Price Discovery of Indexes Futures Across Markets[1]

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Abstract

The trading of foreign index futures by the Singapore Exchange (SGX) offers an ideal opportunity to study price discovery and information efficiency of trading across different markets. We examine four cross-listing of index futures, Nikkei 225 Index, MSCI Taiwan Index, CNX Nifty Index and the FTSE China A50 Index offered by and traded in SGX and compare them with their home market trading. In contrary to standard evidence, we show that smaller bid-ask spread, lower minimum lots and cheaper transaction cost do not necessary improve information efficiency. These results reveal the mechanism of price discovery related to cross listing of securities.

Keyword: information share, price discovery, futures indexes, cross markets, cross-listing

JEL: G10, G14, G15

1. Introduction

Exchanges play important role in trading of securities and financial products which facilitate price discovery and improve information efficiency. To embracing globalization and meeting institutional investors' needs, many exchanges have started to cross list financial products and securities that are already traded in markets elsewhere. The proponents of such cross-listing of securities or financial products argue that such approaches as a financial innovation help improve information efficiency often via reducing trading transaction cost, enlarging institutional base, lengthening trading time and increasing market depth. There are numerous studies on cross-listing of individual stocks (Miller 1999; Eun and Sabherwal, 2003; Doidge, Karolyi and Stulz, 2004, 2009; Jong, Rosenthal and Dijk, 2009). However, cross listing of index futures remain uninvestigated. Different from individual stocks, cross-listing of index futures provides important benefit of enhanced global risk exposure, risk sharing and hedging. We extend the literature by comprehensively examining the factors determining information efficiency or price discovery of cross-listing of index futures.

The emergence and popularity of trading on foreign index futures provided by the Singapore Exchange (SGX) offers an ideal opportunity to systematically study the price discovery and information efficiency of securities cross-traded. The trading of foreign index futures whose fundamentals are the same as their domestic index futures traded in home exchanges allows us to directly compare the difference of information efficiency between foreign index futures and domestic index futures as well as to determine the factors explaining such difference. As one of the largest offshore market, Singapore Exchanges has successfully launched four foreign index futures including Japan Nikki 225 index futures, MSCI Taiwan Index, CNX Nifty Index and the FTSE China A50 Index. For instance, the trading by SGX of the Japanese Nikkei 225 index futures has flourished in SGX instead of Osaka Exchange (OSE) during the late 1990s. Policy makers consider differences in institutional characteristics and trading in the SGX are more attractive and informative than in the OSE because of lower transaction cost and less trading restrictions. Similarly, FTSE China A50 Index is the only Chinese index futures that foreign investors can both long and short outside China, and their trading volume grew substantially since 2015 after Chinese regulator banned short selling of stocks in Chinese exchanges.

The cross trading of index futures with same fundamentals offers a perfect setting to test factors leading to market efficiency and price discovery since arbitrage trading can correct any significant mispricing in lagged or slow-moving market. Transaction cost is regarded as the main factor in affecting information efficiency. For example, Fleming (1996) proposed that low transaction cost in trading helps new information incorporated into the market quicker. Similarly, we hypothesize that by lowering transaction cost, market can improve price efficiency therefore leading to greater price discovery. We directly test Fleming (1996)'s prediction in the cross markets of index futures by relating price discovery to trading cost. Specifically, we empirically test foreign index futures traded in SGX and show that they lead the price discovery process as compared to their domestic index futures counterpart due to lower transaction cost.

One alternative hypothesis that we cannot rule out is the difference in institutional investors. For example, several papers suggest that foreign institution investors maybe be more sophisticated than domestic ones due to their investment experience and expertise (Seasholes, 2000; Grinblatt and Keloharju, 2000; Froot and Ramadorai, 2001, Boehmer and Kelley, 2009). Although many researchers do not think that foreign institutions have advantage over domestic counterparties since local investors possess an information advantage due to close proximity and greater accessibility to local information (Hau, 2001; Dvorak, 2005; Brennan and Cao, 1997; Parwada, 2008). Since we do not possess trader's identity data, it is hard to differentiate whether foreign institutional investors are the ones that drive the differences in information efficiency and price discovery of index futures traded in SGX versus domestic exchanges.

In this paper, we establish the empirical evidence on price discovery of cross traded index futures traded concurrently in their domestic market and SGX. This research thus answers an important question in the literature where price discovery occurs and why. We find that index futures in SGX lead those in their home market when trading transactions by large explain the efficiency of index futures between two markets. We use the four most liquid index futures traded on SGX[2]: The Singapore Exchange's CNX Nifty Index Futures, FTSE China A50 Index Futures, Nikkei 225 Index Futures, MSCI Taiwan Index Futures. In order to study the price discovery of these indices, the corresponding equity-index futures traded in domestic markets are included, and they are CNX Nifty Index Futures listed on the National Stock Exchange of India (NSE), China Shanghai Nifty Index Futures listed on China Financial Future Exchange (CFFEX), Nikkei 225 Index Futures listed on the Osaka Stock Exchange (OSE), and Taiwan Stock Index Futures listed on the Taiwan Futures Exchange (TAIFEX). These index futures share the same or similar underlying fundamentals as those index futures traded in SGX.[3] We follow the methodology

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[2]Total value of offshore futures traded in 2013: China US$170 billion, India US$190 billion, Japan US$2.8 trillion, Taiwan US$530 billion. Detailed information can be found at http://www.sgx.com/wps/portal/sgxweb/home/products/derivatives/overview.

[3] Other than the exception of Japan's Nikkei 225, the underlying of Taiwan's Index futures traded in SGX is the MSCI Taiwan Index instead of the TAIEX Index, and the underlying of China Index traded in SGX is the FTSE China A50 Index instead of China's CSI 300 index. As for the India's the CNX

proposed by Hasbrouck (1995) and subsequently extended to the rotation invariant case by Lien and Shrestha (2009), by constructing an information share ratio that compares the information related variances across different markets. Hasbrouck (1995) proposes an econometric approach based on an implicit unobservable efficient price common to all markets, in which the information share associated with a particular market is defined as the proportional contribution of that market's innovation variance in the total innovation variance of common efficient price. We first calculate the information share of each index futures that is contributed from each markets. We find that the information share of CNX Nifty Index Futures in SGX accounts for about 77.0% of the total information related variance, consistently larger than the contribution from the futures trading in NSE. Similarly, the information shares of Nikkei 225 Index Futures from trading in SGX accounts for about 75.3%. On the other hand, the SGX's contribution to information share of MSCI Taiwan Index Futures and FTSE China A50 Index Futures are around 27.5% and 25.1%, respectively, lower than the information share contributed from their domestic trading. These findings suggest that the price discovery of local securities can actually happen in foreign exchanges far away. This is the first study that shows trading in foreign markets are more informed than trading offered by in domestic exchanges.

Unlike equity that requires access to the depository during settlements, index futures are purely cash settled. Trading of foreign indexes through index futures does not require any regulatory agreement from the domestic country. Since many exchanges are now starting to provide trading services of foreign index futures, it becomes important to understand whether trading of securities across markets results in information efficiency. This paper contributes to the price discovery literature by

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Nifty Index, the futures trading on SGX are denominated in US dollars whereas in India, the futures are denominated in Indian Rupees. These differences are time varying and therefore controlling for these differences are important.

comparing the beneficial effect on developing foreign index futures in developed markets where investors can benefit from trading of foreign index futures. Furthermore, the research helps to shed lights on the effects of financial market integration and globalization，as many argue that financial market integration have benefits such as increased economic growth and the development of local stock markets (Bekaert, Harvey and Lundblad, 2001, 2005, 2009; Gupta and Yuan, 2004; Mitton, 2006), risk-sharing between domestic and foreign investors (Merton, 1987; Karolyi and Stulz, 2003; Kim and Singal, 2000), and improvement of corporate governance and the information environment (Li, Moshirian, Pham and Zein, 2006; Cumming, Imad'Eddine, and Schwienbacher, 2013).

The rest of the paper is organized as follows. Section 2 introduces the relevant literature. Section 3 presents the microstructure detail of SGX with foreign exchange differences. Section 4 introduces data and summary statistics while Section 5 describes the information share measure. Section 6 shows the empirical results on determinants affecting the informational share ratio. Section 7 investigates the cross-markets efficiency by creating trading portfolio and conclusion can be found in section 8.

2. Literature Review and Background

The efficient markets hypothesis (Fama, 1970) posits that price of securities in the market adjusts quickly towards their efficient price by eliminating any available arbitrage profits. However, in practice we do not know how this process is actually being carried out. Some suggest the existence of arbitrageurs profiting from price inefficiency. One main reason why this economic question is still unanswered is because the efficient price is not observable, but instead can only be derived from traded prices, bid prices and ask prices. In this section, we review the literature on price discovery process of futures contracts traded on different markets with similar underlying. One common concern of the existing studies is the data problem as many rely on daily data. Our innovation in this research is to use the futures data with ticker by ticker trades.

2.1 The Literature On Index Futures Across Markets

Several papers investigate the price discovery process of the Japanese Nikkei 225 Index across different markets. Shyy and Shen (1997) used both daily and intra-day data to study the price transmission of Nikkei 225 futures between SIMEX in Singapore and TSE/OSE in Japan. They did not find a significant evidence of the price discovery process for both SIMEX and TSE/OSE market. Lee and Tse (1996) used daily closing prices of Nikkei 225 Index futures from OSE, SGX and CME but found none of them can be considered the main source of information flow. Covrig, Ding and Low (2004) examined the price discovery process using Nikkei 225 index in domestic spot market (Tokyo Stock Exchange), domestic futures market (Osaka Exchange Market) and foreign futures market (Singapore Exchange). They showed evidence that price discovery occurred in both markets and suggested that a satellite market can co-exist with another home market by providing a significant role in the price discovery process.

In relation to the price discovery process of the Taiwan Index, Chou and Lee (2002) studied the period during tax reduction in Taiwan Futures Exchange (TAIFEX) and compared the trading costs and information transmissions between SGX and TAIFEX. They found this reduction of market friction had a great impact on the relative efficiencies of price execution of TAIFEX to SGX and the better price execution was mainly driven by the larger base of market participants and less costs of intermediation. Huang and Chou (2007) compared the difference between TAIFEX order-driven call market and SGX quote-driven continuous trading system and found the spread is minimized in TAIFEX when order imbalance is high while the spread is highest in SGX when order imbalance is high.

Despite of these studies, Kumar (2014) examined the impact of foreign institutional investor's investments on Nifty index futures that are both tradable on National Stock Exchange of India (NSE) and Singapore Exchange (SGX). He found that SGX does not have influence on Nifty futures, which indicates Nifty is not a significant explanatory variable in SGX market. Guo et al. (2013) studied the intraday price discovery and volatility transmission processes between Singapore Exchange (SGX) and China Financial Futures Exchange (CFFE). They found that China's CSI 300 index futures dominate FTSE A50 index futures in SGX in both intraday price discovery and intraday volatility transmission processes.

2.2 Institution Background

Singapore Exchange's derivatives market (SGX-DT) is an order driven market that uses a continuous auction system for regular intra-day trading. It provides a platform for a suite of globally tradable products, including equity index futures and options, interest rates futures and option, and dividend index futures contract. For Singapore's equity-index futures market, trading takes place during the day (T session) and during the evening (T+1 session). During the opening hours of these sessions, investors can submit orders, make amendments or cancel orders at no extra cost. SGX-DT allows investors to submit limit orders, market orders and stop orders. These orders are matched according to the price and time priority rule. SGX derivatives market face three explicit transaction costs: exchange fees, brokerage fees and taxes. Investors pay a 0.04% of the contract value as a clearing fee and 0.0075% access fee once the order is submitted. A GST of 7% is also charged on both clearing and brokerage fees. In addition to providing derivatives clearing and settlement, Singapore Exchange Derivatives Clearing Limited (SGX-DC) also provides a mutual offset system with Chicago Mercantile Exchange (CME). This facility allows investors to initiate positions in one exchange for allocation to the other on a real-time basis. Currently, only three index futures products are eligible for mutual offset with CME (1) Nikkei 225 Index futures (Yen denominated), (2) Nikkei 225 Index futures (USD denominated), and (3) S&P CNX Nifty Index futures.

In order to prevent excessive price volatility in the derivatives market, SGX-DT adopts price limits for the majority of its derivatives contracts. These price limits are designed to provide a cooling off period so as to restrict trading temporarily when the market is volatile. Price limits are set as a percentage of the maximum permitted movement a price can advance or decline from the previous trading day's settlement price during a trading session. This specified percentage varies from contract to contract. When a price hits any of its price limits, SGX-DT will signal a cooling off period. The cooling off period is a specified duration of time where the affected contract may be traded at or within its price limits. The specified duration also varies from contract to contract. Once the cooling off period ends, normal trading resumes for the remainder of the trading day. In regards to options contracts, trading in the options contracts will be halted when their underlying futures contracts hit its price limits and enter into a cooling off period. Subsequently, normal trading for both options contracts and their underlying futures contracts will resume once the cooling off period is lifted.

This paper use the four most liquid index futures traded on SGX: The Singapore Exchange's CNX Nifty Index Futures, FTSE China A50 Index Futures, Nikkei 225 Index Futures, and MSCI Taiwan Index Futures. In order to study the price discovery of these indices, the corresponding equity-index futures are also included respectively: CNX Nifty Index listed on the National Stock Exchange of India (NSE), China Shanghai Nifty Index listed on China Financial Future Exchange (CFFEX), Nikkei 225 Index Futures listed on the Osaka Stock Exchange (OSE), and Taiwan Stock Index listed on the Taiwan Futures Exchange (TAIFEX). These futures share the same or similar underlying as those futures traded on SGX. Appendix B shows the differences between different exchanges including trading time, trading cost, minimum lot sizes and the multiplier. These differences affect the cost of trading which in turn may indirectly encourage certain type of traders to trade in a particular exchange. For example, high-frequency speculators may want to trade in the exchange that is the cheapest to trade with the smallest size, whereas large institutional traders may not be interested in these as these factors do not affect them.

In all cases, the trading time of the four indices in their domestic exchanges is always a subset of the trading time in SGX. For the purpose of the paper, we are only interested in futures quotes and trades prices within the trading period where both the domestic and Singapore exchanges open. In Singapore time, this means that for the Nikkei 225 prices between 0800hrs -1415hrs are used, 0845hrs - 1345hrs for the Taiwan futures index and 1145hrs - 1800hrs for Nifty Index. As for the China's index futures, two sessions, 0915hrs - 1130hrs and 1300hrs - 1515hrs are extracted. All futures prices not within these time intervals are truncated away.

3. Data, Summary Statistics and Methods

3.1 Data and Summary

The intra-day tick, time-stamped market traded, bid and ask quotes for all the index futures trading in both SGX and their home markets are obtained from Bloomberg. Our sample period spans from 1st August 2014 to 31th January 2015. Intra-day foreign exchange rate data are also obtained from Bloomberg. As the time-stamped data are accurate up the seconds, for every second, we take the latest price to represent the price observed in that time stamped. If there are no trades or quotes in a particular second, the price in the previous time period is used instead. Trade prices, Bid and Ask prices are stored separately as individual price interval.

Appendix 3 reports the relative percentage of transacted index futures by the size of the lot in each exchange. For example, in column 2 for the Nifty Index futures traded on SGX, 27.92% means that 27.92% of all the transacted futures contract traded on SGX have lot sizes less than 2. For comparison purposes, all lots sizes are approximately measured as a multiple of SGX lot sizes. If 1 lot in Japan OSE cost twice as much as 1 lot in SGX, we would measure the 1 lot transacted in OSE as 2 lots. Lot ratios measures the relative cost of the smallest size lots in each exchange. For example, the cost of 1 lot in NSE is 1/5 the cost of 1 lot in SGX. It costs 15.68 times more expensive to trade on CFFEX than SGX, 2 times more expensive to trade on OSE than SGX and 1.76 times more expensive to trade on TAIFEX than SGX. In a sum, except the Nifty Index futures on NSE, it is always cheaper to trade on SGX. From appendix 3, we find the evidence that exchanges having a cheaper minimum lot have smaller transactions. From Appendix 4, the time-weighted spread ratio (as a percentage of futures price) is greater in SGX except for the Nikkei 225 index futures. The negative relation between cheaper minimum lot size and smaller spread does not always hold true in our sample. The both the China and Taiwan Index futures are cheaper to trade on SGX but the spread ratio is relatively higher.

Testing where price discovery occurs is an important empirical question. In this paper, we use the information share measure constructed in Hasbrouck (1995) as our measure. In this section, we describe briefly the information share methodology of Hasbrouck (1995). The univariate result on information share is subsequently presented at the end of this section.

3.2 Empirical Methods

Suppose there are n price variables related to a single security. Examples of these observable related price variables are the transaction, bid and ask prices of a traded security. In this paper, the single security of concern is an index, and the price variables related to this security are the transaction, bid and ask futures prices such that the futures underlying is the index itself. If we were to assume a fixed interest rate r over a fixed time period Γ such that Γ also corresponds exactly to the futures contract's time to maturity, then there exist a no arbitrage equation that relates the futures price to its underlying price: $F_{\Gamma} = S_0 e^{r\Gamma}$, here F_{Γ} is the futures price with maturity Γ, and S_0 is the price of the underlying at time $t = 0$. Suppose each price series is integrated of order one, $\mathrm{I}(1)$, which implies that their price changes are covariance-stationary. They can be modelled using a vector moving average model (VMA):

$$\Delta p_t = \Phi(L) e_t \tag{1}$$

where e_t has $\mathrm{E}(e_t) = 0$ and variance covariance matrix Σ. Φ is a polynomial in the lag polynomial.

Although each price is non-stationary, we know that the prices in different markets do not diverge from each other significantly due to arbitrage. Therefore we can assume that the difference between any two price variables is stationary, in particular, the difference between any price variables with the first price variable is stationary. Formally this means that the prices are cointegrated of order *n-1* with co-integrating matrix β:

$$\text{s.t. } \beta' = [\Gamma_{n-1}, -I_{n-1}]$$

$$\text{and } \beta' p_t = I(0)$$

hereΓ_{n-1} is a column unit vector. The requirement that $\beta' p_t$ is stationary implies that $\beta'\Phi(1) = 0$,where $\Phi(1)$is the sum of all the moving average coefficients of equation (1). We can therefore decompose the VMA model into$\delta p_t = \Phi(1)e_t + \Phi(L)e_t$where $\Phi(1)e_t$ intuitively measures the long-run impact of a disturbance on each price variables. Given the unique structure of β, it can be shown that all the rows of $\Phi(1)$ are identical, which suggest a common long-run price impact on each of the price variables. Measuring the contribution from each of the price variables towards this common long-run price impact serve as a measure of information share of a market.

Since the price variables are cointegrated, there exists an error correction model (VECM) of the form:

$$\Delta p_t = \alpha(\beta' p_{t-1} - \mu) + \Gamma_1 \Delta p_{t-1} + \Gamma_2 \Delta p_{t-2} + \cdots + \Gamma_K \Delta p_{t-K} + e_t \qquad (2)$$

The α in equation (2) measures the speed of adjustments towards the long-run mean, μ is the long-run mean and Γ is an *n by n* coefficient matrix. After estimating the parameters of the VECM model in equation (2) we can then estimate the equivalent VMA model in equation (2) using the parameter of the VECM model which will be discuss in more details in the next section.

Finally, the j^{th} market information share on the single security relative to the total variance of the common random walk component can be measured as:

$$S_j = \frac{\phi_j^2 \Sigma_{jj}}{\phi \Sigma \phi'} \qquad (3)$$

Here ϕ denote the common row of Φ and $\phi_j$denote the j^{th} element of ϕ.

Given observable price samples P_t we transform it by taking natural log and define $p_t = \ln(P_t)$.Therefore the change in p_t can be the continuously compounded returns of the price samples P_t. We estimate μ in equation (2) separately from the other parameters, and estimating it as the sample mean of $\beta' p_t$. The remaining parameters in equation (2) can then be estimated via ordinary least squares. For the purpose of this paper, we specify the VECM model to have 300 lags to account for possible autocorrelation up to 5 minutes due to uninformative trades such as trades due to inventory control purposes.[4]

To estimate parameters of the VMA model in equation (1), we "forecast" the VECM system subsequent to a unit perturbation. A recursive loop can then be formulated to estimate the coefficients of the VMA model. Details of this recursive formula can be found in the Appendix. We next compute $\phi(1)$ to the sum of all moving average coefficients. In theory, $\phi(1)$ is equal to $\sum_{i=0}^{\infty} \Gamma_i$. However for the purpose of this paper, we stop the summation if:

$$\|\phi_{k+1} - \phi_k\|_1 < 0.0001 \tag{4}$$

ϕ_k denote $\sum_{i=0}^{k} \Gamma_i$ and $\|M\|_1$ is the matrix 1-norm. This is to ensure that convergence is reached and the system is stable. The information share measure in equation (5) is uniquely define if the variance-covariance matrix Σ is diagonal otherwise the order of the price of the price vector will affect the information share measure, i.e. the information share measure is different if we place SGX futures price as the first element instead as the second element in the n-vector price variable. Following an invariant information share method by Lien and Shrestha (2009), we use the correlation matrix instead of the covariance matrix. Let Σ^* represent the innovation

[4]Since computing technology has improved, unlike Hasbrouck (2003) we do not use any polynomial approximation of the Γ coefficients, but instead estimate all the coefficients of the Γ matrix.

correction matrix which is also a product of the above estimation procedure. Let Λ represent the diagonal matrix with diagonal elements being the eigenvalue of Σ^* and G be the corresponding eigenvector matrix where the columns are eigenvectors. Finally, let V be a diagonal matrix containing the innovation standard deviation on the diagonal, $\mathrm{V} = \mathrm{diag}\left(\sqrt{\Sigma_{1,1}}, \sqrt{\Sigma_{2,2}}, \ldots \sqrt{\Sigma_{n,n}}\right)$. Denote $F^* = [G\Lambda^{-\frac{1}{2}}G^T V^{-1}]^{-1}$ and under this factor structure instead of the Cholesky factorization used by Hasbrouck (1995):

$$S_j = \frac{\phi_j^{*2}}{\phi \Sigma \phi'}$$

Here $\phi^* = \phi F^*$ and ϕ_j^* is the jth element. Proof of the invariance information share can be found in Lien and Shrestha (2009).

3.3 Univariate analysis: Information Share

To compute the information Share result in table 1, both the traded price and bid-ask middle point are used as separate price variables that are cointegrated. The average information share for both price variables is later combined to compute the information share of the exchange, and a summary of the information share contributed by each exchange is reported in Table 1.

[Place Table 1 here]

From table 1, the information share is greater in SGX for Nifty index and Nikkei index. However the information share is lower in SGX for the China Index and Taiwan Index. It means that information discovery happens in SGX for both Nifty and Nikkei 225, but less for FTSE China A50 and MSCI Taiwan Index. All these differences are statistically significant.

4. Main Findings

4.1 Information Share Results

The univariate test only compares the mean of information share in two exchanges without controlling for other factors. Thus, we are interested to know whether the information is persistent and also the determinants of information share. Table 2 shows the key variable we used in the multivariate regression, and Panel A to Panel D show the detailed information for the four index futures. Information share is the same as in univariate test and calculated from the Hasbrouck methodology. Generally, the table also show that SGX has larger spread, higher mean-adjusted price volatility, lower depth and lower traded volume. But there is an exception: for example, the spread in OSE is twice that of SGX and the volatility is slightly larger in OSE. Unlike other exchanges, CFFEX in China owns much smaller depth than SGX, suggesting potential illiquid future market in China. As for the traded volume, local market usually demands more future products than SGX expect for insignificance in OSE. The order imbalance (buy minus sell) tends to be more positive in SGX expect for insignificance in CFFEX.

[Place Table 2 here]

Table 3 conducts a multivariable regression of determinants of information share. All the controls are the ratio of variable in SGX divided by the corresponding in foreign derivative market. We introduced lagged information share in SGX, controlling for the momentum/reversal effect of the price discovery. We also control for day of week effect and index fixed effect to rule out the potential time variant and individual effect.

The first column only control lagged information share in SGX and use fixed effect model. The coefficient of lagged information share is positive, showing a momentum effect of information share. This means that the price discovery is stably dominant in one market. It also suggests that one percent increase of last day's information share leads to the increase today's information share by about 0.13%. Additional market microstructure as independent variables are investigated and reported in Column 2 to Column 6 in Table 3. The coefficients of lagged information share in SGX are slightly lower comparing with previous model but they are still significant. It shows that spread ratio and volatility ratio are significantly negative with the information share. Higher spread in SGX may slow down information transmission comparing with foreign market, while greater volatility usually means more market uncertainty which arbitrage traders do not want to take. We fail to find any relation between information share and depth ratio or volume ratio. Mostly interesting we find that the order imbalance ratio is positive and significant with the information share and the magnitude of the coefficient shows that one unit more buy order traded uplift about 0.1% increase in information share. Column 7 reports the result including all microstructure variables and we see that the result is still unchanged. All standard errors are adjusted by the Newey-West estimation by five order of autocorrelation.

[Place Table 3 here]

Table 8 and Table 9 report the robustness test for multivariate test. In Table 8 we winsorize all variables at 1% and 99% percent level to avoid the extreme values. The result become even stronger and most of the magnitudes are unchanged. In Table 9, we construct the dummy variable of SGX IS Dummy to be one if the information share in SGX is more than 60%, zero if less than 40%. We don't use the information share around 50% since it may not clear which market is in dominant. We adopt logit regression for the dependent variable is censored at one or zero. From Table 9, it shows that the magnitude of lagged information share dummy is around 80%

suggesting that the dominance of one market is very persistent. Besides, the significance level of all exchange variables has dropped but the spread ratio, volatility ratio and order imbalance ratio are still marginally significant.

[Place Table 4 and 5 here]

4.2 Cross Markets Efficiency Results

The evidence that price discovery occurs in SGX for Japan's Nikkei and India's Nifty maybe a surprise from an academic view point. Information superiority from one market implies that a less informational superior market is lagging, and therefore this may lead to possible cross-market arbitrage. However in the long-run these arbitrage opportunities should not exist. Micro-structure differences such as transaction costs and bid-ask spread may lead one market to lag continuously from the other market. Literatures on limits on arbitrage may explain why such lead and lag relationships maybe exist. For examples short selling constrains or expensive trading costs maybe preventing the arbitrageurs from correcting the current price towards to the true price. Therefore understanding reasons why one market lead or lagged the other have strong economic and policy implications. In this section, we attempt to search for empirical evidence of market inefficiency by constructing trading portfolios following certain trading strategy in-line with the information share results in sections 4 and 6.

The trading strategy used in this paper is derived from a special-case model:

$$
\begin{aligned}
P_{1,t} &= P_{1,t-1} + \varepsilon_{1,t} \\
P_{2,t} &= P_{1,t-2} + \varepsilon_{2,t} \qquad (6) \\
P_{2,t} &= P_{1,t-1} + \varepsilon_{1,t-1}\varepsilon_{2,t}
\end{aligned}
$$

The VECM model used to derive the information share measure is general, in particular the above model 6 is a special case of the VECM, and we could use information share results to construct trading strategies to exploit our main results. From model 6, we can observe that the price of a security in one market $P_{1,t}$ follows a random walk and therefore unpredictable. However, the price of the same security in the second market is tracking the price of the first market lagged two periods. We can therefore exploit this relationship as long as we can identify which market is leading and which market is lagging. From table 3 we can infer that the daily information share of one market is very sticky and does not change through time. Therefore using this information, we shall assume throughout our sample period that the Nifty futures and Nikkei futures, SGX leads NSE and OSE respectively. Given this, our trading strategy shall be the following:

Let $P_{1,t}^{Last}$ be the last futures price of the leading market at time interval t, $P_{1,t}^{First}$ be the first futures price of the leading market at time interval t, $P_{2,t}^{Last}$ be the last futures price of the lagging market at time interval t, and $P_{2,t}^{First}$ be the first futures price of the lagging market at time interval *t*. Information in time interval *t* refers to all the price information within the interval $(t-1, t]$. In this paper, trading is carried out every minute[5] from opening to closing. A buy signal is generated if the price in the leading market is higher than the price in the lagging market. This translate to $P_{1,t-1}^{Last} > P_{2,t-1}^{Last}$ and a sell signal is generated if $P_{1,t-1}^{Last} < P_{2,t-1}^{Last}$. We then compute our trading profit at the lagging market as $\pi_t = P_{2,t+1}^{First} - P_{2,t}^{First}$ if it is a buy signal and $\pi_t = P_{2,t}^{First} - P_{2,t+1}^{First}$ if it is a sell signal. This means that at time *t*-1 after we know the trading signal, we trade first available futures price at time t and clear our position at

[5]Other time intervals are used and the results are stronger if we used smaller time interval. Since some markets are not that liquid to have trades every other second, using a 1 minute trading frequency gives a more realistic test. The lead and lagged effect diminished as we use longer time interval.

time *t*+1 regardless whether we incur a profit or loss. For the cash of China and Taiwan where the underlying index is numerically different, index prices cannot be used. Instead we use their first difference, which is return, to determine the buy or sell signal. Table 6 reports the result for both the prefect information case and the predictive random walk case.

[Place Table 6 here]

From Table 6 the statistics for the perfect information and the random walk case are very similar, supporting our previous results that the information share time-series dynamics of all the countries in our sample is rather persistent. The portfolio strategy produces positive average daily returns ranging from 0.08% to 0.62%. The portfolio returns are negatively skewed and tails fatter than the normal distribution (kurtosis value greater than 3). Using the portfolio analysis, we show that empirically it is a lead and a lag market supporting our multivariate analysis results. Since our portfolio strategy assumes that we are able to trade at the bid-ask mid-point, this may not be evidence that the lagging market is inefficient. Transaction cost, trading at the spread and feasibility has to be shown to conclude that the lagging market is indeed inefficient. However for the purpose of our paper, showing the existence of a lagging market is sufficient and conclusive.

5. Conclusion

In this paper we explore the process of price discovery of four different Indices, India's Nifty Index, China's Index, Japan's Nikkei 225 Index and Taiwan's Index. These country indices are available for trading in each of their respective domestic exchanges and in Singapore's exchange (SGX). We then investigative how the SGX contributed in the process of price discovery for each of the four indices though index futures trading. Our results suggest that it is possible for the price discovery process to be occurring in a foreign country's exchange from the evidence of Nifty Index and Nikkei index. In addition, we construct portfolios to check if the measure is truly capturing a leading and lagging relation and show that positive profits is possible if we are able to trade at the bid-ask middle point. Although we are unable to reject the efficient market hypothesis from the negative profit evidence of our second portfolio where we have to buy at the ask and sell at the bid, we are still able to show that one market is truly leading the other.

Our research sheds the lights on the mechanism that drive the price discovery of index futures cross traded in different markets. The factors related to transaction cost can explain the difference in price discovery but they also suggest that arbitrage cost is high for any arbitrage trading to exploit such difference. Our research thus largely supports the market efficiency conjecture.

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Table 1: This table reports the univariate results on the daily information share ratio. The pricevector is used to compute the information share is traded price and bid-ask middle point by onesecond. Daily information share is computed and the one sided T test is used. ***, **, and *denotes statistical significance at the 1%, 5%, and 10% levels respectively.

	CNX Nifty(SGX)	CNX Nifty(NSE)	Difference	
Mean	63.02%	36.98%	26.04%	***
Std. Error	2.11%	2.11%	4.22%	
Obs	119	119	119	
	FTSE China A50 Index Futures (SGX)	CSI 300 Index Futures (CFFEX)	Difference	
Mean	22.79%	77.21%	-54.42%	***
Std. Error	1.47%	1.47%	2.94%	
Obs	123	123	123	
	Nikkei 225 (SGX)	Nikkei 225 (OSE)	Difference	
Mean	61.19%	38.81%	22.38%	***
Std. Error	1.75%	1.75%	3.50%	
Obs	95	95	95	
	MSCI Taiwan Index Futures (SGX)	TAIEX Index Futures (TAIFEX)	Difference	
Mean	25.18%	74.82%	-49.64%	***
Std. Error	1.73%	1.73%	3.46%	
Obs	127	127	127	

Table 2: This table report the summary statistics for the key variables used for each future indexes. *IS* is the information share calculated by the trades and mid quotes. *Spread* is the difference between ask and bid. *Volatility* is the mean-adjusted 5-minute index future price volatility. *Depth* is the total number of ticks by each second. *Traded Volume* is the total number of lots in thousand. *Order Imbalance* is the number of buy order minus the number of sell order within each day. ***,**, and * denotes statistical significance at the 1%, 5%, and 10% levels respectively. Panel E shows the ratio of SGX market divided by the foreign exchange market.

Panel A: CNX Nifty Index Futures (SGX)/ CNX Nifty Index Futures (NSE)					
	SGX	NSE	Difference	T-statistics	
IS	0.631	0.369	0.262	5.227	***
Spread	0.014	0.008	0.006	26.961	***
Volatility	0.025	0.025	0.000	4.907	***
Depth	8.900	31.386	-22.486	-23.545	***
Traded Volume (thousand lots)	38.737	329.734	-290.997	-18.182	***
Order Imbalance	90.864	-134.025	224.890	1.902	*
Panel B: FTSE China A50 Index Futures (SGX) / CSI 300 Index Futures (CFFEX)					
	SGX	CFFEX	Difference	T-statistics	
IS	0.213	0.787	-0.575	-13.683	***
Spread	0.060	0.010	0.052	40.219	***
Volatility	0.075	0.065	0.010	5.110	***
Depth	378.048	133.758	242.290	5.950	***
Traded Volume (thousand lots)	174.919	985.613	-810.694	-20.546	***
Order Imbalance	-121.356	54.822	-176.178	-1.484	
Panel C: Nikkei 225 Index Futures (SGX) / Nikkei 225 Index Futures (OSE)					
	SGX	OSE	Difference	T-statistics	
IS	0.618	0.382	0.236	6.146	***
Spread	0.032	0.061	-0.029	-140.000	***
Volatility	0.029	0.029	0.000	-3.412	***
Depth	54.712	585.495	-530.774	-30.526	***
Traded Volume (thousand lots)	67.237	66.507	0.730	0.547	
Order Imbalance	198.755	-148.266	347.021	3.443	***
Panel D: MSCI Taiwan Index Futures (SGX) / TAIEX Index Futures (TAIFEX)					
	SGX	TAIFEX	Difference	T-statistics	
IS	0.247	0.753	-0.506	-11.438	***
Spread	0.031	0.012	0.019	192.549	***
Volatility	0.027	0.024	0.003	6.355	***
Depth	65.509	302.249	-236.740	-29.644	***
Traded Volume (thousand lots)	38.619	107.199	-68.580	-23.698	***
Order Imbalance	121.216	-633.264	754.480	4.877	***
Panel E: Ratio					
	Obs	Mean	Std. Dev.		
Spread Ratio	455	2.928	2.296		
Volatility Ratio	455	1.103	0.234		
Depth Ratio	455	1.253	2.279		
Volume Ratio	455	0.418	0.401		
Order Imbalance Ratio	455	0.811	22.846		

Table 3: The table examines the determinants of information share. The dependent variable is *SGXinformation share*, which is the proportion of information share calculated from VECM regression specifications. *Spread Ratio* is the spread of the index futures traded on SGX divided by the spread of the index futures traded on its domestic exchange. *Volatility Ratio* is the mean-adjusted 5-minutes index futures price volatility. *Volume Ratio* is the daily traded volume of the index futures on SGX divided by the daily traded volume of its corresponding foreign index futures. *Depth Ratio* is the Depth of SGX index futures divided by the Depth of its corresponding foreign index futures. *Volume Ratio* ismeasured as the number of lots multiplied by the exchange respective lot ratio found in Table 2. *Order Imbalance Ratio* is measured as the 5 minutes net number of buy order minus the sell order. All standard errors are adjusted by Newey-West using the maximum of five orders. ***,**,and *denotes statistical significance at the 1%, 5%, and 10% levels, respectively and the t-statistics are shown in parenthesis.

SGXIS	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Lag SGXIS	0.135***	0.117***	0.137***	0.136***	0.133***	0.132***	0.114***
	(3.38)	(2.89)	(3.45)	(3.44)	(3.38)	(3.29)	(2.85)
Spread Ratio		-0.033***					-0.032***
		(-3.07)					(-2.76)
Volatility Ratio			-0.121***				-0.120***
			(-2.78)				(-2.62)
Depth Ratio				-0.007			-0.008
				(-1.32)			(-1.16)
Volume Ratio					0.022		0.046
					(0.41)		(0.71)
Order Imbalance Ratio						0.001**	0.001***
						(2.36)	(2.63)
Monday	-0.044	-0.043	-0.045	-0.046	-0.043	-0.047	-0.048
	(-1.12)	(-1.11)	(-1.17)	(-1.17)	(-1.09)	(-1.19)	(-1.25)
Tuesday	0.031	0.032	0.029	0.029	0.032	0.031	0.030
	(0.91)	(0.95)	(0.83)	(0.85)	(0.95)	(0.91)	(0.86)
Wednesday	-0.001	0.001	-0.003	-0.003	0.000	-0.001	-0.000
	(-0.03)	(0.02)	(-0.08)	(-0.08)	(0.01)	(-0.02)	(-0.01)
Thursday	0.014	0.017	0.010	0.014	0.016	0.014	0.018
	(0.40)	(0.50)	(0.30)	(0.41)	(0.45)	(0.42)	(0.53)
Constant	0.186***	0.394***	0.335***	0.216***	0.180***	0.187***	0.555***
	(5.60)	(5.58)	(5.53)	(5.62)	(5.07)	(5.63)	(6.30)
Index Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	451	451	451	451	451	451	451

Table 4: The table examines the determinants of information share. All variables are winsorized at 1% and 99% level by each future indexes. The dependent variable is *SGX information share*, which is the proportion of information share calculated from VECM regression specifications. *Spread Ratio* is the spread of the index futures traded on SGX divided by the spread of the index futures traded on its domestic exchange. *Volatility Ratio* is the mean-adjusted 5-minutes index futures price volatility. *Volume Ratio* is the daily traded volume of the index futures on SGX divided by the daily traded volume of its corresponding foreign index futures. *Depth Ratio* is the Depth of SGX index futures divided by the Depth of its corresponding foreign index futures. *Volume Ratio* is measured as the number of lots multiplied by the exchange respective lot ratio found in Table 2. *Order Imbalance Ratio* is measured as the 5 minutes net number of buy order minus the sell order. All standard errors are adjusted by Newey-West using the maximum of five orders. ***,**,and *denotes statistical significance at the 1%, 5%, and 10% levels, respectively and the t-statistics are shown in the parenthesis.

SGXIS	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Lag SGXIS	0.136***	0.118***	0.137***	0.137***	0.131***	0.132***	0.111***
	(3.41)	(2.93)	(3.48)	(3.46)	(3.33)	(3.30)	(2.83)
Spread Ratio		-0.032***					-0.030***
		(-3.04)					(-2.66)
Volatility Ratio			-0.123***				-0.124***
			(-2.81)				(-2.69)
Depth Ratio				-0.006			-0.008
				(-1.21)			(-1.16)
Volume Ratio					0.044		0.074
					(0.68)		(0.92)
Order Imbalance Ratio						0.001***	0.001***
						(2.86)	(2.91)
Monday	-0.043	-0.042	-0.045	-0.045	-0.042	-0.046	-0.047
	(-1.11)	(-1.10)	(-1.16)	(-1.16)	(-1.08)	(-1.19)	(-1.23)
Tuesday	0.032	0.033	0.029	0.029	0.033	0.032	0.030
	(0.93)	(0.96)	(0.84)	(0.87)	(0.97)	(0.93)	(0.86)
Wednesday	-0.001	0.001	-0.002	-0.002	0.001	0.000	0.001
	(-0.02)	(0.03)	(-0.07)	(-0.06)	(0.03)	(0.01)	(0.02)
Thursday	0.014	0.017	0.010	0.014	0.017	0.015	0.019
	(0.41)	(0.49)	(0.30)	(0.41)	(0.49)	(0.43)	(0.57)
Constant	0.185***	0.390***	0.337***	0.213***	0.174***	0.186***	0.546***
	(5.60)	(5.56)	(5.56)	(5.60)	(4.93)	(5.63)	(6.25)
Index Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	451	451	451	451	451	451	451

Table 5: The table examines the determinants of information share with logit regression. The dependent variable is *SGX information share dummy*, which equals to one if the information share is higher than 60% and zero if the information share is lower than 40%. Subscript t denotes trading day. *Spread Ratio* is the spread of the index futures traded on SGX divided by the spread of the index futures traded on its domestic exchange. *Volatility Ratio* is the mean-adjusted 5-minutes index futures price volatility. *Volume Ratio* is the daily traded volume of the index futures on SGX divided by the daily traded volume of its corresponding foreign index futures. *Depth Ratio* is the Depth of SGX index futures divided by the Depth of its corresponding foreign index futures. *Volume Ratio* is measured as the number of lots multiplied by the exchange respective lot ratio found in Table 2. *Order Imbalance Ratio* is measured as the 5 minutes net number of buy order minus the sell order. All standard errors are adjusted by Newey-West using the maximum of five orders. ***,**,and *denotes statistical significance at the 1%, 5%, and 10% levels, respectively and the t-statistics are shown in the parenthesis.

SGXIS Dummy	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Lag SGXIS Dummy	0.810**	0.748**	0.862**	0.818**	0.793**	0.817**	0.797**
	(2.17)	(1.97)	(2.33)	(2.20)	(2.14)	(2.18)	(2.11)
Spread Ratio		-0.283					-0.326*
		(-1.60)					(-1.72)
Volatility Ratio			-1.480*				-1.696*
			(-1.76)				(-1.86)
Depth Ratio				-0.026			-0.014
				(-0.34)			(-0.13)
Volume Ratio					0.225		0.154
					(0.52)		(0.21)
Order Imbalance Ratio						0.012	0.017*
						(1.39)	(1.75)
Monday	-0.556	-0.509	-0.529	-0.562	-0.539	-0.593	-0.507
	(-0.97)	(-0.88)	(-0.92)	(-0.98)	(-0.94)	(-1.04)	(-0.87)
Tuesday	0.472	0.527	0.517	0.466	0.488	0.482	0.619
	(1.00)	(1.08)	(1.10)	(0.99)	(1.03)	(1.03)	(1.28)
Wednesday	0.055	0.097	0.078	0.050	0.076	0.051	0.133
	(0.11)	(0.19)	(0.15)	(0.10)	(0.15)	(0.10)	(0.26)
Thursday	0.267	0.311	0.300	0.271	0.291	0.292	0.428
	(0.55)	(0.64)	(0.62)	(0.55)	(0.60)	(0.61)	(0.89)
Constant	-2.199***	-0.489	-0.476	-2.081***	-2.281***	-2.226***	1.715
	(-4.91)	(-0.48)	(-0.49)	(-3.72)	(-4.63)	(-5.15)	(1.21)
Index Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	314	314	314	314	314	314	314

Table 6: This table tabulates the portfolio trading returns for each country indexes. Perfect Information assumes that the trader knows the exact information share of the day while Random Walk implies that the trader uses the previous day information share. *Total Number of Trades* is the average number of transactions per day given that the trading frequency is 1 minute. *Average Daily Dollar Profits* is the average dollar amount a trader would get every trading day by using our strategy. *Average Daily Returns* is the returns of a fully collateralized futures contract a trader would get every trading day by using our strategy. *Return Volatility* is the standard deviation of the portfolio daily returns. Return Skewness is the skewness of the portfolio daily returns. *Return Kurtosis* is the kurtosis of the portfolio daily returns. *Max Trade Drawdown* is the maximum loss one would suffer from 1 transaction. *Max Daily Drawdown* is the maximum aggregate loss one would suffer every other trading day. *Sharpe Ratio* is computed as *Average Daily Returns* divided by *Return Volatility*.

	Perfect Information (1 min)			
	CHINA	INDIA	JAPAN	TAIWAN
Total Number of Trades	268	373	373	297
Average Daily Dollar Profits	26	7	53	2
Average Daily Returns	0.47%	0.08%	0.31%	0.62%
Return Volatility	2.80%	0.69%	0.90%	0.68%
Return Skewness	-3.229	-0.477	-0.6	-0.309
Return Kurtosis	21.324	3.700	4.195	3.319
Max Trade Drawdown	-91	-43	-140	-10
Max Daily Drawdown	-1830	-185	-428	-4
Sharp Ratio	0.169	0.120	0.341	0.913

	Random Walk (1 min)			
	CHINA	INDIA	JAPAN	TAIWAN
Total Number of Trades	268	373	373	297
Average Daily Dollar Profits	27	7	50	2
Average Daily Returns	0.49%	0.09%	0.29%	0.61%
Return Volatility	2.82%	0.69%	0.92%	0.67%
Return Skewness	-3.207	-0.495	-0.567	-0.361
Return Kurtosis	21.019	3.733	3.999	3.359
Max Trade Drawdown	-91	-43	-140	-10
Max Daily Drawdown	-1830	-185	-428	-4
Sharp Ratio	0.174	0.128	0.318	0.909

Appendix 1: Trading difference for Nikkei 225 Index Futures, MSCI Taiwan Index Futures, CNXNifty Index Futures and FTSE China A50 Index Futures trading in SGX.

Exchange	SGX		SGX	
Underlying Stock Index	**Nikkei 225 Index**		**MSCI Taiwan Index**	
Multiplier	Y500		US$100	
Minimum Price Fluctuation	Outright : 5 index points Strategy Trades: 1 index point		0.1 index points	
Settlement Procedure	Cash Settlement		Cash Settlement	
Contract Months	6 nearest serial months 20 nearest quarterly months		2 nearest serial months 12 nearest quarterly months	
Position Limit	10,000 futures or futures equivalent contracts net long or net short in all contract months combined.		10,000 futures or futures equivalent contracts net long or net short in all contract months combined.	
Trading Costs	Clearing Fee	0.04%	Clearing Fee	0.04%
	Trading Access Fee	0.0075%	Trading Access Fee	0.0075%
Trading Hours	T Session:		T Session:	
	Pre -Opening	07:30-07:43	Pre -Opening	08:30-08:43
	Non -Cancel Period	07:43-07:45	Non -Cancel Period	08:43-08:45
	Opening	07:45-14:25	Opening	08:45-13:45
	Pre-Closing	14:25-14:29	Pre-Closing	13:45-13:49
	Non-Cancel Period	14:29-14:30	Non-Cancel Period	13:49-13:50
	T+1 Session:		T+1 Session:	
	Pre -Opening	15:00-15:13	Pre -Opening	14:20-14:33
	Non -Cancel Period	15:13-15:15	Non -Cancel Period	14:33-14:35
	Opening	15:15-02:00	Opening	14:35-02:00

Exchange	SGX		SGX	
Underlying Stock Index	**CNX Nifty Index**		**FTSE China A50 Index**	
Multiplier	US$2		US$1	
Minimum Price Fluctuation	0.5 index points		5 index points	
Settlement Procedure	Cash Settlement		Cash Settlement	
Contract Months	2 nearest serial months		2 nearest serial months	
	4 nearest quarterly months		4 nearest quarterly months	
Position Limit	25,000 futures or futures equivalent contracts net long or net short in all contract months combined.		15,000 futures or futures equivalent contracts net long or net short in all contract months combined.	
Trading Costs	Clearing Fee	0.04%	Clearing Fee	0.04%
	Trading Access Fee	0.0075%	Trading Access Fee	0.0075%
Trading Hours	T Session:		T Session:	
	Pre -Opening	08:45-08:58	Pre -Opening	08:45-08:58
	Non -Cancel Period	08:58-09:00	Non -Cancel Period	08:58-09:00
	Opening	09:00-18:10	Opening	09:00-15:55
	Pre-Closing	18:10-18:14	Pre-Closing	15:55-15:59
	Non-Cancel Period	18:14-18:15	Non-Cancel Period	15:59-16:00
	T+1 Session:		T+1 Session:	
	Pre -Opening	19:00-19:13	Pre -Opening	16:30-16:38
	Non -Cancel Period	19:13-19:15	Non -Cancel Period	16:38-16:40
	Opening	19:15-02:00	Opening	16:40-02:00

Appendix 2: Trading difference for Nikkei 225 Index Futures, MSCI Taiwan Index Futures, CNXNifty Index Futures and FTSE China A50 Index Futures trading in their home exchanges

Exchange	**Osaka Stock Exchange**		**Taiwan Futures Exchange**	
Underlying Stock Index	**Nikkei 225 Index**		**TAIEX Index**	
Multiplier	Y1000		NT$200	
Minimum Price Fluctuation	0.01 index points		1 index points	
Settlement Procedure	Cash Settlement		Cash Settlement	
Contract Months	Jun and Dec: 10 nearest contract months		2 nearest serial months	
	Mar and Sep: 3 nearest contract months		3 nearest quarterly months	
Position Limit	N.A.		Individual	5,000
			Institution	10,000
			Proprietary Trader	30,000
Trading Costs	Clearing Fee (Proprietary)	Y20	Transaction Fee	NT$12
	Clearing Fee (Customer)	Y20	Clearing Fee	NT$8
	Trading Fee (Proprietary)	Y70	Settlement Fee	NT$8
	Trading Fee (Customer)	Y110	Futures Transaction Tax	0.0002%
Time Zone Difference	1 hour ahead		Same as stock market	
Trading Hours	Day Session		Regular Trading Days	
	Pre-Opening	08:00-09:00	Trading Hours	08:45-13:45
	Regular Session	09:00-15:10		
	Pre-Closing	15:10-15:15		
	Night Session			
	Pre-Opening	16:15-16:30		
	Regular Session	16:30-02:55		
	Pre-Closing	02:55-03:00		

Exchange	National Stock Exchange of India		China Financial Futures Exchange	
Underlying Stock Index	**CNX Nifty Index**		**CSI 300 Index**	
Multiplier	Re.1		CNY 300	
Minimum Price Fluctuation	0.5 index points		0.2 index point	
Settlement Procedure	Cash Settlement		Cash Settlement	
Contract Months	3 nearest serial months		2 nearest serial months	
			2 nearest quarterly months	
Position Limit	15% of the total open interest		Unilateral position limit: 100 Lots	
Trading Costs	Transactions Tax(SELL only)	0.01%	Trading Fee	CNY 30
	Transaction Charges	0.00185%		
	SEBI Turnover Charges	0.0001%		
	Stamp Duty	0.002%		
Time Zone Difference	2:30 hour later		Same as stock market	
Trading Hours	Regular Trading Days		Regular Trading Days	
	Normal Market	09:15-15:30	First Session	09:15-11:30
	Setup Cut-off Time	16:15	Second Session	13:00-15:15
	Trade Modification	16:15		

Appendix 3: This table reports the relative percentage of transacted index futures by the size of the lot in each exchange. (i.e. 27.92 % means that 27.92% of the CNX Nifty Index futures traded on the Singapore Exchange are less than or equal to 2 lots.) All lot sizes for the foreign index futures are scaled such that they are comparable if they are traded at SGX instead. The last column, Ratios, shows the difference between 1 lot sold on SGX against 1 lot sold on the foreign exchange.(i.e. NSE Ratio of 0.21 implies that a lot sold on the NSE is 0.21 times the size of a lot sold on SGX.) SGX: Singapore Stock Exchange, NSE: National Stock Exchange of India, CFFE: China Financial Futures Exchange, OSE: Osaka Stock Exchange, TFE: Taiwan Futures Exchange.

			Lot Size			
Nifty						
Lots	<=2	3 to 5	6 to 10	11 to 20	>20	Lot Ratio
SGX	27.92	18.55	15.47	14.28	23.79	1.00
NSE	59.11	20.87	9.94	5.79	4.28	0.21
A50 / CSI300						
Lots	<=2	3 to 5	6 to 10	11 to 20	>20	Lot Ratio
SGX	41.73	23.45	17.52	10.62	6.69	1.00
CHINA	0.00	0.00	0.00	3.30	96.70	15.68
Nikkei 225						
Lots	<=2	3 to 5	6 to 10	11 to 20	>20	Lot Ratio
SGX	73.31	17.28	6.51	1.99	0.92	1.00
JAPAN	42.28	18.63	17.27	9.60	12.21	2.00
MSCI/TAIEX						
Lots	<=2	3 to 5	6 to 10	11 to 20	>20	Lot Ratio
SGX	76.97	16.77	4.75	0.98	0.53	1.00
TAIWAN	58.06	16.57	15.86	6.14	3.38	1.76