
the introduction of the index futures. After the subsequent event of introduc-
ing designated market makers into the futures market, we observe higher
liquidity in the stock market. The introduction of the index futures contracts
and the market makers does not destabilize the underlying stocks. Overall,
this article documents a positive market impact of employing designated
market makers in the futures market on the underlying stocks.
Article II

Gold is an important instrument in the economy. Except for its usage as jewelry and ornament, gold is also used by central banks and investors to build reserves and invest. Traditionally, the US and the UK have been important markets for gold trading. In the US, the Commodity Exchange (COMEX) started offering gold futures trading in 1974 and accounts for 70% of the global total gold futures trading volume. In the UK, London’s over-the-counter market has been in operation since 1919.

Over the last few years, China has shown large gold demand and supply volume. The United States Geological Survey (2010, 2011, 2012) reports that China has been the largest gold-producing country since 2010. It contributes approximately 13% of the global gold-mining volume. In terms of gold demand, the volume is big from both the Chinese public and private sector. From the public sector, the Chinese central bank had increased the gold reserve by 76% since 2003 and is the sixth-largest government holder of gold in the world. From the private sector, China exceeded the combined demand from the UK, the US, Germany and Switzerland during 2010 and 2012.

Article II, “Price discovery in gold markets: China and the US”, examines the price discovery process between China and the US. Information flows from the market with a leading role in price discovery to the market contributing less to the price discovery process. Cai, Cheung and Wong (2001) document that the information factors that impact gold prices can be gold demand, gold production, and macroeconomic conditions.

A number of previous studies find that larger and more liquid markets (e.g. the US) lead smaller and less efficient markets (e.g. China) in price discovery. Xu and Fung (2005) examine the gold, platinum and silver futures contracts traded in the US and Japan. Their results indicate that the information flows from the US to Japan. This information transmission from the US to Japan is rapid and occurs within one trading day. Lucey, Larkin and O’Connor (2014) document that China remains an isolated gold futures market from the UK and the US in that it does not provide spillovers to other markets. Fung, Leung and Xu (2003) document a leading information role for the US market over the Chinese market for copper and soybean futures contracts.

Despite the importance of the larger and more liquid markets, some studies do not document a leading role for larger markets in price discovery. Fung, Liu and Tse (2010) document the US market does not perform better than China’s in incorporating information into market prices for the aluminium and copper futures contracts. Su and Chong (2007) investigate the price discovery process for mainland Chinese stocks that are cross listed on Stock Exchange of Hong Kong (SEHK) and the New York Stock Exchange
(NYSE). They document that the SEHK makes more contributions than the NYSE to the price discovery process.

This article documents that the Chinese gold futures market leads that of the US in the price discovery process. The Chinese gold futures market was introduced in 2008. Despite its short history, the Chinese gold futures market has become more efficient than the US market in incorporating information to the market prices. In addition, the Chinese gold spot market is led by the Chinese futures market during the daytime trading session and by the US gold futures market during the night-time trading session.

Article III

The market is populated with different type of investors. They can be categorized as informed and uninformed investors according to the information content held by them. They can also be categorized as retail and institutional investors according to their size and legal status. With the development of information technology, a relatively new trader type of trader emerge in the equity market recently, high frequency traders (HFTs). Article III, “How aggressive are high-frequency traders?” studies the trading activities of HFTs and compares HFTs to non-HFTs. This article is written jointly with Björn Hagström, and Lars Nordén and published in The Financial Review as Hagströmer, Nordén and Zhang (2014).

In this article, aggressiveness reflects how large and immediate orders are likely to be executed. For example, limit orders enter and rest in the order book, whereas market orders enter the order book and become executed immediately. Market orders are more aggressive than limit orders. Investors’ choice over orders of different aggressiveness level is documented to be dependent on the order book depth (Parlour 1998), volatility (Foucault 1999), traders’ patience level (Foucault, Kadan and Kandel 2005) and liquidity supply competition (Roşu 2008).

Algorithmic strategies are often used by investors in equity markets. With the help of modern information technology, algorithmic traders are able to handle information and revise orders very fast. HFTs are often referred to as algorithmic traders that trade on their own account. Hendershott and Riordan (2013) and Brogaard (2010) document different order submission strategies between human and algorithmic traders or HFTs.

Following Hagström and Nordén (2013), this article classifies traders into HFTs, non-HFTs and hybrids on NOMX in Sweden. HFTs apply proprietary trading only and use algorithms in trading activities. Non-HFTs trade for clients only, and hybrids engage in both client and proprietary trading. HFTs are further classified into MM-HFTs and opportunistic HFTs (Opp-HFTs). MM-HFTs supply liquidity at the best bid and offer quotes
(BBO) to the limit order book continuously. All other HFTs are classified as Opp-HFTs.

Diagonal effects refer to the trading pattern that the probability of a particular order type being submitted is higher when the previous order is of the same type. Our results indicate that the diagonal effect exists in our sample, but the channel is different for different order types. For marketable limit orders and depth orders, the diagonal effect arises from self-following activities\(^1\). Traders tend to slice their large orders to reduce price impact when they demand liquidity. For limit orders quoted at the BBO, MM-HFTs persistently at BBO regardless which trader group submits the previous order. In contrast, Opp-HFTs (non-HFTs) follow others (themselves) in quoting at the BBO.

Traders’ order submission strategies are not independent from market conditions. Foucault, Kadan and Kandel (2005) document that traders consider the tradeoff between the cost of immediacy and cost of waiting in choosing order aggressiveness. Our results show that both HFT and non-HFTs consider the waiting cost in submitting orders. When the waiting cost is high, aggressive orders are more likely to be used. However, HFTs react stronger to the cost of waiting than non-HFTs.

High intraday volatility, for instance, the flash crash, attracts attention from market regulators and market participants. Foucault (1999) argues that volatility is an important market condition measure according to which investors make their trading decisions. HFTs are questioned for causing large price volatility. Our results about the traders’ choice of aggressiveness on market volatility show that HFTs and non-HFTs both use less aggressive orders when the market volatility is high. The results imply a volatility mitigating effect for both HFTs and non-HFTs. However, non-HFTs are more sensitive to the change in market volatility.

**Article IV**

A pure limit order market relies on voluntary liquidity supply from market participants. Today many equity markets operate mainly under a limit order market structure. At the same time, special market participants are designated to act as market makers and supply liquidity. Article I demonstrates that introducing market makers in the futures market is associated with a liquidity increase in the underlying stocks. Hagströmer and Nordén (2013) show that one group of HFTs, MM-HFTs, can use algorithms and

\(^1\) A marketable limit order is a market order without price impact, for example, a buy order with the price equal to the best ask quote. A depth order is a limit order submitted beyond BBO, for example, a buy order with the price lower than the best bid quote.

NOMX introduced a liquidity provider scheme (LPS) in 2012. This voluntary scheme requires the participants to supply liquidity to the underlying stocks of the OMXS30 index. As a compensation for supplying liquidity, the LPS participants are entitled to lower transaction fees.

This article analyzes the market impacts of the LPS on the OMXS30 stocks traded on NOMX in terms of liquidity and liquidity risk. In addition, this article investigates the impact of the LPS on Chi-X. Outside NOMX, OMXS30 stocks are traded on multilateral trading facilities including Chi-X, BATS, Turquoise and Burgundy. This paper focuses on the biggest competitor to NOMX in terms of market share, Chi-X. This analysis investigates whether, if there is improved liquidity on NOMX after the introduction of the LPS, it is accompanied by a liquidity decrease on Chi-X. If so, it will indicate that liquidity migrates away from NOMX’s competitor market.

The LPS motivates registered members to supply liquidity. If the scheme achieves the desired results, liquidity is expected to increase on NOMX. Menkveld and Wang (2013) document reduced liquidity risk when small-cap firms hire designated market makers (DMMs) to supply liquidity. Instead of small-cap stocks, LPS was introduced for the 30 most actively traded large-cap stocks on NOMX. Acharya and Pedersen (2005) and Pastor and Stambaugh (2003) demonstrate that liquidity risk is larger for illiquid stocks, which tend to have higher volatility and to be smaller in size than liquid stocks. However, liquidity risk still exists for large-cap and more frequently traded stocks. Acharya and Pedersen (2005) and Lee (2011) find that the market may still reward the liquidity risk of taking on large-cap stocks.

The results in this paper show that the OMXS30 constituent stocks’ liquidity is increased after the introduction of the LPS, i.e., the bid-ask spread decreases by 1.08 basis points. This result is in line with the liquidity improvement gained from employing DMMs in Menkveld and Wang (2013). The documented spread decrease in this paper is economically meaningful. It is equivalent to a daily trading cost saving of nearly 1.2 million Swedish Krona (SEK). The result does not document a migration of liquidity from Chi-X to NOMX after the LPS is introduced. The liquidity level on Chi-X

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The average daily trading volume for the OMXS30 stocks is approximately 10.7 billion SEK during the month before the LPS introduction. The decrease of 1.08 basis points in the bid-ask spread is equivalent to a daily trading cost saving of approximately 1.2 million SEK. The trading volume data are available at https://newsclient.omxgroup.com/cdsPublic/viewDisclosure.action?disclosureId=499617&lang=en
increases after the LPS’s introduction as well. Regarding liquidity risk, the findings suggest that the liquidity risk remains unchanged for the OMXS30 stocks on NOMX.

This study decomposes the bid-ask spread to investigate the channel through which the spread is reduced and how market participants benefit from the reduced spread. The results show that the order-processing cost decreases after the LPS’s introduction. This is likely due to the fact that qualified market makers receive the benefit of lower transaction fees from NOMX. Market makers claim less compensation for supplying liquidity, which is shown in reduced spreads. This reduction benefits liquidity consumers by decreasing their trading costs in crossing the bid-ask spread. Another component of the spread is the adverse selection cost. Liquidity suppliers experience adverse selection cost when they trade with informed traders. The adverse selection cost becomes smaller for the OMXS30 stocks on NOMX after the LPS is introduced.

This study contributes to the literature on market impacts from contracted market makers for liquid stocks. Venkataraman and Waisburd (2007) and Menkveld and Wang (2013) investigate the DMMs employed by small-cap firms. There are substantial differences between the LPS liquidity suppliers and DMMs. The LPS specifies a relative liquidity supply demand, while DMMs are usually required to maintain the liquidity at some absolute level. This article also contributes to the literature on competition among trading venues. The LPS increases the competitiveness of NOMX by specifying a relative liquidity supply requirement. Previous literature investigate competition from other market structures, for instance, introducing a new market venue (Foucault and Menkveld 2008), or changing market fee structure (Malinova and Park 2015).

Conclusion

This dissertation contains four studies on the market structure and design. Article I, III and IV document a positive market impact from market makers in different markets. Collectively the results show that market makers improve the liquidity level, and increase the efficiency of the resource allocating function of the financial markets.

In article I, employing market makers in the futures market is associated with improved liquidity in the underlying stocks. Article III demonstrates that MM-HFTs act as market makers and supply liquidity consistently to the BBO. HFTs are not found to increase the volatility. In article IV, contracting market makers in NOMX improves the liquidity and decreases the trading costs. The liquidity improvement is not associated with deteriorated liquidity on NOMX’s competitor market.
Article II investigates financial markets’ function of providing price discovery. The Chinese gold futures market was introduced in 2008. The results show that despite its short history, the Chinese gold futures market has become more efficient than the US market in incorporating information to the market prices. In addition, the Chinese gold spot market is led by the Chinese futures market during the daytime trading session and by the US gold futures market during the night-time trading session.

The financial markets provide means for risk management. Futures markets offer a cost effective way for investors to change their exposure to the risk. Different type of investors can be attracted to the futures markets. However, the possibility of the risk management benefit can imply a sacrifice of the underlying market. For example, Stein (1987) suggests volatility can increase in the underlying after the futures market’s introduction. Article I document a decreased liquidity in the underlying stocks after the introduction of the index futures contract. However, contracting market makers in the futures market increases the liquidity, while the trading activity and volatility remain unchanged.
References


