Available online at www.sciencedirect.com
SCIENCE DIRECT®
Pacific-Basin Finance Journal 14 (2006) 1–32
PACIFIC-BASIN FINANCE JOURNAL
www.elsevier.com/locate/pacfin

The current state of Asia-Pacific stock exchanges: A critical review of market design

Carole Comerton-Forde *, James Rydge

Finance Discipline, School of Business, University of Sydney, Australia

Received 4 October 2004; accepted 16 May 2005
Available online 9 August 2005

Abstract

This paper provides a review of the market microstructure of ten Asia-Pacific stock exchanges. Asia-Pacific stock exchanges face significant challenges in an increasingly global and competitive world equity market. These exchanges need to provide an efficient, fair and competitive trading environment if they are to attract new listings and attract investors. This paper documents significant differences in market design across Asia-Pacific stock exchanges. Many of these design features are at odds with the existing microstructure research. Achieving competitive markets may involve a review of market design and regional consolidation. Failure to increase attractiveness may result in Asia-Pacific exchanges losing market share in the global equity market. A review of current best practice in a number of critical microstructure areas is useful for market organizers to assist in policy development, is helpful for academics wishing to undertake empirical research in these markets and is a source for future research ideas.

JEL classification: G14
Keywords: Asia-Pacific exchanges; Market microstructure; Market design

* Corresponding author. Economics and Business Building (H69), University of Sydney, NSW, 2006, Australia. Tel.: +612 9351 7650; fax: +612 9351 6461.
E-mail address: C.Comerton-Forde@econ.usyd.edu.au (C. Comerton-Forde).

0927-538X/$ - see front matter © 2005 Elsevier B.V. All rights reserved.
doi:10.1016/j.pacfin.2005.05.002

1. Introduction

Ten to fifteen years ago stock exchanges operated monopoly businesses in national markets. The only option for most companies was to list on their national exchange and investors were only able to invest in their national market. Today, technology and globalization have radically changed the exchange landscape. Companies can choose where to list and institutional investors can trade in virtually any market. Retail investors also have much greater access to foreign markets. Exchanges must now compete for both listings and for investors. Their success depends critically on their ability to attract order flow to their market.

Exchanges around the world unanimously state that their objectives are to ensure market efficiency and integrity. Market efficiency refers to the ability of investors to transact easily at low transaction costs. Market integrity refers to the ability of investors to transact in a fair and informed market where prices reflect information. Exchanges essentially compete for order flow based on their ability to meet these objectives.

While the objectives of market efficiency and integrity are unanimously sought by exchanges, the path to achieving them is not clear. This is evident as market design differs across exchanges. For example, the Taiwan Stock Exchange operates a call market while until recently, the Hong Kong Exchanges and Clearing operated a pure continuous market. In addition, exchanges have tended to develop in isolation from one another. They have developed at different paces and face different issues. As a result, there is no consensus on what market design is the most efficient and fair. However, it is accepted that optimal market design will vary depending on the types of securities traded and the types of investors trading (e.g., Lauterbach, 2001; O'Hara, 2001).

Exchanges in the Asia-Pacific region are not immune from an increasingly competitive and global equity market. Asia-Pacific exchanges must compete in this new market reality. This will present challenges for these exchanges that will be increasingly forced to compete or falter.[1] As a result, market design is taking on new importance (O'Hara, 2001).

O'Hara (2001) argues that exchange size, technology and market design are critical in achieving efficient price discovery and liquidity, the two factors that govern exchange viability. In order to gain critical mass and enhance competitiveness, greater cooperation between exchanges in the region is required. In addition, exchanges must demonstrate flexibility in their market design in order to meet the changing needs of participants, particularly institutional investors. Exchange demutualisation is also critical to exchange success. This means that success will not only be measured by the liquidity and integrity of the market, but also by its profitability.

The aim of this paper is to review the market design of ten of the Asia-Pacific region's largest stock exchanges. By drawing on a large and growing body of market microstructure literature, and by making comparisons with markets in other regions, this paper examines how differences in market structure influence the success of Asia-Pacific

[1] The inability of NASDAQ Europe and NASDAQ Deutschland to compete in the European equity market lead to their closures in 2003.

exchanges. The paper also identifies the challenges faced by Asia-Pacific exchanges and discusses trends. The exchanges reviewed in the paper include: the Australian Stock Exchange (ASX), Bursa Malaysia (BMA), Hong Kong Exchanges and Clearing (HKEx), the Jakarta Stock Exchange (JSX), the Korea Exchange (KRX), the Stock Exchange of Thailand (SET), the Shanghai Stock Exchange (SSE), the Singapore Exchange (SGX), the Tokyo Stock Exchange (TSE) and the Taiwan Stock Exchange (TSEC). These markets are referred to collectively throughout this paper as Asia-Pacific exchanges.

The remainder of the paper is organised as follows. The next section presents statistics on the size and activity of Asia-Pacific exchanges. Section 3 outlines current market structures. Section 4 considers pre and post-trade transparency. Section 5 considers price controls and Section 6 concludes. Appendix A provides details of the trading mechanism in each Asia-Pacific market. The Appendix may also be read as a stand alone reference on the microstructure of the selected markets.

2. Statistical overview of Asia-pacific exchanges

Figs. 1, 2 and Table 1 present a statistical overview of the selected Asia-Pacific exchanges. Fig. 1 indicates total market capitalization for the period 1990–2003, by exchange, expressed in dollars (USD). Significant size variations are evident between Asia-Pacific exchanges. In addition, Asia-Pacific markets have not experienced similar

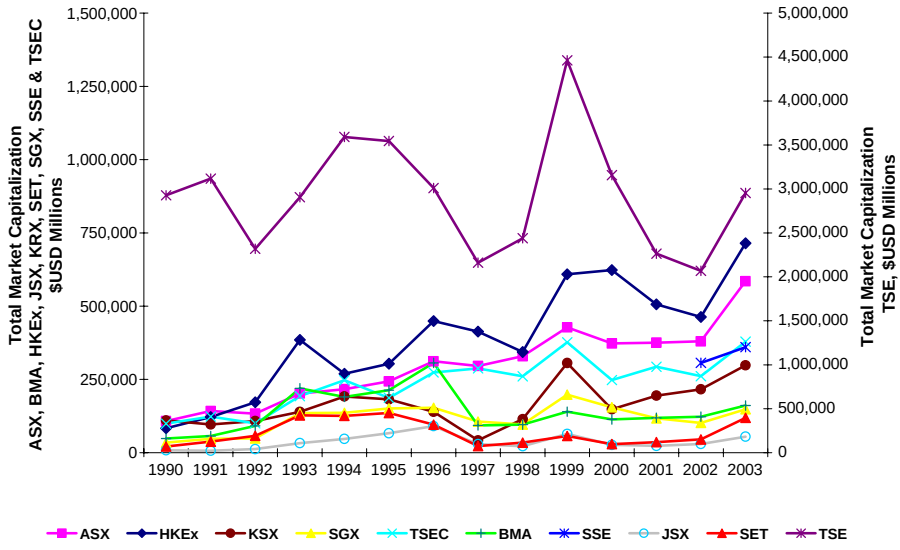

Fig. 1. Market Capitalization. Total market capitalization is presented on an annual basis from 1990–2003, by Asia-Pacific exchange in USD. The Australian Stock Exchange (ASX), Bursa Malaysia (BMA), Hong Kong Exchanges and Clearing (HKEx), Jakarta Stock Exchange (JSX), Korea Exchange (KRX), Stock Exchange of Thailand (SET), Singapore Exchange (SGX), Shanghai Stock Exchange (SSE) and the Taiwan Stock Exchange (TSEC) are represented on the left hand vertical axis. The Tokyo Stock Exchange (TSE) is represented on the right hand vertical axis due to its large size compared to the other markets.

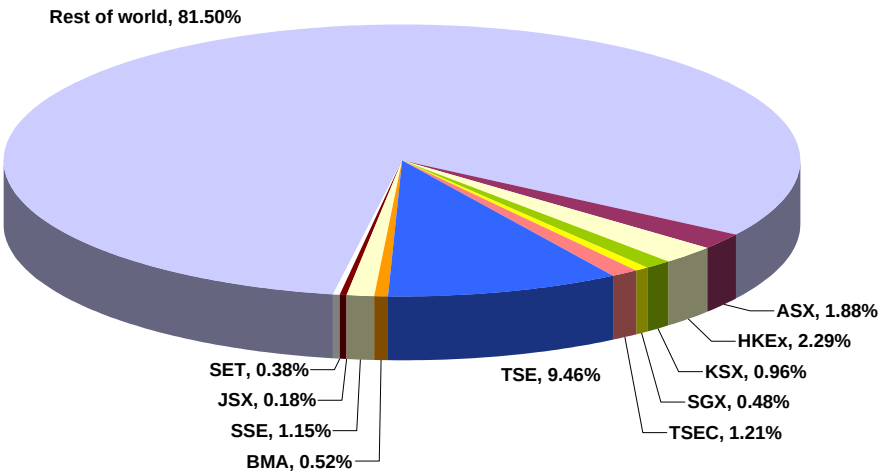

Fig. 2. Asia-Pacific exchanges share of world market capitalization, 2003. This figure presents total market capitalization as a percentage of total world market capitalization, by Asia-Pacific exchange in USD. The Australian Stock Exchange (ASX), Bursa Malaysia (BMA), Hong Kong Exchanges and Clearing (HKEx), Jakarta Stock Exchange (JSX), Korea Exchange (KRX), Stock Exchange of Thailand (SET), Singapore Exchange (SGX), Shanghai Stock Exchange (SSE), Tokyo Stock Exchange (TSE) and the Taiwan Stock Exchange (TSEC) are presented.

growth rates over time, although an upward trend is evident. HKEx and ASX market capitalization is significantly larger in 2003 compared to 1990. In contrast, market capitalization on the KSX, while similar to HKEx and ASX market capitalization in 1990, has not experienced the same growth rates. TSE market capitalization, while larger than the other markets, is significantly more volatile, reflecting instability in the Japanese economy over this period.

Fig. 2 indicates Asia-Pacific exchanges' share of total world market capitalization, at the end of 2003. With the exception of the TSE, Asia-Pacific exchanges account for a relatively small share of total world market capitalization. The TSE is the largest Asia-Pacific exchange, accounting for over 9% of total world market capitalization. At the end of 2003, the TSE was the second largest stock exchange in the world behind the New York Stock Exchange (NYSE).

Significant variations in total trade value are evident between Asia-Pacific exchanges. In 2003, TSE trade value is nearly double that of all other Asia-Pacific exchanges combined. The JSX exhibits the smallest trade value. In addition, most Asia-Pacific exchanges examined exhibit significant volatility in trade value, especially after the South East Asian Financial Crisis in 1997/98. The exception is the ASX. The ASX has achieved a consistent increase in trade value over the period 1990–2003.

Table 1, Panel A presents an estimate of market concentration across the Asia-Pacific exchanges. Concentration is defined as the proportion of total market trade value attributable to the top 5% of listed companies. Data for the TSEC is not available in 1996 and 1998, and data for the SSE is only available from 2002. The ASX is the most concentrated market examined, closely followed by the JSX and the HKEx. BMA, KSX and the SSE are the least concentrated markets. Table 1, Panel B presents turnover velocity

Table 1
Market concentration and turnover velocity

Panel A: Market concentration

% of trade value	1995 (%)	1996 (%)	1997 (%)	1998 (%)	1999 (%)	2000 (%)	2001 (%)	2002 (%)	2003 (%)
ASX	81	75	79	84	81	80	88	87	84
BMA	34	16	39	60	46	44	49	46	30
HKEx	71	62	53	77	65	65	71	74	70
JSX	44	42	43	64	59	60	76	71	81
KSX	35	28	28	50	40	64	60	58	20
SET	45	41	48	49	43	30	33	34	35
SGX	13	25	33	43	18	37	35	31	55
SSE	–	–	–	–	–	–	–	21	34
TSE	43	44	43	62	66	71	66	66	64
TSEC	28	–	38	–	48	53	52	44	43

Panel B: Turnover velocity

Turnover Velocity	1995 (%)	1996 (%)	1997 (%)	1998 (%)	1999 (%)	2000 (%)	2001 (%)	2002 (%)	2003 (%)
ASX	43	51	54	53	52	57	67	76	80
BMA	29	66	60	30	34	33	19	25	34
HKEx	34	44	91	62	51	61	44	40	52
JSX	27	41	57	57	42	37	39	42	35
KSX	101	104	146	207	345	243	219	254	193
SET	43	39	50	69	78	55	91	90	136
SGX	47	39	56	64	75	75	59	54	74
SSE	–	–	–	–	–	–	–	–	118
TSE	26	27	33	34	49	59	60	68	83
TSEC	199	208	407	314	289	259	207	217	191

Table 1, Panel A presents market concentration statistics for the Australian Stock Exchange (ASX), Bursa Malaysia (BMA), Hong Kong Exchanges and Clearing (HKEx), Jakarta Stock Exchange (JSX), Korea Exchange (KRX), Stock Exchange of Thailand (SET), Singapore Exchange (SGX), Shanghai Stock Exchange (SSE), Tokyo Stock Exchange (TSE) and the Taiwan Stock Exchange (TSEC). The top 5 percent of listed companies (ranked on market capitalization, USD) are selected in each market. Total trade value of the top 5 percent of listed companies is divided by total market value to obtain an estimate of market concentration. Panel B presents turnover velocity statistics for the selected Asia-Pacific exchanges. Turnover velocity is calculated monthly, as total monthly trade value divided by month end market capitalization, in USD. This value is annualized by multiplying the monthly moving average by 12.
Source: World Federation of Exchanges, 2003.

statistics for the selected Asia-Pacific exchanges. Turnover velocity is calculated as total monthly trade value divided by month end market capitalization. This value is annualized by multiplying the monthly moving average by twelve. Turnover velocity varies widely between Asia-Pacific exchanges, although an upward trend is evident in recent years. Significant differences are observed on the TSEC and the KRX. Turnover velocity on the TSEC and KRX is consistently around two times total market capitalization. This is significantly higher than other Asia-Pacific exchanges. This is explained by the large proportion of retail trading on these two markets. For example, in the 2003 calendar year, retail trading on the TSEC (KRX) accounted for nearly 80% (90%) of total market trade

value. In contrast, in the 2003 calendar year, retail trading on the ASX, which displays lower turnover velocity, accounted for only 18% of total market trade value.[2]

The statistics presented demonstrate the diversity in size, activity and concentration across the Asia-Pacific exchanges. The remainder of the paper demonstrates that this diversity is also reflected in trading structures and practices.

3. Current market structure

3.1. Market Type

All Asia-Pacific exchanges operate fully electronic order driven trading systems. Specific trading mechanisms are indicated in Table A1. Most Asia-Pacific exchanges open and close their markets with a call auction, while a continuous auction is held throughout the trading day.[3] This market structure is consistent with accepted practice. Economides and Schwartz (1995) advocate the use of an electronic call auction mechanism to open and close the market. By consolidating liquidity at one point in time, they suggest this trading mechanism may reduce trading costs. Amihud et al. (1990) examine a continuous auction mechanism and a call auction mechanism at the market open. They find that a call auction is more effective than a continuous auction at reducing volatility and determining efficient prices at the market open when information asymmetry is high. Rhee et al. (2004) examine the introduction of an opening and closing call auction on the SGX. They find improved price discovery and a decline in market manipulation at the close. Comerton-Forde et al. (2004) also examine the introduction of an opening and closing call auction on the SGX. They find that call auctions enhance market quality; the call auction assisted to reduce chaotic trading at the open on the first day of Initial Public Offerings (IPO) and significant increases in trade volumes at the open and close are reported. In addition, Pagano and Schwartz (2003) find that the introduction of a closing call auction on the Paris Bourse lead to lower execution costs and enhanced price discovery. Consistent with these findings, Madhavan (1992) argues that when information asymmetry is high and price volatility is present, a call auction may be superior to a continuous auction.

There are five exceptions to the accepted practice of using opening and closing call auctions combined with a continuous auction. First, BMA does not use a continuous auction. For the morning and afternoon session, intra-day call auctions are held every 10 s following the opening call auctions. The market closes immediately after the last intra-day call auction at 12:30 and 17:00, respectively. No extended pre-open precedes the final intra-day call auctions.

The TSEC operates a similar trading system. A call auction is held at the open, at the close following a 5-min pre-open period, and since September 2004, every 30 s throughout the trading day. A significant volume of academic research focuses on the unique TSEC

[2] Retail trading statistics are sourced from the relevant exchange websites.

[3] Rhee (2000) provides a summary and discussion of the various trading systems used by Asia-Pacific exchanges.

microstructure. For example, Liu (1994) simulates trading in a call market and a continuous market. The simulated call auction replicates the design of the TSEC call auction. Liu concludes that a continuous market incurs higher execution costs but with better price discovery than a call market. Chang et al. (1999) compare volatility and liquidity using TSEC data and a simulated continuous auction data set. They find price volatility is significantly reduced in a call market, especially at the start and end of the trading day. They also find the call market reduces volatility without a decline in liquidity. Rhee and Wang (1997) analyze stock return behavior on the TSEC. They find that prices in the pre-open bounce between the best bid and ask as they do in a continuous market. This induces measurement errors in stock returns and causes negative autocorrelation in stock returns. Lang and Lee (1999) examine the TSEC call market around changes in call auction frequency. After controlling for exogenous factors and differing turnover rates between stocks, they conclude that more frequent call auctions increase volatility over all firms and increase liquidity in low turnover firms. However, market efficiency, examined by calculating intra-day autocorrelation of returns and residuals, is not significantly enhanced.

Empirical evidence does not indicate a call auction market, such as the TSEC, is necessarily superior to more standard market designs which combine continuous and call trading. Amihud et al. (1997) examine a change in trading structure on the Tel Aviv Stock Exchange. This involved the transfer of larger, "highly marketable" stocks from call trading to a mechanism where a call auction is followed by continuous auction. They find that the stocks transferred away from exclusive call auction trading exhibit price appreciation, increased liquidity, increased efficiency and enhanced price discovery. Consistent with this research, BMA plans to introduce a new trading system in late 2005. This will incorporate an opening call auction, a continuous auction during the trading day and a closing call auction.[4]

However, some evidence indicates that call auction trading may be suited to illiquid stocks. A number of exchanges around the world, including Euronext and Borsa Italiana (BIA), trade illiquid stocks only in call auctions. In addition, the ASX plans to trial intra-day call auctions in mid and small capitalization securities.[5] A number of studies support the use of call auctions in less liquid stocks (e.g., Stoll and Whaley, 1990; Stoll, 1985). This literature suggests that liquidity may increase through the use of call auctions. Therefore, the optimum trading mechanism or combination of trading mechanisms may depend on stock liquidity.

In contrast, Chang et al. (1999) find that call auction trading is more effective at reducing price volatility in liquid stocks, rather than less liquid stocks. In addition, Madhavan and Panchapagesan (2000) find that call auction trading increases with stock liquidity and small order imbalances in illiquid stocks may generate inefficient call auction prices. Further research is required to determine the optimal use of call auctions and the most efficient call auction designs. The TSEC provides a unique market to conduct

[4] Trading on BMA is split into a morning and afternoon session. Under the new trading system the morning session will be closed with a call auction and the afternoon session opened with a call auction.

[5] See www.asx.com.au/investor/pdf/MARKET_REFORMS_Decision_Paper.pdf.

research into call auction trading. The proposed ASX trial of intra-day call auctions in illiquid stocks will also provide an ideal research setting to advance knowledge on the optimal use of call auctions.

The third exception to the accepted practice of opening and closing call auctions is the HKEx. While the HKEx uses a call auction to open trading, it adopts a unique closing procedure. The trading system selects up to five samples of the best prices in the limit order book from 15:59 to 16:00 at 15 s intervals. The median of these five prices is used as the closing price. The HKEx states that the reason for this price calculation is it ensures no single order can impact the closing price.[6]

The fourth exception is the SSE. The SSE uses an opening call auction. However the closing price is calculated as the Volume Weighted Average Price (VWAP) of trades over the last minute of trading. The final exception is the JSX. An opening call auction was introduced progressively from January to June 2004 in LQ45 Index stocks.[7] Less liquid stocks outside this index open with continuous trading. This contrasts to the findings in Comerton-Forde (1999) who compares the ASX and JSX opening procedures. Comerton-Forde finds that liquidity is enhanced by a call auction at the open, especially in illiquid stocks. In addition, trading stops at the end of day on the JSX without any special closing mechanism.

A limitation of the HKEx and SSE closing mechanisms, and the lack of a closing mechanism on the JSX, is the difficulty of obtaining execution at the closing price. Cushing and Madhavan (2000) indicate that execution at the closing price is desired by investors, especially passive index funds. The question of whether the HKEx and SSE closing mechanisms operate as effectively as a closing call auction is a topic that requires further research.

3.2. Market linkages

Cross market linkages are increasingly evident in the Asia-Pacific region. These linkages are designed to facilitate trading between market centres and enhance liquidity. A number of strategic alliances have been signed in the Asia-Pacific region. For example, the TSE signed an agreement with SGX in 2001 to facilitate cross market trading and enhance liquidity on both markets. In 2001 the HKEx announced it was in talks with nine other exchanges, including the NYSE, with the purpose of discussing the feasibility of cross market trading links.[8] However, these agreements are largely symbolic or are still under consideration, and few real trading arrangements have been developed and implemented.

One exception is the cross border arrangement between the ASX and the SGX. Under this arrangement brokers in Singapore (Australia) may submit orders through the SGX (ASX) trading platform to trade in around 100 Australian (Singapore) listed securities. This reciprocal arrangement should reduce trading costs for international investors and

[6] See www.hkex.com.hk/tradinfo/closepricecal/closepricecal.htm.
[7] The LQ45 Index is a capitalization weighted index of the 45 most heavily traded JSX stocks.
[8] See www.hkex.com.hk/news/hkexnews/010913news.htm.

enhance market liquidity. In addition, the SGX and BMA intend to establish a similar cross border trading arrangement by the end of 2006.

Research on the effectiveness of these types of cross border trading arrangements is warranted. Recent press reports reveal interest in the ASX/SGX trade facility is small and insignificant, (e.g., Ng, 2004, The Business Times, Singapore). During the 2003 (2002) financial year, the total value of stocks traded through the ASX/SGX trade facility totalled approximately USD160 (USD80) million. The low level of activity is disappointing for both the ASX and SGX. Extensive marketing is underway to promote this trading facility and both exchanges remain committed to its development.

European exchanges have taken a substantially different path in an effort to increase their liquidity and competitiveness. This path is largely driven by the introduction of the single currency and European Union (EU) regulations, especially the Investment Services Directive (ISD). These economic reforms have been responsible for forcing major changes upon European equity markets (e.g., Demarchi and Foucault, 2000). Specifically, these economics reforms have increased competition for order flow in European equity markets and have driven market consolidation.

Mergers and alliances between existing exchanges have become common. For example, Paris, Brussels and Amsterdam exchanges merged to form Euronext in September 2000. O'Hara (2001) indicates that Euronext is now the second largest exchange in Europe and the success of this market is undeniable. Therefore, market consolidation is resulting in large and liquid cross border markets. In addition, European exchanges are introducing new trading structures to compete for institutional order flow. For example, the electronic block trading facility Xetra XXL, recently introduced on Deutsche Borse AG (DBAG). This facility allows investors to execute block trades on market, rather than in the OTC market. These changes are designed to reduce trading costs for investors, particularly institutional investors, and increase the efficiency of European equity markets.

Given the lack of progress in developing real trading links between Asia-Pacific markets and the disappointing interest in the ASX/SGX cross border agreement, it is questionable whether cross market linkages between Asia-Pacific markets will significantly benefit Asia-Pacific exchanges in the near future. However, a coherent regional strategy is required to ensure Asia-Pacific exchanges remain competitive with large, low cost European and North American exchanges. Given the relatively small size of Asia-Pacific exchanges, regional consolidation may provide a more effective way to increase liquidity, reduce trading costs and enhance competitiveness. Significant political constraints need to be overcome before such a consolidation strategy could be successfully implemented. However, these constraints have been overcome in Europe (for example, currency and legal constraints) and the European region is now rapidly developing efficient, liquid and internationally competitive equity markets.

3.3. Market fragmentation

Asia-Pacific markets are fragmented in a number of ways. Eight of the Asia-Pacific exchanges examined permit trading outside official exchange trading hours. This fragments liquidity by providing an alternate trading venue to the main trading session.

Table A2 presents details on the after hours trading arrangements in these markets. The after hours mechanism on the TSE, KRX, SET, SSE and TSEC accommodate block trades to cater for institutional investor needs. However, on the TSEC, orders are randomly matched in the after hours session. This may create uncertainty for traders over the probability of order execution.

In addition to after hours trading, all markets, except the TSEC and the SSE, allow off-market trading. Off-market trading rules differ widely between Asia-Pacific exchanges. The ASX imposes minimum size requirements on off-market trades while the TSE imposes both size and price restrictions on off-market trades. The KRX permits off-market block trading following the after hours trading session. Size and price restrictions apply. In addition, some Asia-Pacific exchanges allow delayed reporting of off-market trades (see Section 4.2.1 for further details).

Little research exists examining the impact of fragmentation in Asia-Pacific markets. However, in US markets, recent concerns have been raised over the excessive level of market fragmentation. North American exchanges face significant competition, especially from Electronic Communications Networks (ECNs), resulting in significant fragmentation of order flow. The NASDAQ and the NYSE, have sought to address this by reforming their trading systems to more effectively compete in this fragmented, low cost trading environment. For example, the NYSE introduced the in-house ECN, NYSE Direct+™, and the NASDAQ introduced an enhanced trading platform, SuperMontage, in an effort to consolidate fragmented liquidity. Easley et al. (1996) argue that the desirability of fragmentation is debatable. They argue that increased competition generated by fragmentation may reduce the monopoly power of price-setting agents resulting in improved execution and prices for traders. However, they argue that this competition may also reduce liquidity in individual markets, reducing price stability and impairing price discovery. In addition, the impact of fragmentation on market quality may be exacerbated if markets compete by 'cream skimming', the process of purchasing retail order flow through brokers. Easley et al. (1996) examine the impact of purchased order flow and find this is consistent with cream-skimming. They find that the least risky orders are diverted from the NYSE, resulting in increased adverse selection costs on the remaining order flow, and as a result, higher trading costs.

The particular problems caused by fragmentation in US markets, partly driven by ECNs, are unlikely to develop in Asia-Pacific markets due to the use of fully electronic order books that consolidate liquidity in single market centres. However, market fragmentation is relevant to Asia-Pacific markets. Asia-Pacific markets need to cater for different investor needs. Harris (1993) indicates that traders prefer a variety of execution mechanisms to solve different trading problems. Therefore, Asia-Pacific market structures must accommodate different investors trading needs through a variety of execution platforms. However, Asia-Pacific exchanges need to ensure that this fragmentation does not lead to reduced liquidity that may impair efficiency.

3.4. Market makers

No official market makers currently operate on Asia-Pacific markets, except for the HKEx. HKEx has recently introduced market makers that operate in its Pilot Program.

This program trades NASDAQ and American Stock Exchange (AMEX) listed stocks on the HKEx trading system, AMS/3.[9] The benefits of market makers are extensively documented in the academic literature. For example, Rust and Hall (2003) illustrate that the inclusion of a market maker increases a market participant's expected gains from trading. Brusco and Jackson (1999) argue that an efficient exchange structure involves multiple market makers. In addition, Madhavan and Panchapagesan (2000) conclude that a dealer intermediated call auction is a more efficient trading mechanism than a fully automated call auction. Consistent with this literature, market makers are firmly established in European and US market design. For example, the NASDAQ, NYSE and DBAG. Market makers are integral in the effective operations of these markets and are especially important in reducing trading costs in illiquid stocks. Other European markets such as Stockholmsbörsen and the Helsinki Exchange, have recently introduced market makers. Preliminary results indicate that the introduction of market makers on Stockholmsbörsen in May 2003 has significantly reduced spreads and increased liquidity.[10] In addition, the LSE recently introduced a new market segment that will trade medium sized securities, SETSmm. This segment combines an electronic order driven market similar to SETS with registered market makers.

Asia-Pacific markets have been slow to consider the use of market makers. However, the ASX has decided to trial official market makers in mid and small capitalization securities with a view to increasing market liquidity.[11] BMA also plans to introduce market makers in illiquid stocks. Moves to further explore the introduction of market makers on a wider scale are warranted. This may improve the liquidity and efficiency of Asia-Pacific exchanges.

3.5. Order priority rules

Order priority rules on Asia-Pacific exchanges largely follow price then time priority in the continuous auction and the call auction. Table A3 provides an overview of these order priority rules. There are three exceptions to price then time priority. These exceptions apply in the call auction on the TSE, the TSEC and the KRX.

In the TSE opening call auction, order precedence rules follow price priority only. There is no time priority assigned to orders and therefore the system deems orders at a particular price to have been received simultaneously in the pre-open period. A complex process is used to allocate executed orders to traders. TSEC order precedence rules follow price then random time priority for the opening call auction. Orders received at the same price are assigned a random time priority. For all other call auctions held throughout the trading day, price then time priority applies. KRX order precedence rules follow price then time priority in the call auction. However at the opening call auction there is an exception to time priority if the indicative auction price (IAP) exceeds the price variation limit of ±

[9] Our focus is on the role of market makers in stock/securities trading. On many Asia-Pacific exchanges, market makers participate in the trading of financial instruments such as stock options, equity linked instruments, warrants and Exchange Traded Option's. The role of market makers in these other markets is not considered.

[10] Preliminary results are available at http://clientweb01.waymaker.se/en/pm.asp?pm=32732.

[11] See www.asx.com.au/investor/pdf/MARKET_REFORMS_Decision_Paper.pdf.

15% form the previous closing price. In this case, time priority is ignored and is replaced by client then size priority. Client priority gives client orders precedence over broker's orders at the same price. After price then client priority, orders are executed based on size, the largest orders being filled first. A size priority encourages large traders to enter the market.

These order priority rules are inconsistent with accepted practice. All major world markets adopt strict price then time priority (for example, Euronext, London Stock Exchange (LSE) and the NYSE). Demarchi and Foucault (2000) indicate order priority is important as it influences traders' incentives to supply liquidity. Harris (1990), suggests that price should be the first priority, then orders that *display* both broker identity and size, then time. He suggests a secondary size priority would discourage small traders from supplying liquidity. Demarchi and Foucault (2000) argue that price then time priority is optimal as it encourages price competition. Traders must offer competitive prices if they are to increase their probability of execution. Despite the clear direction on order priority, variations persist on Asia-Pacific exchanges.[12] Little research exists examining the impact of these order priority rules on market efficiency in Asia-Pacific markets. Further research in this area is required.

3.6. Price steps

Price steps or minimum tick sizes vary significantly between Asia-Pacific exchanges. Table A4 indicates the extent of the differences in tick sizes between Asia-Pacific exchanges. The HKEx has eleven different tick sizes while the ASX has four and the SSE has only one. This diversity contrasts to most US exchanges, for example the NYSE and the NASDAQ, where the minimum tick size is USD 0.01 for all stocks. The complexity of Asia-Pacific exchange tick schedules requires further research.

The HKEx and ASX have recently reduced their tick sizes. Empirical evidence suggests that a reduction in tick size on Asia-Pacific exchanges increases market efficiency. Lau and McInish (1995) find a reduction in the tick size on the SGX from $0.50 to $0.10 for stocks trading at $25 or more reduced bid ask spreads. Ke et al. (2004) examine an increase in the tick size from $0.1 to $0.5 for stocks trading above $50 on the TSEC. They conclude this increased spreads and volatility. However, it is also widely reported that tick sizes which are too narrow may harm market efficiency (e.g., Demarchi and Foucault, 2000; Harris, 1994). Aitken and Comerton-Forde (2005) examine a reduction in tick size on the ASX. They find that lower tick sizes increase liquidity. However, this result was not universal. Low volume stocks with low relative tick sizes experienced reduced liquidity.

Angel (1997) examines optimal relative tick sizes and finds that they are a function of firm size, idiosyncratic risk and firm visibility. He argues that companies split their stock

[12] Order priority on the NASDAQ also deviates from strict price then time priority. Order Handling Rules (OHR) introduced in 1997 attempted to increase quote competition by requiring, among other things, that limit orders be displayed in the Montage when they are better than quotes posted by market makers. The OHR also require market makers to display their best quotes. This allows the public to compete directly with market makers. However, Rhee and Tang (2004) find that preference trading on the NASDAQ, a violation of strict price then time priority, impedes the quote competition these rules were designed to enhance.

to obtain the optimal relative tick. This implies that companies should be given the opportunity to select their own tick size. He also argues that a trade-off exists between the incentives to provide liquidity generated by a high minimum bid-ask spread and additional trading costs faced by investors. Given the complexity of tick size schedules and the differences observed between Asia-Pacific exchanges, further research is needed to determine the most efficient tick size schedules for these markets.

3.7. Short selling restrictions

All Asia-Pacific exchanges allow short selling, except BMA and the SSE. Short selling was suspended on BMA during the South East Asian Financial Crisis in 1997. However, BMA is currently considering the re-introduction of short selling. Short selling is strictly prohibited on the SSE.

Short selling restrictions differ between Asia-Pacific exchanges. The SGX is the only market examined that has no short selling restrictions. The ASX, SET, TSEC, TSE and KRX require margin cover and short positions are marked to market on a daily basis. HKEx and JSX do not require margin cover. In addition, the ASX, HKEx, SET, TSE and TSEC apply price restrictions on short sales. On the ASX, short selling is prohibited if the stock is trading on a downtick. On the HKEx short sales must not be made below the current best ask price for the stock. An up-tick rule applies to short sales on the SET, TSEC and TSE.

Ho (1996) provides a review of short selling literature (also see Bris et al. (2004)). This literature is largely based on US markets and examines the impact of short sale restrictions on asset prices and returns. Ho (1996) states that Asia-Pacific exchanges have short selling rules to decrease speculation and volatility. He examines a specific event on SGX in 1985 when short sales were restricted for a period of one month. This restriction on short sales led to an increase in market volatility. Consistent with this result, Jiang et al. (2001) find that informational efficiency is enhanced in the absence of short selling restrictions.

Bris et al. (2004) examine the impact of short selling in forty-six world equity markets. They suggest market regulators impose short sale restrictions to reduce the severity of market corrections. However, the results of this comprehensive study indicate that short sale restrictions have no impact on the severity of market declines and price discovery/efficiency is enhanced in the presence of short selling. Charoenrook and Daouk (2004) examine the impact of short selling constraints at the market level on over one hundred exchanges. They find that short sale constraints reduce market quality. On exchanges where short selling is permitted, volatility of returns is lower, liquidity is higher and the cost of capital is lower. They also find that stock prices increase when short selling restrictions are removed. Consistent with this evidence, no European exchanges adopt short selling restrictions. In addition, US regulators are considering the removal of short selling restrictions.[13] Asia-Pacific exchanges may need to re-consider short sales restrictions. Removal of these restrictions may increase liquidity and market efficiency and would reflect international best practice.

[13] See www.sec.gov/rules/proposal/34-48709.htm#V.

4. Transparency

O'Hara (1995) defines transparency as the ability of market participants to observe information in the trading process. Pre-trade transparency refers to the level of trading information provided to investors prior to trading (for example, the extent of limit order book disclosure). Post-trade transparency refers to the availability and speed of publication of trade details. The level of pre-trade and post-trade transparency differs widely between Asia-Pacific exchanges. The most significant of these differences are examined.

4.1. Pre-trade transparency

4.1.1. Extent of limit order book disclosure

The extent of limit order book disclosure is presented in Table A5. Asia-Pacific exchanges vary widely in their level of order book disclosure. However the trend is towards greater transparency. The TSEC now discloses the best five bid and ask orders and order volumes at those prices during intra-day call auction trading. Prior to 2003 only the best bid and ask was disclosed, prior to this the entire limit order book was closed. The HKEx increased transparency of its main market in 2003 and its odd-lot market in 2004, by disclosing the best five bid and ask prices and order volumes at those prices. Prior to this, only the best bid and ask prices were displayed. In late 2005 with the introduction of the new trading system, BMA will increase its limit order book disclosure from the best three bid and ask prices to the best five. During normal market trading, the TSE discloses the best five bid and ask prices and order volumes at those prices. Prior to June 2003, only the best three bid and ask prices were displayed. In addition, in June 2003, the TSE increased Special Quote (SQ) transparency by displaying the SQ, the next four bid and ask prices and aggregate order volumes at those prices.[14]

The optimal level of order book disclosure in continuous trading is unresolved in the academic literature. Madhavan (1996) demonstrates that increased transparency can increase volatility and decrease liquidity. Consistent with this research, Madhavan et al. (in press), examining the dissemination of the order book on the Toronto Stock Exchange (TSX) in 1990, find that increased transparency does not improve market quality. They report that order book disclosure lead to increased transaction costs and reduced liquidity due to the reluctance of limit order traders to offer free options to the market.

In contrast, Boehmer et al. (2005) find that the introduction of NYSE OpenBook, which increases pre-trade transparency by disseminating the Specialist's limit order book to all traders, increases liquidity, reduces execution costs and increases stock returns. In addition, Pagano and Röell (1996) find that increased transparency increases liquidity and lowers trading costs for uninformed investors across a range of trading mechanisms.

In practice, exchanges are moving to increased pre-trade disclosure. The largest European and US exchanges now display the full limit order book, including the LSE, the NYSE and the NASDAQ. This indicates that a high degree of transparency is preferred

[14] Details on the Special Quote (SQ) procedure are available in the Guide to TSE Trading Methodology. Available at www.tse.or.jp/english/cash/stock/methodology/guide.pdf.

across markets. However, in contrast, the TSX has recently introduced a hidden order type. This measure decreases pre-trade transparency. This may imply that the optimal level of transparency in a continuous auction is less than complete pre-trade transparency. O'Hara (2001) states that excessive transparency may encourage free-riding on the back of trading strategies or may even encourage manipulation. She argues that allowing traders to hide specific features of their orders may protect traders, enhance participation and market liquidity (O'Hara, 2001).

The level of order book disclosure in the call auction differs from the continuous trading session on four of the Asia-Pacific exchanges examined. Surprisingly, disclosure is lower during the call auction. The KRX disseminates only the best bid and ask price, the TSE the best four bid and ask prices, and the TSEC and the JSX close their order books completely over the pre-open period prior to the opening call auction. Domowitz and Madhavan (2001) argue that too little transparency in the call auction may attract trading by informed traders or corporate insiders, reducing liquidity and increasing price volatility. In addition, they state that some level of transparency is warranted, as displaying the order book may attract further liquidity. However, Domowitz and Madhavan (2001) also argue that excessive transparency may impair order flow as traders are reluctant to reveal their information. Therefore, similar to continuous trading, a pre-open period needs to be transparent, but provide protection to traders that fear their orders may be exploited. This level of transparency may attract liquidity, enable learning and enhance call auction price efficiency.

4.1.2. Liquidity provider identity displayed?

Table A5 provides a list of Asia-Pacific exchanges that display broker identification (ID). The HKEx display broker firms' ID to other brokers. The KRX adopts a unique identification system where the ID of the five most active brokers in terms of volume traded are displayed to the market. This system has been in place since October 1999. The BMA, JSX, SET, SGX, SSE and TSEC do not display broker ID, while the TSE removed broker ID in June 2003 and the ASX will remove broker ID in late 2005.

There is no consensus on whether broker ID should be disclosed. Theissen (2003) examines the impact of trader identity on price formation and liquidity on the Frankfurt Stock Exchange. His findings imply broker identification should be disclosed as an anonymous market displays higher adverse selection risk. That is, uninformed traders are less able to protect against adverse selection risk in an anonymous market as they do not know the identity of the party, informed or uninformed, on the opposite side of the trade. This may deter uninformed liquidity.

Contrary to this finding, Foucault et al. (2003) find the removal of broker identification on Euronext Paris reduced quoted spreads and enhanced quoted depths. A recent ASX release detailing market reforms indicates that the ASX plans to remove broker ID from the order book.[15] In this release the ASX argues that disclosing broker ID encourages predatory trading behavior, increasing trading costs. They also argue that this behavior detracts from efficient price discovery as traders may shift liquidity off-market. Therefore,

[15] See www.asx.com.au/investor/pdf/MARKET_REFORMS_Decision_Paper.pdf.

the ASX believes that removing broker ID may enhance liquidity, price discovery and the fairness of the market. Following the removal of broker ID from the trading screen, the ASX will begin releasing trading history with broker ID disclosed to the market after a delay of three days.

Simaan et al. (2003) propose that the introduction of an anonymous order type on the NASDAQ could improve price competition and narrow spreads. Their study suggests a number of reasons why trade anonymity is preferred. The major reason relates to collusion around quote setting.[16] Simaan et al. (2003) describe a period on the NASDAQ when market makers were colluding to maintain wide spreads. As trader identity is displayed on the NASDAQ, identification and harassment of dealers was common if they narrowed spreads. As a result, quote competition was reduced. Other reasons described for preferring trade anonymity include protecting dealer relationships with institutions and avoiding market impact of large trades by institutions that the market perceives to be informed. In this case, revealing trader identity allows competing traders to front-run these large orders.

Consistent with Foucault et al. (2003) and Simaan et al. (2003), many exchanges are introducing anonymous order types. For example, the TSX and the NASDAQ have recently introduced an anonymous order type where broker ID may be suppressed. The TSX states that this benefits traders who wish to avoid market impact associated with holding a known interest in a stock.[17] Further research is required to examine the impact of the introduction of anonymous order types on market efficiency.

4.1.3. Hidden orders

Table A5 indicates that only three Asia-Pacific exchanges allow hidden orders, the ASX, SET and the SGX. Hidden orders may be important in market design. Harris (1990) argues that hidden orders are important to protect traders concerned about the free option value of limit orders. The absence of such an order may deter liquidity. Consistent with this argument, Aitken et al. (2001) suggest that hidden orders on the ASX are used to reduce the free option value of limit orders. They find that an increase in the hidden order minimum disclosure level reduces market liquidity. This evidence indicates that a hidden order may be valued by large traders and may increase market liquidity on Asia-Pacific exchanges. Despite this conclusion, hidden orders are not used on the majority of Asia-Pacific exchanges.

4.2. Post-trade transparency

4.2.1. Delayed trade publication

Immediate reporting is generally required for both on- and off-market trades with the definition of immediate varying by Asia-Pacific exchange. However, some Asia-Pacific exchanges permit exceptions to the immediate reporting of off-market trades. These

[16] See Christie and Schultz (1994) and subsequent Securities and Exchange Commission (SEC) and Department of Justice investigation documents for further details of quote setting collusion on the NASDAQ.

[17] See www.tsx.com/en/productsAndServices/tradingProducts/tse/attribution/index.html.

exceptions permit trade reporting to be delayed for a specified period of time. Table A6 indicates that the ASX, BMA, HKEx, JSX and the SGX allow delayed reporting of some trades.

Delayed reporting decreases post-trade transparency. Gemmill (1996) examines a number of contrary views on the impact of delayed reporting. One view is that immediate publication of trades reduces liquidity. Consistent with this view, Madhavan (1995) indicates liquidity will migrate to markets where disclosure rules are less stringent. Another view is that delayed trade publication gives market makers an unfair informational advantage. Bloomfield and O'Hara (2000) construct experimental asset markets with differing levels of transparency. They seek to understand whether markets that require immediate trade reporting can compete with markets that allow delayed trade reporting. They cite examples suggesting less transparent markets are favored. The introduction of the delayed reporting regime on the LSE is one example. This change in post trade transparency saw the transfer of the majority of block trade volumes on the Paris Bourse to the LSE. The Paris Bourse was eventually forced to change its reporting rules. Bloomfield and O'Hara's experiments indicate that dealers favor less transparent markets. However, they find a small number of transparent dealers persist and remain competitive for two reasons. The informational advantage among many non-transparent dealers is low and non-transparent dealers send misleading and unprofitable orders to transparent dealers.

Gemmill (1996) examines the delayed reporting regime on the LSE. This regime changes three times over the sample period, from immediate reporting to a 24-h delay to a 90-min delay. Surprisingly, he finds delayed publication has little impact on spreads, speed of price adjustment and volatility. Traders appear unable to exploit any informational advantage from delayed trade publication (Gemmill, 1996).

Despite the contrary views on delayed reporting, some evidence indicates that delayed reporting is valued by institutional traders. An ASX Circular states that their delayed reporting regime provides a trading environment conducive to large traders. Specifically, institutional brokers report that delayed reporting discourages front-running and allows principal traders to more adequately manage risk. This should attract liquidity and increase efficiency.[18] Therefore, a delayed reporting regime may be of significant benefit on markets where there is a high proportion of institutional trading.

Asia-Pacific markets with a high percentage of institutional trading adopt a delayed reporting regime. For example, institutional trading on the ASX accounted for over 80% of total market trade value in the 2003 financial year. On the HKEx, institutional trading accounted for over 60% of total market trade value in the year ended September 2003. In contrast, in the financial year 2003, institutional trading on the TSEC, a market with no delayed reporting regime, accounted for only 20% of total market trade value.[19] However, the introduction of a delayed reporting regime on the TSEC may be warranted given the trend towards increased institutional trading on this market. Institutional trading has increased from 12% of total market trade value in 1998 to 20% of total market trade value in 2003.

[18] See SEATS Circular 175/2001. Available at www.asxonline.com.
[19] Turnover statistics are sourced from the relevant exchange websites.

5. Price variation controls

Price variation controls are an integral part of the microstructure on all Asia-Pacific exchanges, except the ASX. The ASX has no price controls incorporated into its market structure.

Price variation controls enforce mandatory price variation limits that are automatically activated if prices deviate excessively. Price variation controls vary significantly between Asia-Pacific exchanges. Table A7 provides a description of the price controls in place on each Asia-Pacific exchange.

Empirical evidence on price controls in Asia-Pacific markets is mixed. Kim and Rhee (1997) conclude that price limits may not be effective on the TSE. The TSE uses a unique and complex price control system.[20] Kim and Rhee (1997) conclude that stocks that hit the price limit exhibit higher levels of volatility, delayed price discovery and increased trade volumes on the day after the limit hit. Ryoo and Smith (2002) examine the random walk hypothesis on the KRX. They find evidence that stocks do not follow a random walk and attribute this to price controls. As price controls are widened, an increased number of stocks follow a random walk. Du et al. (2005) examine the magnet effect on the KRX. They find that prices accelerate towards price limits as investors place more (market) orders and change quotes more frequently to ensure execution before the price limit is reached. They also find narrower price limits exhibit higher acceleration and that this magnet effect is unique to markets with daily price limits. Cho et al. (2003) examine price limits on the TSEC. They also find evidence to suggest prices accelerate towards the price limit. Chan et al. (2004) examine price limits on BMA. They note that Asia-Pacific exchanges are increasing their price limits, for example the KRX which recently increased its price limits from 6% to 15%. However, they find that wider price limits hinder price discovery and cause significant costs. They propose that finding an optimal price limit may be futile and elimination of price controls should be considered. Berkman and Lee (2002) examine the widening of price limits on the KRX and conclude that this change increased volatility and decreased stock liquidity, especially in small stocks. However, as small stocks are common on Asia-Pacific markets, Berkman and Lee (2002) suggest this result may indicate why strict price controls are popular on emerging markets. That is, they may reduce volatility and enhancing liquidity in small stocks.

In comparison with Asia-Pacific exchanges, the use of price controls on European and North American markets is mixed. The LSE, DGBA and Euronext mandate strict price control regimes. In contrast the NYSE and the TSX do not adopt strict price control regimes. Further research is required to better understand the impact of price controls on market efficiency.

The impact of price controls on equity based derivative contracts is also of interest. Trading in equity based derivative contracts is halted in all markets when trading in the stock market is halted. For example, on the KRX, if the equity market circuit breaker is triggered, (trading in the equity market is halted for 20 min if the Korean Share Price 200 Index falls by more than 10% from the previous closing value and this continues for 1 min

[20] See Guide to TSE Trading Methodology for a full description of TSE price controls. Available at www.tse.or.jp/english/cash/stock/methodology/guide.pdf.

or longer), then the futures and options markets are also suspended. A number of other price limits apply to trading in equity based derivatives contracts. These price limits are presented in Table A7.

6. Conclusions

This paper reviews the microstructure of six of the largest Asia-Pacific exchanges. Examination of market microstructure reveals significant differences in market design across the Asia-Pacific exchanges. For example, differences are evident in the design of trading mechanisms, market transparency, order priority rules and tick sizes.

Asia-Pacific market practices also differ in important ways from other major world markets. For example, markets such as the NYSE, the LSE and Euronext, offer higher levels of pre-trade transparency, provide a wider range of mechanisms to cater effectively for different investor needs and adhere to strict price then time priority rules. In addition, North American and especially European market practices are changing rapidly to accommodate the increasingly competitive economic landscape. For example, the LSE's introduction of the SETSmm market segment (see Section 3.4).

A growing body of literature examines market microstructure in Asia-Pacific exchanges. However, it is evident that additional research is required in many areas. This will provide direction on the most efficient market designs for the region. The design of a market has significant implications for market efficiency. Therefore, market structure is a matter of importance for the future success of Asia-Pacific exchanges. O'Hara (2001) suggests the most efficient market practices, that enhance liquidity and price discovery, depend on the characteristics of firms and their investors. Therefore, optimal market structure may differ between Asia-Pacific exchanges depending on the characteristics of stocks and traders in each individual market. This may explain some differences observed between market designs. For example, the ASX has a highly concentrated market dominated by institutional investors. This may require special mechanisms for institutional investors, such as delayed reporting. In contrast, the KRX has a large proportion of retail investors and no delayed reporting regime.

O'Hara (2001) indicates that exchange revenues in the Asia-Pacific region have fallen since 1994. To reverse this trend, exchanges in the Asia-Pacific region, including the markets examined in this review, need to re-examine market design. Evidence indicates that some Asia-Pacific exchanges are modernizing their market design. For example, BMA plans to introduce a new trading structure in late 2005 based on the Euronext trading platform and SSE recently announced it will develop a new trading system based on Deutsche Bourse's Xetra trading platform. The ASX has also announced significant market reforms to the level of anonymity and the trading environment for small to mid-cap stocks.

While O'Hara (2001) warns against exchanges copying other successful market designs, if Asia-Pacific exchanges are to compete in an increasingly global equity market they must become more efficient. This may be achieved by adopting market practices that enhance market liquidity and price discovery. O'Hara (2001) suggests this may involve the use of market makers, the use of continuous and call auctions, and more optimal levels of transparency. This may also involve regional consolidation, a path towards enhanced efficiency and competitiveness which is proving successful in European equity markets.

Acknowledgements

The authors thank Ghon Rhee (the editor), Sie Ting Lau, Juan Yao and Karmei Tang for helpful comments and suggestions. The authors also thank staff at Bursa Malaysia, the Stock Exchange of Thailand, the Jakarta Stock Exchange, the Singapore Exchange, the Taiwan Stock Exchange, the Korea Exchange and the Australian Stock Exchange for their assistance clarifying exchange rules. James thanks the Australian Stock Exchange for providing him with a PhD scholarship.

Appendix A

Table A1
Trading mechanism

Exchange	Market type	Market segmentation	Intraday trading mechanism(s)	Call auction	
				At market opening?	At market closing?
ASX	Order driven	No	Continuous auction	Yes	Yes
BMA	Order driven	Yes[1]	Call auctions[2]	Yes	No
HKEx	Order driven	Yes[3]	Continuous auction	Yes	No[4]
JSX	Order driven	Yes[5]	Continuous auction	Yes	No
KRX	Order driven	No	Continuous auction	Yes	Yes
SET	Order driven	Yes[6]	Continuous auction	Yes	Yes
SGX	Order driven	Yes[7]	Continuous auction	Yes	Yes
SSE	Order driven	Yes[8]	Continuous auction	Yes	No
TSE	Order driven	Yes[9]	Continuous auction[10]	Yes	Yes
SEC	Order driven	No	Call auctions	Yes	Yes

Table A1 indicates the market type, the trading mechanisms used, when these mechanisms are used and market segmentation details.

[1] BMA is segmented into the main board, second board and the MESDAQ market.

[2] BMA plans to introduce a new trading system in late 2005. The new system incorporates a continuous auction during the trading day with opening and closing call auctions.

[3] HKEx operates the main market and the Growth Enterprise Market (GEM).

[4] HKEx does not use a call auction to close the market. A special closing procedure is used. See Section 3.1.

[5] The JSX is segmented into trading boards. The regular board and the negotiated boards.

[6] The SET is segmented into trading boards. These include the main board which trades most common stocks, the foreign board, the big lot board and the odd lot board.

[7] SGX operates the main board and SGX SESDAQ.

[8] There are two stock markets in China, the Shanghai Stock Exchange (SSE) and the Shenzhen Stock Exchange. The majority of companies are listed on the SSE. Therefore this paper only considers the SSE. However, both exchanges trade A shares and B shares. Therefore, the Chinese equity market is segmented into four markets. A shares are common stocks available to the public denominated in local currency. B shares are local stocks that are bought and sold in international currencies. Stocks may trade simultaneously in all four markets.

[9] The TSE market is divided into four market segments. The first segment trades liquid blue chip stocks, the second trades less liquid stocks, the third is called Mothers and trades small emerging growth stocks and the fourth segment trades foreign stocks.

[10] The continuous auction (zaraba) is suspended if a ‘Special Quote’ is entered. A call auction (itayose) is used to restart the continuous auction.

Table A2
Opening hours

Exchange	Trading hours[1]	After hours trading	Description of after hours trading
ASX	10:00–16:00	✓	*During the Closing Phase, between 16:05 to 17:00, orders may be entered into the electronic trading system, SEATS, however orders do not automatically execute. Brokers contact each other, agree to execute a trade based on prices in the limit order book. Price then time priority applies. These are called late trades. Trade data is immediately entered into SEATS manually by the selling broker. *During the After Hours Adjust Phase, between 17:00 to 19:00, orders may not be entered into SEATS however existing orders may be amended or cancelled. Trades are executed in a manner similar to the process described above in the Closing Phase, brokers contact each other and agree to execute a trade. Trades are reported immediately.
BMA	9:00–12:30 & 14:30–17:00	✓	*The Trading-at-last phase follows the closing call auction. Traders may enter orders during this phase that are matched at the closing price determined by the closing call auction. Orders are matched in time priority.
HKEx	10:00–12:30 & 14:30–16:00	×	
JSX	9:30–10:00 and	×	
KRX	09:00–15:00 & 13:30–16:00[2]	✓	*Orders are entered from 15:10–15:30 and are matched in time priority at the closing price from the main trading session. After-hours single price trading operates from 15:30–18:00. Orders are matched every 30 min during this period at no more than ± 5% from the closing price. The KRX allows block transactions to be traded in the after-hours session from 15:10–18:00. Block orders are transactions of at least 500 shares or greater than 100 million Won. Before a block trade is executed, a broker firm must submit a block transaction application to the exchange containing the counterpart brokers name. Basket trades are also allowed in the after-hours session on the KRX. A basket trade comprises at least 5 stocks with a total amount of at least 1 billion won. However, the traded prices for both block and basket orders must not be more than ± 5% from the closing price and within the highest and lowest prices of the day.
SET	10:00–12:30 & 14:30–16:30	✓	*In the off-hour trading session, held from the closing call auction to 17:00, off-market orders may be executed and recorded in the trading system. Only Main Board, Big Board and Foreign Board trading is permitted. Main Board trades, less than 1 million shares and less than 3 million baht are traded at the closing price of the trading day. Transactions of greater than 1 million shares and 3 million baht trade on the Big-Lot Board without price restrictions. Foreign Board trades have no size, value or price restrictions.

(continued on next page)

Table A2 (*continued*)

Exchange	Trading hours[1]	After hours trading	Description of after hours trading
SGX	09:00–12:00 & 14:00–17:00	✓	*Orders may be submitted from 20:30 until 20:59. From 20:59 pm to 21:00 no entry, amendment or cancellation of orders is possible. Orders are matched at 21:00 using the single price call auction.
SSE	9:30–11:30 & 13:00–15:00	✓	*After hours block trades are permitted from 17:00 to 17:30. These trades are negotiated between brokers off market. Prices must be between the day's high and low prices that prevail in the market up until the time of the block trade. Price, volume and trader identification are released to the market after the close of this trading session.
TSE	09:00–11:00 & 12:30–15:00	✓	*The TSE Trading Network System (ToSTNeT-1) executes block and basket orders by anonymous negotiation through the trading platform. This is not an off-market transaction. ToSTNet-2 matches investor's orders of any size at the closing price of the stock.
TSEC	09:00–13:30	✓	*Orders under 500,000 shares are accepted from 14:00–14:30. The system randomly matches these orders at the stock's closing price from the main trading session. The new Block Trading System also operates in the after-hours trading session. The minimum order quantity is 500,000 shares or greater than $NT 15 million. (Basket orders are also permitted. The minimum quantity is 5 stocks and $NT 15 million.) Block limit orders are submitted between 13:35 and 13:50 and are continuously matched using price/time priority. Prices are restricted to within 2% of the closing price from the main trading session.

Table A2 presents Asia-Pacific exchange opening hours and a description of after hours trading rules.
[1]All Asia-Pacific exchanges are open Monday to Friday only. BMA, HKEx, SGX, SET, SSE and TSE split the trading day into a morning and afternoon session. HKEx, SGX and SSE do not use a special mechanism to close the morning session or open the afternoon session. On the SET, no special mechanism is used to close the morning session. However, the afternoon session is opened with a call auction. On BMA and the TSE the morning session is closed with a call auction and the afternoon session is opened with a call auction.
[2]On Friday the JSX operating hours are 9:30 to 11:30 and 14:00 to 16:00.

Table A3
Order priority rules

Exchange	Continuous trading	Call auction trading
ASX	Price/time	Price/time
BMA	No continuous trading[1]	Price/time
HKEx	Price/time[2]	Order type/price/time[3]
JSX	Price/time	Price/time
KRX	Price/time	Price/time[4]
SET	Price/time	Price/time
SGX	Price/time	Price/time
SSE	Price/time	Price/time

Table A3 (*continued*)

Exchange	Continuous trading	Call auction trading
TSE	Price/time	Price/no time priority[5]
TSEC	No continuous trading	Price/random time priority[6]

Table A3 presents details on order priority rules in the continuous auction and the call auction.
[1]The new BMA trading system, to be introduced in late 2005, incorporates a continuous auction where orders are matched in price/time priority.
[2]Odd lot orders are not automatically matched in price/time priority in AMS/3. They are executed manually at the conclusion of the trading session. (Both semi-automatching and manual conclusions are available for odd lot orders).
[3]At-auction orders (market-on-open) have a higher priority than at-auction limit orders.
[4]There is one exception to time priority in call auction trading. See Section 3.5 for further details.
[5]Orders at the same price are deemed to reach the order book simultaneously.
[6]Orders at the same price are allocated a random time priority by the trading system.

Table A4
Tick size

ASX		SGX	
Stock price (AUD)	Minimum tick size (AUD)	Stock Price (SGD)	Minimum tick size (SGD)
0.10 or less	0.001	1 or less	0.5
Greater than 0.10 to 2.00	0.005	Greater than 1 to 3	1
Greater than 2.00 to 998.99	0.01	Greater than 3 to 5	2
999 or greater	1.00	Greater than 5 to 10	5
		Greater than 10	10
HKEx		**TSE**	
Stock price (HKD)	Minimum tick size (HKD)	Stock price Yen (¥)	Minimum tick size (¥)
0.25 or less	0.001	2000 or less	1
Greater than 0.25 to 0.5	0.005	Greater than 2000 to 3000	5
Greater than 0.5 to 2	0.01	Greater than 3000 to 30,000	10
Greater than 2 to 5	0.025	Greater than 30,000 to 50,000	50
Greater than 5 to 100	0.05	Greater than 50,000 to 100,000	100
Greater than 100 to 200	0.10	Greater than 100,000 to 1 m	1000
Greater than 200 to 500	0.20	Greater than 1 m to 20 m	10,000
Greater than 500 to 1000	0.50	Greater than 20 m to 30 m	50,000
Greater than 1000 to 2000	1.0	Greater than 30 m	100,000
Greater than 2000 to 5000	2.0	(m=million)	
Greater than 5000 to 9995	5.0		

(continued on next page)

Table A4 (*continued*)

KRX		TSEC	
Stock price (Won)	Minimum tick size (Won)	Stock price (TWD)	Minimum tick size(TWD)
Less than 5000	5	10 or less	0.01
5000 to less than 10,000	10	Greater than 10 to 50	0.05
10,000 to less than 50,000	50	Greater than 50 to 100	0.10
50,000 to less than 100,000	100	Greater than 100 to 500	0.5
100,000 to less than 500,000	500	Greater than 500 to 1000	1
		Greater than 1000	5
BMA		SET	
Stock price (Rm)	Minimum tick size (Sen)	Stock price (baht)	Minimum tick size (baht)
Less than 1	0.5	Less than 2	0.01
1 to less than 3	1	2 to less than 5	0.02
3 to less than 5	2	5 to less than 10	0.05
5 to less than 10	5	10 to less than 25	0.10
10 to less than 25	10	25 to less than 50	0.25
25 to less than 100	25	50 to less than 100	0.50
100 or greater	50	100 to less than 200	1.00
		200 to less than 400	2.00
		400 to less than 800	4.00
		800 or greater	6.00
JSX		SSE	
Stock price (Rp)	Minimum tick size (Rp)		
Less than 500	5	A shares: RMB 1c	
500 to less than 2000	10	B shares: USD 0.001 or HKD 0.01	
2,000 to less than 5000	25		
5,000 or greater	50		

Minimum tick sizes are presented in Table A4.

Table A5
Pre-trade transparency

Exchange	Continuous Auction		Call Auction			Continuous & Call Auction	
	Trader/Broker	Investor	Trader/Broker	IAP[1]	IEV[2]	Broker ID displayed	Hidden orders
ASX	Full order book	Full order book	Full order book	✓	×[3]	×	✓[4]
BMA[5]	3 best prices	3 best prices	3 best prices	×	×	×	×
HKEx	5 best prices	5 best prices	5 best prices	✓	✓	✓	×
JSX	Full order book	Full order book	Closed	×	×	×	×
KRX	10 best prices	10 best prices	Best prices	✓	✓	✓[6]	×
SET	3 best prices	3 best prices	3 best prices	✓	×	×	✓
SGX	Full order book	Full order book for a fee[7]	Full order book	×	×	×	✓
SSE	3 best prices	3 best prices	3 best prices	×	×	×	×

Table A5 (*continued*)

Exchange	Continuous Auction		Call Auction			Continuous & Call Auction	
	Trader/Broker	Investor	Trader/Broker	IAP[1]	IEV[2]	Broker ID displayed	Hidden orders
TSE	5 best prices[8]	5 best prices	4 best prices	✓[9]	✓	×	×
TSEC	N/A[10]	N/A[10]	Closed[10]	×		×	×

The level of pre-trade transparency is presented in Table A5. Details are presented separately for the continuous auction and the call auction. Information on the dissemination of Indicative Auction Prices (IAP), Indicative Equilibrium Volumes (IEV), the disclosure of broker identification and the use of hidden orders is also presented.
[1]Indicative Auction Price (IAP). Also known as Indicative Equilibrium Price (IEP) or Indicative Opening Price (IOP).
[2]Indicative Equilibrium Volume (IEV).
[3]The ASX displays surplus volume.
[4]The current ASX hidden or undisclosed order will be replaced by an iceberg order in 2006 where the hidden part of the order will lose time priority. The iceberg order may be used in any trading session.
[5]When the BMA introduce a new trading system in late 2005, it will also increase transparency to the best 5 prices and introduce an IAP and IEV in the opening and closing call auctions.
[6]Broker ID is displayed according to trading volume. The ID's of the five most active brokers in each stock are displayed.
[7]SGX displays the top 50 levels of the order book however this is available only on subscription. The best bid and ask is available at no cost.
[8]If a Special Quote (SQ) is displayed, the SQ price and cumulative volume at that price is displayed and the next 4 bid and ask prices and volumes.
[9]The TSE displays an IAP prior to the call auction at the open of the morning and afternoon session.
[10]There is no continuous auction on the TSEC. Therefore N/A is recorded in columns two and three. For call auction trading, the order book is completely closed over the pre-open period prior to the opening call auction. However, the best 5 bid and ask orders are displayed at subsequent call auctions throughout the trading day and at the closing call auction.

Table A6
Fragmentation of order flow and delayed reporting

Exchange	Block trade facility/mechanism?	Off-market trading		
		Off market trading?	Price links to order book?	Delayed reporting allowed?
ASX	×	✓	×[1]	✓
BMA	×[2]	✓	✓	✓
HKEx	×	✓	✓	✓
JSX	✓	✓	×	✓
KRX	✓	✓	✓	×
SET	✓	✓[3]	×[4]	×[5]
SGX	×	✓	×	✓
SSE	✓	×	×	×

(continued on next page)

Table A6 (*continued*)

Exchange	Block trade facility/mechanism?	Off-market trading		
		Off market trading?	Price links to order book?	Delayed reporting allowed?
TSE	×	✓	✓	×
TSEC	✓	×	×	×

Table A6 presents details on market fragmentation. The availability of block trade facilities is indicated. Details on off-market trading are also presented. These include the use of price links to the order book and delayed reporting.

[1]Off-market *late trading* must be conducted with reference to the limit order book. See Table A1. Prices of other off-market trades are negotiated between the parties without reference to the limit order book.

[2]BMA plans to introduce a block trading facility/mechanism.

[3]Put Through (PT) trading is a form of off-market trading where brokers advertise their positions and trade between themselves. PT trading is the only trading mechanism used on the big lot board. Trading may be conducted by automatic matching or PT trading on the foreign board.

[4]Off-hours trading on the Main Board is permitted by PT trading and trades are executed at the closing price of that trading day. See Table A2.

[5]Big lot board traders must input details of the trade into the trading system within 15 min of the trade and within trading hours.

Table A7
Price variation controls

Exchange	Price controls	Description of price controls	
		Equity market	Equity based derivatives contracts
ASX	×	There are no set price variation controls on the ASX. However the exchange can, at its discretion, query significant price movements in a stock and halt trading.	No price controls
BMA	✓	Every stock has a daily price variation limit. In the morning session this is set at ±30% of the previous days closing price. In the afternoon session the daily price variation limit is set at ±30% of the closing price from the morning session.	Kuala Lumpur Composite Index (KLCI) contract. Price limit of 20% per trading session. However, there is no price limit for the spot month contact and no price limit for the second month contract for the final 5 business days prior to expiration.
HKEx	✓	Price variation limits are set so that no bid order shall be entered into the system that is more than 8 minimum ticks below the best bid and no sell order shall be entered into the system that is more than 8 minimum ticks above the best ask price in the limit order book.	No price controls
JSX	✓	An auto rejection system is in place on the JSX. The price limit is set as a percentage of the previous trade price. For example, for a stock that last traded on the previous day at Rp. 3000, the price limit is set at ±25% (that is, the stock may trade between Rp. 2250 and Rp. 3750).	No price controls

Table A7 (*continued*)

Exchange	Price controls	Description of price controls	
		Equity market	Equity based derivatives contracts
		Previous trade price (Rp.) — *Price limit* 5–100 — 50% greater than 100 to 500 — 35% greater than 500 to 2500 — 30% greater than 2500 to 5000 — 25% greater than 5000 — 20%	
KRX	✓	Every stock has a daily price variation limit set at ± 15% of the previous days closing price. Orders outside this limit are rejected. If the price limit is reached trading is not officially halted however will only continue when/if the price moves back to within this ± 15% daily price variation range.	For the majority of share price index contracts, when the lead month contract is ± 5% from the previous closing price for one minute, and the difference between the current price and the theoretical price is greater than or equal to ± 3%, trading of all contracts is halted for 5 min. Following the 5-min cooling off period, orders are batched for a 10 min period and executed at a single price. A daily price limit of 10% of the previous closing price also applies to certain contracts.
SET	✓	Stock prices may fluctuate within a range of ± 30% of the previous closing price. If the stock price is less than 1 baht, the stock price may fluctuate within a range of ± 100% of the previous closing price. Price controls do not apply on the foreignboard or big lot board.	Not available
SGX	✓	An order greater than 6 minimum ticks from the market or an order that overlaps the best price on the other side of the market generates a warning signal. This warning signal is to alert brokers to possible errors in order entry. The order may proceed if a $S0.20 fee is paid to the exchange.	A price limit of ± 15% from the previous day's settlement price applies for equity based index futures such as the Straits Times Index (STI) Futures. If this limit is exceeded, a cooling off period of 10 min applies where trading is not permitted outside the ± 15% price limit. Price limits are then lifted for the remainder of the day. There are no price limits on the expiry date. There are no price limits on single stock futures.
SSE	✓	Stock prices may fluctuate within a range of ± 10% of the previous closing price. In the opening call auction, orders can only be submitted ± 10% of the previous closing price. Therefore the opening price will never exceed the price limits.	Not available

(continued on next page)

Table A7 (*continued*)

Exchange	Price controls	Description of price controls	
		Equity market	Equity based derivatives contracts
TSE	✓	Every stock has a daily price variation limit set at around ± 10–20% of the previous day's closing price. Orders submitted outside this price range are rejected.[1] Orders submitted inside this daily price variation range are also subject to price controls that restrict excessive price deviations from the last traded price of the stock.	Equity based index contracts, for example the Tokyo Stock Price Index (TOPIX), attract the following price limits. *Previous day's Closing price* — *Price limit* Less than 2000 — ± 100 points 2000 to less than 3000 — ± 150 points 3000 to less than 4000 — ± 200 points 4000 or more — ± 250 points Price limits on equity options are identical to the price limits applicable to the underlying stock on the same day.
TSEC	✓	Every stock has a daily price variation limit set at ± 7% of the previous day's closing price. In addition, the intra-day volatility interruption rule also applies but only in intra-day call auctions. Intra-day call auctions are held at 30 s intervals. This rule suspends the call auction for 2–3 min if the system detects that the price of the security is likely to move by at least ± 3.5% from the last traded price, as determined in the previous call auction. This has replaced the two-tick rule.	Equity based index futures contracts are restricted to ± 7% of the previous days settlement price. For options contracts, the daily price limit is calculated as the maximum change in the underlying equity divided by $5000. This gives the maximum permitted change in the premium.

Table A7 presents a detailed description of price variation controls used on Asia-Pacific exchanges.
[1]See Guide to TSE Trading Methodology for a full list of price variation limits. This document is available at http://www.tse.or.jp/english/cash/stock/methodology/guide.pdf.

Table A8
Order types — continuous auction

	Continuous Auction									
Order type	ASX	BMA	HKEx	JSX	KRX	SET	SGX	SSE	TSE	TSEC
Market order	✓	✓	×	×	✓	✓	✓	×	✓	×
Limit order	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Stop market order	×	×	×	×	×	×	×	×	×	×
Stop limit order	×	×	×	×	×	×	×	×	×	×
Fill or kill order	✓	×	✓	×	✓	✓	✓	×	×	×
IOC order	✓	×	×	×	✓	✓	×	×	✓	×
Incomplete order	×	×	×	×	✓	×	×	×	✓	×
Market-on-open	–	–	–	–	–	–	–	–	–	–

Table A8 (*continued*)

	Continuous Auction									
Order type	ASX	BMA	HKEx	JSX	KRX	SET	SGX	SSE	TSE	TSEC
Market-on-close	–	–	–	–	–	–	–	–	–	–
Maximum order validity (days)	63	1	1	1	1	1	1	1	1	1

Order types allowed in the continuous auction are presented in Table A8. Descriptions of these order types are provided. The maximum order validity period is also presented.

Description of order types:

•*Market order*; an order specifying the stock and volume however no transaction price is specified.

•*Limit order*; an order specifying the stock, volume and the maximum or minimum transaction price.

•*Stop market order*; an order that activates and becomes a market order when a specified price level (the stop price) is reached.

•*Stop limit order*; an order that becomes a limit order at a specified limit price when a specified price level (the stop price) is reached.

•*Fill or kill order*; an order that must be executed in full or the entire order is rejected. Immediacy of execution may or may not be necessary.

•*Immediate and cancel order (IOC)*; an order that must execute immediately but not necessarily entirely. Any unfilled portion is cancelled.

•*Incomplete (market) order*; sometimes known as an at-market order or market-to-limit order, an order where the unfilled portion of the market order is converted into a limit order at the price of the executed portion.

•*Market-on-open order*; an order that trades at the opening price for that trading day. If the order is not executed in the call auction the order may either be cancelled or continue for possible execution in the continuous trading session.

•*Market-on-close order*; an order that trades at the closing price for that trading day. This also includes limit orders that if not executed by the close of continuous trading, convert to market-on-close orders and are executed at the closing price or are executed in the closing call auction if a closing call auction is used.

Table A9
Order types – call auction

Order type	ASX	BMA	HKEx	JSX	KRX	SET	SGX	SSE	TSE	TSEC
Market order	✓	✓	×	×	✓	✓	×	×	✓	×
Limit order	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Market-on-open	×	×	✓	×	×	✓	×	×	✓	×
Market-on-close	×	×	×	×	✓	✓	×	×	✓	×

Order types allowed in the call auction are presented in Table A8. Descriptions of these order types are provided in Table A8.

Table A10
Call auction design

Exchange	Length of pre-open prior to the call auction		Order non-cancellation period?	Volatility/imbalance extension?
	Opening call auction	Closing call auction		
ASX	180 min[1]	5–6 min[2]	×	×
BMA	30 min[3]	N/A[4]	×	×
HKEx	30 min	N/A	✓	×
JSX	15 min	N/A	×	×
KRX	60 min	10 min	×	✓
SET	30 min[5]	10 min[6]	×	×
SGX	30 min	6 min	✓	×
SSE	10 min	N/A	×	×
TSE	60 min[7]	0 min[8]	×	✓
TSEC	30 min	5 min[9]	×	×[10]

Details on call auction design are presented in Table A10. The length of the pre-open period prior to the call auction is presented, for both the opening and closing call auction. The use of order non-cancellation periods and volatility extensions are also presented. N/A indicates that the design feature is not applicable to the market.
[1]The market opens in five batches of stocks between 10:00 and 10:09. Each batch opens randomly up to ± 15 s from its designated opening time.
[2]The closing call auction occurs randomly between 5 and 6 min after the close of normal trading. On the last trading day of each month the pre-open prior to the closing call auction is extended by 5 min.
[3]The afternoon session also commences with a call auction, the pre-open period is also 30 min. This pre-open facilitates order entry as orders are only valid for one trading session.
[4]Intra-day call auctions on BMA are held every 10 s. No extended pre-open precedes the closing call auction at either the close of the morning or the afternoon session. With the introduction of the new trading system, a pre-open period of 5 min will be introduced prior to the closing call auction.
[5]The market in each stock opens randomly between 9:55 and 10:00. The pre-open prior to the afternoon session is 30 min with a random call auction opening between 14:25 and 14:30.
[6]The closing call auction occurs randomly between 16:35 and 16:40.
[7]The pre-open period prior to the call auction at the start of the afternoon session is 25 min.
[8]There is no set pre-open period before the closing call auction held at the end each trading session.
[9]Intra-day call auctions on the TSEC are held every 30 s. However, a 5 min pre-open precedes the closing call auction at 13.30. Therefore, intra-day call auctions cease 5 min prior to the closing call auction.
[10]Volatility/imbalance extensions only apply at intra-day call auctions, not at the opening or closing call auction.

References

Aitken, M., Comerton-Forde, C., 2005. Do Reductions in Tick Sizes Influence Liquidity? Accounting and Finance 45, 171–184.
Aitken, M., Berkman, H., Mak, D., 2001. The use of undisclosed limit orders on the Australian Stock Exchange. Journal of Banking and Finance 25, 1589–1603.
Amihud, Y., Mendelson, H., Murgia, M., 1990. Stock market microstructure and return volatility, evidence from Italy. Journal of Banking and Finance 14, 423–440.
Amihud, Y., Mendelson, H., Lauterbach, B., 1997. Market microstructure and securities values: evidence from the Tel Aviv Stock Exchange. Journal of Financial Economics 45, 365–390.
Angel, J., 1997. Tick size, share prices and stock splits. Journal of Finance 52, 655–681.
Berkman, H., Lee, J., 2002. The effectiveness of price limits in an emerging market: evidence from the Korean Stock Exchange. Pacific-Basin Finance Journal 10, 517–530.
Bloomfield, R., O'Hara, M., 2000. Can transparent markets survive? Journal of Financial Economics 55, 425–459.

Boehmer, E., Saar, G., Yu, L., 2005. Lifting the veil: an analysis of pre-trade transparency at the NYSE. Journal of Finance 60, 783–815.

Bris, A., Goetzmann, W., Zhu, N., 2004. Efficiency and the Bear: Short Sales and Markets Around the World. Yale ICF Working Paper, vol. 02-45.

Brusco, S., Jackson, M., 1999. The optimal design of a market. Journal of Economic Theory 88, 1–39.

Chan, S., Kim, K., Rhee, S., 2004. Price limit performance: evidence from transactions data and the limit order book. Journal of Empirical Finance 12, 269–290.

Chang, R., Hsu, S., Huang, N., Rhee, S., 1999. The effects of trading methods on volatility and liquidity: evidence from the Taiwan Stock Exchange. Journal of Business Finance and Accounting 26, 137–168.

Charoenrook, A., Daouk, H., 2004. The World Price of Short Selling. Vanderbilt University Working Paper.

Cho, D., Russell, J., Tiao, G., Tsay, R., 2003. The magnet effect of price limits: evidence from high-frequency data on Taiwan Stock Exchange. Journal of Empirical Finance 10, 133–168.

Christie, W., Schultz, P., 1994. Why do NASDAQ market makers avoid odd-eighth quotes? Journal of Finance 49, 1813–1840.

Comerton-Forde, C., 1999. Do trading rules impact on market efficiency? A comparison of opening procedures on the Australian and Jakarta Stock Exchanges. Pacific-Basin Finance Journal 7, 495–521.

Comerton-Forde, C., Lau, S.T., McInish, T., 2005. Opening and closing behavior following the introduction of call auctions in Singapore. Working Paper.

Cushing, D., Madhavan, A., 2000. Stock returns and trading at the close. Journal of Financial Markets 3, 45–67.

Demarchi, M., Foucault, T., 2000. Equity trading systems in Europe, a survey of recent changes. Journal of Economics and Statistics, 60.

Domowitz, I., Madhavan, A., 2001. Open Sesame: Alternative Opening Algorithms in Securities Markets. In: Schwartz, R.A. (Ed.), The Electronic Call Auction: Market Mechanism and Trading, Building a Better Stock Market. Kluwer Academic Publishers, Boston, pp. 375–394.

Du, Y., Liu, Q., Rhee, S., 2005. An Anatomy of the Magnet Effect: Evidence from the Korea Stock Exchange High-Frequency Data. University of Hawaii Working Paper.

Easley, D., Kiefer, N., O'Hara, M., 1996. Cream-skimming or profit-sharing? The curious role of purchased order flow. The Journal of Finance 51, 811–833.

Economides, N., Schwartz, R., 1995. Electronic call market trading. Journal of Portfolio Management 21, 10–18.

Foucault, T., Moinas, S., Theissen, E., 2003. Does anonymity matter in electronic limit order markets? CEPR Discussion Papers 4091.

Gemmill, G., 1996. Transparency and liquidity: a study of block trades on the LSE under different publication rules. Journal of Finance 51, 1765–1790.

Harris, L., 1990. Liquidity, Trading Rules and Electronic Trading Systems, New York University Salomon Centre Monograph Series in Finance.

Harris, L., 1993. Consolidation, fragmentation, segmentation and regulation. Financial Markets, Institutions and Instruments 2, 1–28.

Harris, L., 1994. Minimum price variations, discrete bid/ask spreads and quotation sizes. Review of Financial Studies 7, 149–178.

Ho, K., 1996. Short-sales restrictions and volatility: the case of the Stock Exchange of Singapore. Pacific-Basin Finance Journal 4, 377–391.

Jiang, F., Joseph, K., Cheng, L., 2001. The lead-lag relation between spot and futures markets under different short-selling regimes. Financial Review 36, 63–88.

Ke, M., Jiang, C., Huang, Y., 2004. The impact of tick size on intraday stock price behaviour: evidence from the Taiwan Stock Exchange. Pacific-Basin Finance Journal 12, 19–39.

Kim, K., Rhee, S., 1997. Price limit performance: evidence from the Tokyo Stock Exchange. Journal of Finance 52, 885–899.

Lang, L., Lee, Y., 1999. Performance of various transaction frequencies under call markets: the case of Taiwan. Pacific-Basin Finance Journal 7, 23–39.

Lau, S.T., McInish, T., 1995. Reducing tick size on the Stock Exchange of Singapore. Pacific-Basin Finance Journal 3, 485–496.

Lauterbach, B., 2001. A note on trading mechanism and securities' value: the analysis of rejects from continuous trade. Journal of Banking and Finance 25, 419–430.

Liu, Y., 1994. A simulation model of the Taiwan security market. Journal of Asian Economics 5, 413–423.
Madhavan, A., 1992. Trading mechanisms in securities markets. The Journal of Finance 47, 607–641.
Madhavan, A., 1995. Consolidation, fragmentation, and the disclosure of trading information. The Review of Financial Studies 8, 579–603.
Madhavan, A., 1996. Security prices and market transparency. Journal of Financial Intermediation 5, 255–283.
Madhavan, A., Panchapagesan, V., 2000. Price discovery in auction markets: a look inside the black box. The Review of Financial Studies 13, 627–658.
Madhavan, A., Porter, D., Weaver, D., in press. Should securities markets be transparent. Journal of Financial Markets.
Ng, S., 2004. SGX Pushed Trading Link with Aussie Bourse. The Business Times, Singapore. 31 May.
O'Hara, M., 1995. Market Microstructure Theory. Blackwell Publishers Limited, Oxford.
O'Hara, M., 2001. Designing markets for developing countries. International Review of Finance 2, 205–215.
Pagano, M., Röell, A., 1996. Transparency and liquidity: a comparison of auction and dealer markets with informed trading. Journal of Finance 51, 579–611.
Pagano, M., Schwartz, R., 2003. A closing call's impact on market quality at Euronext Paris. Journal of Financial Economics 68, 439–484.
Rhee, S., 2000. Rising to Asia's Challenge: Enhanced Role of Capital Markets. Rising to the Challenge in Asia: A Study of Financial Markets, vol. 1, pp. 107–174. Manila Philippines Development Bank.
Rhee, S., Tang, N., 2004. The Competition of Order Flow under the New Order Handling Rules. University of Hawaii Working Paper.
Rhee, S., Wang, C., 1997. The bid-ask bounce effect and the spread size effect: evidence from the Taiwan stock market. Pacific-Basin Finance Journal 5, 231–258.
Rhee, S., Stone, G., Tang, N., 2004. The Impact of Trading Method on Volatility and Market Manipulation: New Evidence from the Singapore Exchange. University of Hawaii Working Paper. .
Rust, J., Hall, G., 2003. Middlemen versus market makers: a theory of competitive exchange. Journal of Political Economy 111, 353–403.
Ryoo, H., Smith, G., 2002. Korean stock prices under price limits: variance ratio tests of random walks. Applied Financial Economics 12, 545–553.
Simaan, Y., Weaver, D., Whitcomb, D., 2003. Market maker quotation behavior and pretrade transparency. The Journal of Finance 58, 1247–1267.
Stoll, H., 1985. Alternative views of market making. In: Amihud, Y., Ho, T., Schwartz, R. (Eds.), Market Making and the Changing Structure of the Securities Industry. Lexington Books, Lexington, MA, pp. 67–91.
Stoll, H., Whaley, R., 1990. Stock market structure and volatility. Review of Financial Studies 3, 37–71.
Theissen, E., 2003. Trader anonymity, price formation and liquidity. European Finance Review 7, 2003.