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The Microstructure Behavior of SGX Nikkei 225 Index Futures Resulting from Component Changes of the Underlying Cash Market Index

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บทคัดย่อ

งานวิจัยนี้ศึกษาผลกระทบของการเปลี่ยนแปลงที่เกี่ยวข้องกับหุ้นในองค์ประกอบของดัชนีหุ้นนิกเกอิ 225 ต่อพฤติกรรมของดัชนีหุ้นนิกเกอิ 225 ฟิวเจอร์ส โดยเฉพาะการตรวจสอบหาผลกระทบจากการเปลี่ยนแปลง ปริมาณการซื้อขาย (volume) อัตราผลตอบแทน (return) ค่าความผันผวน (volatility) และช่องห่างระหว่างราคาเสนอซื้อกับราคาเสนอขาย (BAS) ของหุ้นในองค์ประกอบของดัชนีหุ้นนิกเกอิ 225 ต่อสัญญาซื้อขายล่วงหน้าของดัชนีหุ้นนิกเกอิ 225 ที่ทำการซื้อขายอยู่ในตลาดหลักทรัพย์สิงคโปร์ (SGX) ผลการวิจัยพบว่ามีการเพิ่มขึ้นของปริมาณการซื้อขาย และช่องห่างระหว่างราคาลดลง แต่ไม่มีการเปลี่ยนแปลงอย่างมีนัยสำคัญของอัตราผลตอบแทนของดัชนีหุ้นนิกเกอิ 225 ฟิวเจอร์สในตลาดหลักทรัพย์สิงคโปร์ หลังจากที่มีการเปลี่ยนแปลงเกิดขึ้นในหุ้นองค์ประกอบของดัชนีหุ้นนิกเกอิ 225 การพบนี้ไม่สนับสนุนสมมติฐานเรื่องแรงกดดันต่อราคา (Price Pressure Hypothesis) ซึ่งระบุว่าการเพิ่มขึ้นของราคาหุ้นหลังจากที่หุ้นนั้นกลายเป็นองค์ประกอบใหม่ในดัชนีหุ้นเป็นเพียงการเพิ่มขึ้นชั่วคราว โดยต่อมาราคาหุ้นนั้นค่อยคืนกลับดังเดิม (Vespro, 2006; Harris and Gurel, 1986; Lynch and Mendenhall, 1997) และมีการพบหลักฐานที่อ่อนแอว่าค่าความผันผวนของดัชนีลดลง การค้นพบนี้ตรงกันข้ามกับผลงานวิจัยของ Vespro (2006) และ Lynch and Mendenhall (1997)

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ABSTRACT

We study the effect of changes involving component stocks of the Nikkei 225 stock index on the behavior of the Nikkei 225 index futures. Specifically, we examine the effects of component changes of the Nikkei 225 on the volume, returns, volatility, and bid-ask spreads (BAS) on its corresponding futures contract traded on the Singapore Exchange (SGX). We find that trading volume increases and the bid-ask spread decreases but there is no significant change in the returns of the SGX Nikkei 225 index futures after a component change takes place. This does not support the Price Pressure Hypothesis, which states that the increase in price of a stock after it is newly added into a stock index is only temporary and gradually reverts (Vespro, 2006; Harris and Gurel, 1986; Lynch and Mendenhall, 1997). We find weak evidence that volatility decreases, contrary to the findings of Vespro (2006) and Lynch and Mendenhall (1997).

JEL Classifications: G13, G15.

Key Words: Nikkei 225 Futures; Component Changes; Singapore Exchange.

1. INTRODUCTION

Many studies identify the effects of an event change, such as Erwin and Miller (1998) and Shankar and Miller (2006), who find that a component change increases the trading volume and returns of a stock index. Others, like those of Herbst, McCormack, and West (1987) and Kawaller, Koch, and Koch (1987), show how a domestic futures market is a leading indicator of the stock market. However, little has been done to show how event changes of a stock index in a domestic market affect the futures contract of the index in a foreign market. For example, how does a component change in the Nikkei 225 stock index affect the Nikkei 225 index futures in Singapore?

The primary objective of this study is to determine whether event changes on the Tokyo Stock Exchange (TSE) affect the underlying market microstructure of the Nikkei 225 index futures traded on the Singapore Exchange (SGX). In particular, we examine the impact of component changes of the Nikkei 225 stock index in Japan on the volume, returns, volatility, and bid-ask spreads (BAS) of the SGX Nikkei 225 index futures.

There have been numerous occurrences of component stock changes in the Nikkei 225 stock index. Through news services such as *Jiji Press English News Service*[1] and *The Wall Street Journal*[2], it is reported that component stock changes of the Nikkei 225 stock index have led to increased trading in the Japanese stock market. We aim to find the effects that these component changes have on the Nikkei 225 stock index on the whole, and link it back to the subsequent effects they have on the Nikkei 225 index futures on SGX.

Erwin and Miller (1998) and Shankar and Miller (2006) find that whenever there has been a component stock change in a particular index, and whenever there has been an addition to the stock index, the stock in question experiences an increase in its trading volume and stock price. These increases would in turn impact the trading volume and price changes of the stock index.

We explore whether or not event changes in the cash market would affect the microstructure (volume, returns, volatility, and bid-ask spreads) of the futures market. We do this in the context of a satellite market (Covrig, Ding, and Low, 2004). We want to observe if there is a pattern that suggests whether an occurrence of an event affects the microstructure

[1] Publication of Japan http://eng.jw.jiji.com/, 24 Apr 2000 P.16
[2] Wall Street Journal (Eastern Edition), 24 Apr 2000. P.16

of the futures market. We focus on the Japanese financial market as it is one of the world's leading markets.[3] We expect to see an impact on Japanese-linked securities in an offshore market should there be any event changes on the TSE. We also look at the SGX Nikkei 225 index futures because it is the most heavily traded contract on the SGX.[4] The results of the study would allow investors to further understand how event changes on the TSE would affect the microstructure of the SGX futures market. This, in turn, would help traders to better predict the direction and the magnitude of any price and liquidity changes whenever an event change occurs on the TSE. Hence, traders would be able to make more informed decisions on their investments in the Nikkei 225 index futures on the SGX.

As a result of component changes on the Nikkei 225 stock index on the TSE, we find that trading volume increases, suggesting that component changes in the Nikkei 225 stock index has an immediate spillover effect on the trading volume of the SGX Nikkei 225 index futures. We also observe that BAS of the index futures decreases, suggesting improved market liquidity. However, component changes have insignificant effect on the returns and volatility of the SGX Nikkei 225 index futures.

The remainder of this paper is organized as follows. Section II provides important background information about the TSE and the Nikkei 225 futures on SGX. Section III provides a review of prior studies on component changes of stock indices, leading to the development of the theoretical framework and proposal of four hypotheses. Section IV describes the data and research methodology employed. In Section V, we present the findings regarding the impact of component changes in the Nikkei 225 stock index on TSE on the volume, returns, volatility, and bid-ask spreads of the SGX Nikkei 225 index futures. Finally, in Section VI, a summary of the research and concluding remarks are provided.

[3] Market capitalization of over 4 trillion USD, the TSE is second only to the New York Exchange.
[4] Total volume of over 15 million from Jan 06-Oct 06, it represents approximately 50% of the total futures and Options volume traded on the SGX.

2. INSTITUTIONAL BACKGROUND MARKETS

2.1 Tokyo Stock Exchange[5]

The Tokyo Stock Exchange (TSE) is one of the most active exchanges, trading an average of 2,281 million shares per day, in 2005. It operates from 9:00 to 11:00 am, and from 12:30 to 3:00 pm, Tokyo time. It is the largest of five exchanges in Japan, but with 2,419 companies listed as of February 2007. Stocks listed on the TSE are assigned to one of three markets: the First Section, Second Section, or Mothers (market of the high-growth and emerging stocks). The most stringent listing criteria must be met for the First Section and all newly listed stocks begin on the Second Section. Stocks of high growth, emerging companies are listed on the Mothers market.

Since April 30, 1999, the TSE uses an electronic, continuous auction system of trading, where brokers place orders online and, when a buy and a sell price match, the trade is automatically executed. Deals are made directly between buyer and seller, rather than through a market maker. On the TSE, price controls are implemented so that the price of a stock cannot rise or fall below a certain point throughout the day. These controls are used to prevent dramatic swings in prices that may lead to market uncertainty or stock crashes. If a major swing in price occurs, the exchange can stop trading on that stock for a specified period of time. To prevent wild short-term fluctuations in prices, the TSE adopts various measures, such as special bid and ask quotes, daily price limits, and a cap on the trading units. These measures not only help ensure price continuity, but also work as “circuit breakers” in an emergency.

When a major order imbalance occurs, special bid or asked quotes are indicated. Special quotes are disseminated publicly through the TSE market information system. If counter orders come into the market and the orders are matched at that price, the quote is withdrawn. Conversely, if the imbalance continues, the special quotes are revised up or down within certain parameters (see Appendix A), at intervals of five minutes until the imbalance are resolved.

In addition, the TSE sets daily price limits for individual stocks to prevent day-to-day wild swings in stock prices and provide for “time-out” in the event of a sharp rise or decline in price and the resulting reaction from the investing public. Daily price limits are set in terms

[5] Details on TSE can be obtained from the TSE website at http://www.tse.or.jp/english/

of absolute yen values according to the price range of each stock (see Appendix A). As price limits prohibit bids and offers at prices beyond the set limits, the market for a stock is open for trading within these limits, even though the stock might have hit a limit. Daily price limits also apply to special quotes. Consequently, special quotes cannot be indicated outside the daily price limit.

Trading units are the minimum amount of each individual stock that may be traded. With an amendment made to the commercial code in October 2001, the number of shares which constitute one unit may now be determined under the constitution of each listed company. TSE has been working to encourage listed companies with large prices and large trading units to lower the size of their trading units to provide increased accessibility for individual investors (see Appendix B).

2.2 Nikkei 225 Futures on the SGX[6]

Since October 2, 2006, the Singapore Exchange (SGX) has gone fully electronic where open positions are marked-to-market on a daily basis using the daily settlement price determined by SGX. The Futures Trading Act of 1986 governs futures trading in Singapore. SGX also regulates with its own set of rules and regulations.

The Nikkei 225 futures contract on the SGX was the world's first Japanese stock index futures. It is a price-weighted index that is calculated based on the prices of 225 stocks listed on the First Section of the TSE. Since its inception, the contract has shown tremendous growth, and is the most active futures contract traded on SGX, with a total volume of 15,387,162 million from January to October 2006. This represents approximately 50% of the total futures and options volume traded on SGX.

Trading hours for the Nikkei futures start from 7:55 am to 10:15 am and continue from 11:15 am to 2:25 pm daily (Singapore time). Contracts expire in the three nearest serial months as well as on a five quarterly-month cycle (March, June, September, and December). The last trading day for a particular contract is the day before the second Friday of the contract month. The size of each contract is ¥500 times the Nikkei 225 index futures price. The minimum price fluctuation is five points (one tick) or ¥2,500. The final settlement price is calculated using the opening prices of each component issue in the index on the business

[6] Details on SGX and the contract specifications of the Nikkei 225 Stock Index Futures can be obtained from the SGX website at http://www.sgx.com.sg

day following the last trading day. Delivery under the Nikkei Stock Average contract is by cash settlement. A trader is not permitted to control more than 10,000 contracts net long or short in all contract months combined. Table 1 shows the contract specifications governing the trading of SGX Nikkei 225 futures market.

The SGX stipulates the rules governing the trading of the Nikkei 225 futures. This includes a two-tier system for the daily price limits is imposed on the Nikkei 225 futures, where trading is constrained by two sets of limits: the initial upper and lower limits and the final upper and lower limits. The initial upper (lower) limit refers to a price 5% above (below) the previous trading day's settlement price for the Nikkei 225 futures contract. Similarly, the final upper (lower) limit refers to a price of 10% above (below) the previous trading day's settlement price. Since September 25, 1995, the two-tier system was broadened to 7.5% and 12.5% for the initial and final limits, respectively.

SGX Futures Trading Rules on *Price Limits and Cooling-Off* state that "The Exchange may prescribe, for certain contracts, price limits which are designed to temporarily restrict trading when the market(s) becomes volatile. "Price Limit" refers to the maximum price advanced or declined from the previous trading day's settlement price permitted during one trading session, as provided under the relevant contract specifications. If, in the course of any trading day, the price for any contract reaches any of its price limits, the Exchange may signal a cooling-off period. "Cooling-Off Period" means a period of ten minutes or any other period as set forth in the relevant contract specifications during which each contract may be traded at or within its price limits. Trading may resume upon the lapse of the Cooling-Off Period, for the remainder of the trading day."

3. LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

3.1 Component Changes of Stock Indices

Major stock indices are subjected to periodic reviews on the component stocks that they hold. Erwin and Miller (1998) have shown that a new addition into the S&P 500 stock index would result in the newly added stock experiencing a decrease in BAS, and increase in its trading volume and stock price. This signifies an increase in liquidity of the stock that has been added into a stock index, brought about by informational efficiencies achieved via index arbitrage trading.

Whenever a stock is added into a stock index, another stock which was previously included in the index would be taken out and be replaced by the new stock. The effects on prices and volume of a stock which has been removed from a stock index are generally the opposite of what is experienced by the stock that has been added into the index (Shankar and Miller, 2006). For example, while price and volume increase after a stock is added into an index, these two factors decrease for the stock that is removed from the index.

Shankar and Miller (2006) studied the S&P SmallCap 600 Index and found that firms that are added into an index experience a significant price increase at announcement, while trading volume and institutional ownership increase after announcement. However, these price and volume effects are temporary and will be reversed within 60 days. This is consistent with the *Price Pressure Hypothesis*, which states that the increase in price of a stock after it is newly added into a stock index is only temporary and gradually reverts (Vespro, 2006; Harris and Gurel, 1986; Lynch and Mendenhall, 1997). The Price Pressure Hypothesis assumes the Efficient Market Hypothesis, which holds that long-run demand curves are perfectly elastic but allows short-run demand curves to be less elastic and slope downwards temporarily. In contrast, Shleifer (1986) proposed the *Downward Sloping Demand Curve Hypothesis* which argues that the price increase after addition is permanent and driven by increased demand in the presence of downward sloping demand curves.

Liu (2000), who did a study on the Nikkei 500 Index, also found that prices increase significantly when stocks are added, with no significant post-event reversals, supporting the Downward Sloping Demand Curve Hypothesis. Trading volume, however, increases in the short run but declines significantly in the long run. However, other researchers have hypothesized that the permanent price increase may be the result of new information signaled by the change in index, rather than a downward sloping demand curve.

Taking all perspectives into account, we believe that component stock changes of the Nikkei 225 stock index will lead to changes in the volume, returns, volatility and bid-ask spreads of the stock index. We want to find out if these changes will subsequently affect the SGX Nikkei 225 index futures. As such, our first research question is: *How do changes in the component stocks of the Nikkei 225 stock index on the TSE affect the Nikkei 225 index futures on SGX?* Figure 1 gives a brief summary of the hypotheses that we have formulated based on component changes in the stock index.

Trading Volume and Returns

Shankar and Miller (2006) and Erwin and Miller (1998) have found that when there is a component change in a stock index, the index will experience an increase in trading volume and returns. This finding is further supported by Liu (2000), who studied the Nikkei 500 stock index. We want to extend these studies to investigate how component changes in a stock index affects the trading volume and returns of its futures contracts in a foreign market. We expect the increases in trading volume and prices to hold for the futures market, as shown in the hypotheses below:

Hypothesis 1: Component changes will lead to an increase in trading volume of the Nikkei 225 index futures on SGX.

Hypothesis 2: Component changes will lead to a change in returns of the Nikkei 225 index futures on SGX.

Volatility

Vespro (2006) found that whenever a component change occurs in the French and UK stock markets, positive abnormal returns were observed by the markets on and after the announcement day of the component change, leading to a change in volatility of the markets. This is supported by Lynch and Mendenhall (1997), who found similar results with the S&P 500 index. We want to determine if the change in volatility also occurs in the Nikkei 225 index and whether there is a subsequent impact on the Nikkei 225 futures on the SGX. Thus, we investigate the following hypothesis:

Hypothesis 3: Component changes will lead to a change in volatility of the Nikkei 225 index futures on SGX.

Bid-Ask Spreads

Erwin & Miller (1998) found that bid-ask spreads significantly decreases when a stock has been added into the S&P 500 Index. This is due to an increase in stock liquidity due to informational efficiencies. This view is supported by Hegde and McDermott (2003). We expect this result to hold in the Nikkei 225 stock index and we want to find out if the index futures will have a similar effect.

In addition, Amihud and Mendelson (1986) study the effect of securities' bid-ask spreads on their returns. They show that, among other results, average returns are an increasing function of the bid-ask spread and that asset returns, increase with the spread. Since we expect trading volume of the Nikkei 225 index futures on SGX to increase upon a component change, thus resulting in higher liquidity, we expect the following hypothesis to hold:

Hypothesis 4: Component changes will lead to a decrease in bid-ask spreads of the Nikkei 225 index futures on SGX.

4. DATA AND METHODOLOGY

4.1 Data

The time period of our study spans from April 2002 to March 2003. Over this period, the Nikkei 225 started from 10,812.00 points and quickly moved up to peak at 11,979.85 points on May 23, 2002, then zig-zagged downward and reached the bottom at 7,862.43 points on March 11, 2003. The high volatility over the study period captures the sentiment of futures traders switching back and forth between optimism and pessimism. It provides an ideal condition for a stress test to investigate the effect of index changes on the microstructure behavior.

The data used in the analysis are extracted from the SGX Tick Data & Statistics. This data shows the time-stamped tick-by-tick bid, ask, traded, and settlement prices for every trading day, and also the daily trading volume for each contract of the SGX Nikkei 225 index futures. We identify every component change of the Nikkei 225 stock index from April 1, 2002, to March 31, 2003, using data obtained from the TSE which shows the dates and companies added or removed from the Nikkei 225 stock index, whenever there is a component change. We also study the subsequent effect on the volume, returns, volatility and BAS of the Nikkei 225 stock index as well as that of the Nikkei 225 index futures on SGX. Due to lack of information on when the announcement of component change was made known to the public, we will identify the day where the component stocks change takes effect. We will look at the volume, returns, volatility, and BAS and then compare it with that of the days before and after the effective day of change.

In order to determine the cut-off date for each contract, we first examine the daily trading volume of the next two nearest contracts. For instance, on April 1, 2002, the start of our study period, we retrieve the daily trading volume for the June 2002 and September 2002 contracts until the last trading day of the June 2002 contract, which is one day before the second last Friday of June 2002. All contracts expire on the second Friday of the contract month. In this case, the June 2002 contract expires on June 14, 2002, and the last trading day is on June 13, 2002. Hence from June 14, 2002, onwards, both the September 2002 and December 2002 contracts will be included. The above procedure is repeated till March 31, 2003.

After examining the daily trading volume, we found that the cross-over to the next contract occurs on the last trading day of the contract. Cross-over is identified when on a particular day; there is a big shift in the trading volume from the nearest contract to the next nearest contract. Hence for each particular contract, we collect the data till the second last day before the expiration of the contract. Continuing from the above example, we found that the cross over to September 2002 contract occurs on June 13, 2002. Hence for the June 2002 contract, data is collected till June 12, 2002.

Descriptive statistics of the volume, returns, volatility, and BAS of the Nikkei 225 index futures on SGX are shown in Table 3. We have included the various combinations of data, ranging from cumulative data of five days before to five days after the effective component change date. In our descriptive statistics, we have included the number of observations (N), the minimum and maximum values, and the standard deviation of the volume, returns, volatility and BAS of the data we have compiled.

From Table 3, we see that the five-minute trading volume increases on the day of the component change itself, while the five-minute returns and volatility seem to fluctuate throughout the ten days of observation. However, five-minute time-weighted BAS seems to decrease after a component change date. The charts which show the daily movement of the five-minute volume, returns, volatility and BAS, using data from our descriptive statistics, can be seen in Figure 2.

4.2 Methodology

4.2.1 Component Changes

We identify the dates where the Nikkei 225 stock index experiences a component change. We then run one-sample t-tests on the data of the SGX Nikkei 225 futures contract that accounts for five trading days before against the five trading days after the component change, in order to compare the means of volume, returns, volatility, and BAS across these days. We then expand our test to compare different combinations of the number of trading days, using the same one-sample t-tests, against different combinations of the number of trading days after a component change date.[7] We compare the different combinations of the number of trading days because a significant change in volume, returns, volatility, and BAS may occur on individual days or across a shorter period (e.g., four days before or after a component change), instead of across a period of five days.

Volume

According to Ma et al. (1989a, 1989b), trading volume is a proxy for liquidity. Even though Ma et al. (1989a, 1989b) used this test to calculate trading volume for price limit hits, we adopt their method to study trading volume before and after a component change day. As transaction-by-transaction trading volume is not available from the SGX Tick Data & Daily Statistics, the mean volume per trade for every limit move is estimated. The number of transacted prices for each business day is used as an indication of the number of trades per day (m_j). In the day where a j-th component change occurs, the mean volume per trade is estimated by dividing the daily traded volume (VOL_j) by the total number of trades in that day (m_j). The trading volume in the t-th five minutes interval of the j-th component change ($vol_{t,j}$) is then approximated by multiplying the number of trades in that five minutes interval ($S_{t,j}$) by the mean volume per trade. The traded volume in a five-minute interval is defined as:

$$vol_{t,j} = \frac{VOL_j}{m_j} s_{t,j} \tag{1}$$

Across n event changes, the mean volume traded for every five-minute interval ($MVOL_t$) is calculated by:

$$MVOL_t = \sum_{j=1}^{n} vol_{t,j} / n \tag{2}$$

Returns

We study the returns of the SGX Nikkei 225 index futures per five-minute interval as well. We calculate the returns using the formula:

$$r_t = (\frac{p_t - p_{t-1}}{p_{t-1}} \cdot 100\%) \tag{3}$$

[7] Refer to Table 4-7 for the different combinations of trading days.

where r_t denotes the return at the *t*-th five-minute interval; p_t is the value of the SGX Nikkei 225 index futures on day *t* and $p_{t-1-}$is the value of the index futures on day *t-1*.

Volatility

We use an approach similar to that used by Kim and Rhee (1997), where volatility is captured by the square of the minute-by-minute returns. However, instead of minute-by-minute returns, we will observe the returns in five-minute intervals.

$$r_{t,j}^2 = (\frac{p_{t,j} - p_{t-1,j}}{p_{t-1,j}} \times 100)^2 \tag{4}$$

where $r_{t,j}$ denotes the return at the t-th minute of the *j*-th event change when put into effect, $p_{t,j}$ and $p_{t-1,j}$ denote the last traded price at the *t*-th and *(t-1)*-th minute of the *j*-th component stock change when put into effect respectively. The mean volatility (MR_t) at the *t*-th minute is defined as:

$$MR_t = \sum_{j=1}^{n} r_{t,j}^2 / n \tag{5}$$

where $r_{t,j}^2$ is as defined above and *n* is the number of event changes during the sample period.

Bid-Ask Spreads

$$BAS = Bid - Ask \tag{6}$$

Following McInish and Wood (1992), the time-weighted BAS for every five-minute interval during the trading day is then computed as:

$$\sum_{i=0}^{N} \frac{BAS_i(t_{i+1} - t_i)}{(T' - T)} \tag{7}$$

where in the interval (*T, T'*), there are *N* quotation updates, occurring at times t_i, *i* = 1,..., *N*, with spreads BAS_i, *i* = 1,..., *N*. For each trading day before and after a component change, a time series of the five-minute time-weighted BAS is constructed. The time-weighted BAS measures the average spread based on the length of time each quote remains outstanding.

In this case, five-minute time-weighted BAS is used instead of five-minute closing BAS because this allows us to better examine the intraday BAS. Five-minute time-weighted BAS takes into account every intraday change in BAS, unlike five- minute closing BAS, which only includes the first and last BAS of every five-minute interval.

5. RESULTS

Table 4 shows the results for the effect of component changes on the five-minute volume, returns, volatility and BAS of the Nikkei 225 index futures on SGX. We also discuss the inferences of the findings and offer some implications of the results.

5.1 Volume Effects of Component Change

Our results show that the average five-minute volume of the SGX Nikkei 225 index futures for the five days after the component change is significantly higher, at 1% significance level, than the five days before the component change, with a mean difference of 31.49. This is seen in Table 4, where we compare the trading days (t-5, t-1) against (t+1, t+5). This supports Hypothesis 1 which states that trading volume of the Nikkei 225 index futures increases after a component change. This is also in line with the findings of Erwin and Miller (1998), and Shankar and Miller (2006).

Subsequently, we use different combinations to compare the five-minute volume of the days before the component change to the five-minute volume of days after the component change. We find that a component change leads to an immediate increase of volume on day t itself, with a mean difference of 66.52, which is significant at the 1% level. This suggests that component changes in the stock index on the TSE have an immediate spillover effect on the trading volume of the index futures on SGX. We also find that the volume on day t+1 and days (t+1, t+2) is either lower or around the same level as that of the days prior to the component change,[8] before rising again on t+3 onwards.

One possible explanation for this phenomenon is that investors overreact on the effective day of the component change and thus trading volume increases very significantly. Following that, during the period (t+1, t+2), the market starts to cool down from the

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[8] The differences between the volume of both periods t+1 and (t+1, t+2) when compared to the volume prior to the component change are, however, not significant at the 5% significance level (with the exception of (t-4, t-1):(t+1, t+2), which is significant at a 5% level).

over-trading on the effective day of component change, and on days (t+3, t+4) and (t+3, t+5), the market stabilizes at a significantly higher level of trading volume, at the 1% significance level.

When we run our tests to compare the trading volume of single days, we find that the volume on day t, when compared to the days before the component change, is significantly higher at the 1% level, indicating that the effect of the component change on volume takes place on day t itself. Overall, our results are in line with those found by Shankar and Miller (2006) and Liu (2000), who found that trading volume does experience an increase with component changes in the stock index.

5.2 Returns Effects of Component Change

The results in Table 4 show that the average five-minute returns of the SGX Nikkei 225 index futures for the five days after the component change is not significantly different, at the 5% significance level, from the five days before the component change. This implies there are no significant increases in the five-minute returns of the Nikkei 225 index futures on SGX across the period of five days after a component change, contrary to what we have suggested in Hypothesis 2, which states that a component change will lead to a change in the returns of the Nikkei 225 index futures on SGX.

We also compared the different combinations of the five-minute returns before the component change day to the five-minute returns of the days after the component change. Similarly, we find no significant results. This finding is further emphasized when we compare the data for individual dates against each other. Thus our findings do not support Hypothesis 2, which states that a component change will lead to a change in the returns of the Nikkei 225 index futures on SGX.

This may be explained by the Price Pressure Hypothesis suggested by Shankar and Miller (2006), which states that the increase in price of a stock after it is newly added into a stock index, is only temporary and gradually reverts. In our study, this reversion may have occurred within the component change date itself. Hence the short-term impact on the stock index is not significant enough to cause an increase in price of the index futures. Alternatively, it could be because the price changes have already occurred when the news of the component change was announced instead of the effective date of change.

5.3 Volatility Effects of Component Change

Results for volatility shown in Table 4 show that the average five-minute volatility of the SGX Nikkei 225 index futures for the five days after the component are marginally lower[9] than the five days before the component change. This provides weak evidence in light of Hypothesis 3, which states that a component change will lead to a change in the volatility of the Nikkei 225 index futures on SGX.

Our results contradict with those done by Vespro (2006) and Lynch and Mendenhall (1997), who found that volatility increases after a component change in the stock market. We find this occurrence in our results only on day t+1, but the increase is not significant at the 5% significance level. Our results also show that volatility actually decreases on t, and from t+2 onwards. This finding that volatility decreases from t+2 onwards is further backed up when we compare the volatility between individual dates, and find that volatility on t+2 is significantly lower as compared to dates before the component change.

One explanation for our finding is that a decrease in volatility is consistent with a lower level of risk. This could be so as each time there is a component change; investors associate it with an improvement of the quality of the stock index thus lowering its risk. This is also consistent with our finding that the BAS decreases after the component change, as a decrease in risk would in turn lead to a decrease in BAS (Erwin and Miller, 1998).

Another cause for the decrease in volatility after a component change occurs is that price changes have already occurred when the news of the component change was announced, instead of the effective date of change; hence a change in volatility would have occurred during the announcement date.

One other reason for our findings is that the increase in trading volume of the index futures did not lead to a significant increase in the fluctuation of the futures prices. Thus, the volatility of the Nikkei 225 index futures on SGX is not expected to show a significant change as our volatility measure is derived from the returns of the futures contract.

5.4 Bid-Ask Spreads Effects of Component Change

Results in Table 4 show that the average five-minute time-weighted BAS of the SGX Nikkei 225 index futures for the five days after the component change is significantly lower, at the 1% significance level, with a mean difference of -0.08, than the five days before the component change. This supports Hypothesis 4, which states that a component change will lead to a decrease in the BAS of the Nikkei 225 index futures on SGX. Our results

[9] This test is almost significant based on the 5% significance level, with a p-value of 0.056

support the findings of Erwin & Miller (1998), who also found that bid-ask spread significantly decreases when a stock has been added into the S&P 500 Index. Our results are also consistent with the predictions of Amihud and Mendelson (1986) that trading volume (liquidity) increases while the bid-ask spread decreases.

We also compared the five-minute time-weighted BAS on various days before the component change day to the five-minute time-weighted BAS of the days after the component change. We found that five-minute time-weighted BAS decreases after the component change. However, not all the decreases are significantly lower.

When we run the tests to compare the five-minute time-weighted BAS of individual dates, we find that five-minute time-weighted BAS decreases from day t-5 onwards. This is consistent with the increase in volume after day t-5, which will in turn leads to increased liquidity and therefore narrower BAS.

Thus, our results imply that the spillover effect of the trading volume described earlier is significant and substantial enough to cause a significant decrease of the BAS of the Nikkei 225 index futures on the SGX.

6. SUMMARY AND CONCLUDING REMARKS

The objective of this study is to determine whether event changes in the Tokyo Stock Exchange (TSE) affect the underlying market microstructure of the Nikkei 225 index futures traded on the Singapore Exchange (SGX). Specifically, we want to investigate how component changes of the underlying Nikkei 225 stock index affects the volume, returns, volatility, and BAS of the Nikkei 225 index futures on the SGX.

We then use the data from the SGX Tick Data & Statistics to calculate the five-minute volume, returns, volatility and five-minute time-weighted BAS of the Nikkei 225 index futures on SGX for the period of five days before and after a component change day. The volume, returns, volatility and BAS data are grouped into different combination of periods and put through one-sample t-tests to compare the means of these different groups.

In our study, we have found out that component changes of the Nikkei 225 stock index have marginal effect on the SGX Nikkei 225 index futures contracts. This is not consistent with the findings of prior studies, such as Shankar and Miller (2006) and Lynch and Mendenhall (1997), except for our tests on trading volume and BAS. This could be because changes in returns and volatility are only applicable to the cash market whenever a component change occurs, and have limited spillover effects on the futures market.

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TABLE 1 : Details of SGX Nikkei 225 index futures

Listed below are the detailed contract specifications of the Nikkei 225 index futures on the SGX for the year 2002, which corresponds to the time period of our study, i.e., April 2002 through March 2003.

Contract Size	¥500 x Nikkei 225 Index Futures Price
Ticker Symbol	NK
Contract Months	3 nearest serial months & 5 nearest quarterly months.
Minimum Price Fluctuation	5 index points (¥2500)
Trading Hours	Singapore Time: 7.55 am - 10.15 am (Open Outcry Trading) 11.15 am - 2.30 pm (Open Outcry Trading) 3.30 pm - 7.00 pm (Electronic Trading) Last Trading Day: 7.55 am – 10.15 am 11.15 am – 2.25 pm
Last Trading Day	The day before the second Friday of the expiring contract month.
Settlement Basis	Cash settlement
Final Settlement Price	The final settlement price shall be the Special Nikkei 225 Index Quotation based on the opening prices of each component issue in the Nikkei 225 Index on the business day following the last trading day.
Daily Price Limit	Whenever the price moves by 7.5%, in either direction from the previous day's settlement price, trading within the price limit of 7.5% is allowed for the next 15 minutes. Thereafter, an expanded price limit of 12.5% (above or below the previous day's settlement price) shall apply for the rest of the day. On the last trading day for the expiring contract, there shall be no price limits following the 15 minutes cooling-off period after the initial price limit (7.5%) has been reached. No price limit shall come into effect during the last 30 minutes before the close of trading on the last trading day for the expiring contract.

Source: SGX 2001 Handbook.

TABLE 2 : Dates of component changes for the period Apr 2002 – Mar 2003

Listed below in the table are the component changes that took place on the Nikkei 225 stock index in the above mentioned period.

DATE	Company In	Company Out
2 Apr 2002	Millea Holdings, Inc.	
6 Sep 2002		Fujita
11 Sep 2002	Mitsui Trust Holdings, Inc.	
19 Sep 2002	Trend Micro Inc. Olympus Corp. Isetan Co., Ltd.	Japan Energy Kawasaki Steel NKK
25 Sep 2002		Matsushita Communication Japan Airlines
27 Sep 2002	Nippon Mining Holdings, Inc. JFE Holdings, Inc.	
2 Oct 2002	Japan Airlines Corp. CSK Holdings Corp.	Kyokuyo Tobishima
26 Nov 2002		Sumitomo Mitsui Banking
3 Dec 2002	Sumitomo Mitsui Financial Group, Inc.	
6 Mar 2003		Mizuho Holdings

TABLE 3 : Summary Descriptive Statistics

Tabulated below is the summary statistics of the volume, returns, volatility and bidask spreads data for individual days as well as for the different periods from t-5 to t+5. From the SGX tick data & Statistics, we used the tick-by-tick bid, ask and settlement prices, the traded prices and the daily trading volume to determine the volume, returns, volatility and BAS of the SGX Nikkei 225 index futures in 5-minute intervals. We estimate the volume of each 5-min interval by multiplying the average volume per trade by the number of trades in each 5-min interval. The simple returns are reported in percentages and are determined by using the last traded price of a 5-min interval to minus the last traded price of the previous 5-min interval divided by the last traded price of the previous 5-min interval. $r_t = (\frac{p_t - p_{t-1}}{p_{t-1}} \times 100)$

Volatility is calculated as the square of the returns. A five-minute interval BAS, which measures the average spread based on the length of time each quote remains outstanding, is computed as $\sum_{i=0}^{N} \frac{BAS_i(t_{i+1} - t_i)}{(T'-T)}$

TABLE 3 : Summary Descriptive Statistics

	Volume					Returns (%)					Volatility					BAS (%)				
Period	N	Min	Max	Mean	Std Dev	N	Min	Max	Mean	Std Dev	N	Min	Max	Mean	Std Dev	N	Min.	Max	Mean	Std Dev
t-5	629	0	1668	367	339	587	-0.01	0.01	0.0014	0.19	587	0	1.0×10^{-2}	3.5×10^{-4}	9.7×10^{-4}	604	0.1	70.4	5.6	4.6
t-4	629	0	1525	284	246	570	-0.01	0.02	0.0062	0.19	570	0	2.3×10^{-2}	3.7×10^{-4}	1.5×10^{-3}	605	0.0	12.7	5.3	1.0
t-3	708	0	1627	377	341	593	-0.04	0.01	-0.0039	0.23	593	0	1.3×10^{-1}	5.2×10^{-4}	5.5×10^{-3}	604	0.1	10.7	5.3	0.9
t-2	708	0	1525	351	290	586	-0.01	0.01	0.0016	0.18	586	0	1.3×10^{-2}	3.4×10^{-4}	9.7×10^{-4}	604	0.3	70.4	5.6	3.8
t-1	787	0	1876	360	320	640	-0.01	0.02	0.0033	0.19	640	0	2.3×10^{-2}	3.5×10^{-4}	1.5×10^{-3}	669	0.1	66.4	5.4	2.7
t	787	0	1669	416	325	646	-0.01	0.01	-0.0034	0.18	646	0	9.3×10^{-3}	3.2×10^{-4}	7.6×10^{-4}	674	0.1	70.4	5.4	2.8
t+1	787	0	1446	346	268	644	-0.01	0.02	0.0020	0.20	644	0	6.0×10^{-2}	4.1×10^{-4}	2.5×10^{-3}	674	-5.1	12.7	5.3	1.2
t+2	787	0	1528	374	324	642	-0.01	0.01	0.0073	0.16	642	0	1.0×10^{-2}	2.7×10^{-4}	6.1×10^{-4}	671	0.1	14.1	5.3	1.0
t+3	787	0	1833	404	361	647	-0.01	0.01	-0.0032	0.18	647	0	1.3×10^{-2}	3.2×10^{-4}	9.1×10^{-4}	673	0.1	70.4	5.5	2.9
t+4	787	0	2630	397	382	606	-0.01	0.02	0.0035	0.19	606	0	2.3×10^{-2}	3.7×10^{-4}	1.5×10^{-3}	672	0.0	14.1	5.4	1.2
t+5	708	0	1601	382	305	568	-0.01	0.01	-0.0058	0.18	568	0	9.3×10^{-3}	3.1×10^{-4}	7.1×10^{-4}	606	0.2	10.9	5.3	1.0
(t-5, t-1)	3461	0	1876	349	311	2976	-0.04	0.02	0.0017	0.20	2976	0	1.3×10^{-1}	3.9×10^{-4}	2.7×10^{-3}	3086	0.0	70.4	5.4	3.0
(t+1, t+5)	3856	0	2630	381	332	3107	-0.01	0.02	0.0008	0.18	3107	0	6.0×10^{-2}	3.4×10^{-4}	1.4×10^{-3}	3296	-5.1	70.4	5.4	1.6
(t-4, t-1)	2832	0	1876	345	305	2389	-0.04	0.02	0.0018	0.20	2389	0	1.3×10^{-1}	3.9×10^{-4}	3.0×10^{-3}	2482	0.0	70.4	5.4	2.4
(t+1, t+4)	3148	0	2630	380	337	2539	-0.01	0.02	0.0024	0.19	2539	0	6.0×10^{-2}	3.4×10^{-4}	1.5×10^{-3}	2690	-5.1	70.4	5.4	1.7
(t-3, t-1)	2203	0	1876	363	318	1819	-0.04	0.02	0.0004	0.20	1819	0	1.3×10^{-1}	4.0×10^{-4}	3.3×10^{-3}	1877	0.1	70.4	5.4	2.7
(t+1, t+3)	2361	0	1833	375	321	1933	-0.01	0.02	0.0002	0.18	1933	0	6.0×10^{-2}	3.3×10^{-4}	1.6×10^{-3}	2018	-5.1	70.4	5.4	1.9
(t-2, t-1)	1495	0	1876	356	306	1226	-0.01	0.02	0.0025	0.19	1226	0	2.3×10^{-2}	3.5×10^{-4}	1.3×10^{-3}	1273	0.1	70.4	5.5	3.3
(t+1, t+2)	1574	0	1528	360	298	1286	-0.01	0.02	0.0047	0.18	1286	0	6.0×10^{-2}	3.4×10^{-4}	1.8×10^{-3}	1345	-5.1	14.1	5.3	1.1

TABLE 4 : Results for the Test of Volume, Returns, Volatility and BAS of Nikkei 225 Index Futures on SGX

Tabulated below are the results of our tests, using the data described in Table 4. We run the tests using one-sample t-tests and identify the p-values that are significant at both 1% and 5% significance levels. Using various means of different time periods, we will then be able to show how different combinations of data compare with each other. We test the means of the different time periods against each other to test whether there is a significance difference in the means of the two time periods. For example, in the first row under the volume column, we test the mean volume of time period Day_{t-5} to Day_{t-1} against the mean volume of time period Day_t, (t-5, t-1): t. We test whether there is a significant difference between the means of these two time periods. More specifically, we can see whether volume, returns, volatility and BAS increases or decreases when two different periods are compared against each other. This is done by looking at the significant values of the "Mean Diff", where a positive value indicates an increase when comparing against a constant period (indicated by the test value), and a negative value indicates a decrease. Mean difference = mean of non-constant period – mean of constant period

Period	Volume			Returns (%)			Volatility			BAS (%)		
	Mean Diff	t-stat	Sig.	Mean Diff	t-stat	Sig.	Mean Diff	t-stat	Sig.	Mean Diff	t-stat	Sig.
	Mean volume for (t-5,t-1) = 349.1148			Mean return for (t-5,t-1) = 0.00172807			Mean volatility for (t-5,t-1) = 0.00038577			Mean BAS for (t-5,t-1) = 5.447148412		
(t-5,t-1) : t	66.51	5.74 **	0.0000	-0.0051	-0.73	0.4654	-6.87×10^{-5}	-2.30 *	0.0217	-0.05	-0.48	
(t-5,t-1) : t+1	-2.63	-0.28	0.7834	0.0003	0.04	0.9698	2.77×10^{-5}	0.28	0.7773	-0.13	-2.84	**
(t-5,t-1) : (t+1,t+2)	10.99	1.47	0.1431	0.0029	0.57	0.5679	-4.65×10^{-5}	-0.92	0.3585	-0.13	-4.22	**
(t-5,t-1) : (t+1,t+3)	25.63	3.88 **	0.0001	0.0003	0.07	0.9448	-5.15×10^{-5}	-1.44	0.1496	-0.07	-1.62	
(t-5,t-1) : (t+1,t+4)	31.26	5.20 **	0.0000	0.0006	0.18	0.8605	-4.30×10^{-5}	-1.40	0.1604	-0.07	-1.94	
(t-5,t-1) : (t+1,t+5)	31.49	5.90 **	0.0000	-0.0009	-0.26	0.7953	-4.90×10^{-5}	-1.91	0.0559	-0.08	-2.77	**
	Mean volume for (t-4,t-1) = 345.1395			Mean return for (t-4,t-1) = 0.00180259			Mean volatility for (t-4,t-1) = 0.00039414			Mean BAS for (t-4,t-1) = 5.403303787		
(t-4,t-1) : t	70.49	6.09 **	0.0000	-0.0052	-0.74	0.4590	-7.71×10^{-5}	-2.58 *	0.0101	-0.01	-0.07	
(t-4,t-1) : t+1	1.35	0.14	0.8880	0.0002	0.03	0.9772	1.94×10^{-5}	0.20	0.8434	-0.09	-1.88	
(t-4,t-1) : (t+1,t+2)	14.96	2.00 *	0.0462	0.0029	0.56	0.5778	-5.48×10^{-5}	-1.08	0.2786	-0.08	-2.75	**
(t-4,t-1) : (t+1,t+3)	29.61	4.48 **	0.0000	0.0002	0.05	0.9590	-5.9×10^{-5}	-1.68	0.0939	-0.02	-0.58	
(t-4,t-1) : (t+1,t+4)	35.23	5.86 **	0.0000	0.0006	0.16	0.8764	-5.14×10^{-5}	-1.68	0.0936	-0.02	-0.64	
(t-4,t-1) : (t+1,t+5)	35.46	6.64 **	0.0000	-0.0009	-0.28	0.7779	-5.74×10^{-5}	-2.24 *	0.0252	-0.03	-1.23	
	Mean volume for (t-3,t-1) = 362.6227			Mean return for (t-3,t-1) = 0.00041771			Mean volatility for (t-3,t-1) = 0.00040162			Mean BAS for (t-3,t-1) = 5.422136388		
(t-3,t-1) : t	53.01	4.58 **	0.0000	-0.0038	-0.54	0.5870	-8.46×10^{-5}	-2.83 **	0.0048	-0.03	-0.24	
(t-3,t-1) : t+1	-16.14	-1.69	0.0918	0.0016	0.20	0.8406	1.19×10^{-5}	0.12	0.9034	-0.10	-2.30	*
(t-3,t-1) : (t+1,t+2)	-2.52	-0.34	0.7371	0.0042	0.83	0.4088	-6.23×10^{-5}	-1.23	0.2182	-0.10	-3.38	**
(t-3,t-1) : (t+1,t+3)	12.13	1.84	0.0664	0.0016	0.38	0.7008	-6.74×10^{-5}	-1.89	0.0596	-0.04	-1.03	
(t-3,t-1) : (t+1,t+4)	17.75	2.95 **	0.0032	0.0020	0.53	0.5945	-5.89×10^{-5}	-1.92	0.0548	-0.04	-1.19	
(t-3,t-1) : (t+1,t+5)	17.98	3.37 **	0.0008	0.0005	0.14	0.8898	-6.49×10^{-5}	-2.53 *	0.0114	-0.05	-1.89	
	Mean volume for (t-2,t-1) = 355.7660			Mean return for (t-2,t-1) = 0.00248868			Mean volatility for (t-2,t-1) = 0.00034525			Mean BAS for (t-2,t-1) = 5.47771668		
(t-2,t-1) : t	59.86	5.17 **	0.0000	-0.0059	-0.84	0.4019	-2.82×10^{-5}	-0.94	0.3455	-0.08	-0.76	
(t-2,t-1) : t+1	-9.28	-0.97	0.3319	-0.0005	-0.06	0.9546	6.83×10^{-5}	0.70	0.4865	-0.16	-3.52	**
(t-2,t-1) : (t+1,t+2)	4.34	0.58	0.5631	0.0022	0.42	0.6722	-6.00×10^{-6}	-0.12	0.9064	-0.16	-5.25	**
(t-2,t-1) : (t+1,t+3)	18.98	2.88 **	0.0041	-0.0005	-0.11	0.9096	-1.10×10^{-5}	-0.31	0.7583	-0.10	-2.34	*
(t-2,t-1) : (t+1,t+4)	24.60	4.09 **	0.0000	-0.0001	-0.03	0.9751	-2.50 x 10-6	-0.08	0.9346	-0.10	-2.84	**
(t-2,t-1) : (t+1,t+5)	24.84	4.65 **	0.0000	-0.0016	-0.49	0.6239	-8.50 x 10-6	-0.33	0.7405	-0.11	-3.84	**

Table 4 (continued)

Period	Volume			Returns (%)			Volatility			BAS (%)		
	Mean Diff	t-stat	Sig.	Mean Diff	t-stat	Sig.	Mean Diff	t-stat	Sig.	Mean Diff	t-stat	Sig.
	Mean volume for t-1 = 359.9559			Mean return for t-1 = 0.00328305			Mean volatility for t-1 = 0.00035316			Mean BAS for t-1 = 5.391155954		
t-1 : t	55.67	4.81 **	0.0000	-0.0067	-0.95	0.3414	-3.61×10^{-5}	-1.21	0.2272	0.00	0.04	
t-1 : t+1	-13.47	-1.41	0.1592	-0.0013	-0.16	0.8760	6.04×10^{-5}	0.62	0.5384	-0.07	-1.62	
t-1 : (t+1,t+2)	0.15	0.02	0.9842	0.0014	0.27	0.7883	-1.39×10^{-5}	-0.27	0.7841	-0.07	-2.34	*
t-1 : (t+1,t+3)	14.79	2.24 *	0.0252	-0.0013	-0.30	0.7607	-1.89×10^{-5}	-0.53	0.5968	-0.01	-0.30	
t-1 : (t+1,t+4)	20.41	3.40 **	0.0007	-0.0009	-0.25	0.8046	-1.04×10^{-5}	-0.34	0.7338	-0.01	-0.28	
t-1 : (t+1,t+5)	20.65	3.87 **	0.0001	-0.0024	-0.73	0.4644	-1.64×10^{-5}	-0.64	0.5223	-0.02	-0.80	
	Mean volume for t = 415.6297			Mean return for t = -0.00339172			Mean volatility for t = 0.00031706			Mean BAS for t = 5.395845697		
t : t+1	-69.14	-7.23 **	0.0000	0.0054	0.68	0.4991	9.65×10^{-5}	0.98	0.3256	-0.08	-1.72	
t : (t+1,t+2)	-55.53	-7.40 **	0.0000	0.0081	1.57	0.1171	2.22×10^{-5}	0.44	0.6603	-0.07	-2.50	*
t : (t+1,t+3)	-40.88	-6.19 **	0.0000	0.0054	1.30	0.1937	1.72×10^{-5}	0.48	0.6305	-0.02	-0.41	
t : (t+1,t+4)	-35.26	-5.87 **	0.0000	0.0058	1.57	0.1167	2.57×10^{-5}	0.84	0.4022	-0.01	-0.42	
t : (t+1,t+5)	-35.03	-6.56 **	0.0000	0.0043	1.30	0.1953	1.97×10^{-5}	0.77	0.4420	-0.03	-0.96	
	Mean volume for t-5 = 367.0128699			Mean return for t-5 = 0.001425			Mean volatility for t-5 = 0.00035172			Mean BAS for t-5 = 5.627317881		
t-4 : t-5	-83.11	-8.48 **	0.0000	0.0048	0.60	0.5520	1.86×10^{-5}	0.29	0.7710	-0.28	-6.77	**
t-3 : t-5	10.09	0.79	0.4310	-0.0053	-0.57	0.5720	1.66×10^{-4}	0.74	0.4570	-0.32	-8.74	**
t-2 : t-5	-15.90	-1.46	0.1450	0.0002	0.03	0.9790	-1.51×10^{-5}	-0.38	0.7060	-0.05	-0.35	
t-1 : t-5	-7.06	-0.62	0.5360	0.0019	0.25	0.8030	1.40×10^{-6}	0.03	0.9800	-0.24	-2.27	*
t : t-5	48.62	4.20 **	0.0000	-0.0048	-0.69	0.4920	-3.47×10^{-5}	-1.16	0.2460	-0.23	-2.15	*
t+1 : t-5	-20.53	-2.15 *	0.0320	0.0006	0.08	0.9400	6.18×10^{-5}	0.63	0.5290	-0.31	-6.80	**
t+2 : t-5	6.71	0.58	0.5610	0.0059	0.92	0.3600	-8.69×10^{-5}	-3.59 **	0.0000	-0.30	-7.91	**
t+3 :t-5	37.02	2.88 **	0.0040	-0.0047	-0.66	0.5100	-2.75×10^{-5}	-0.77	0.4440	-0.14	-1.20	
t+4 : t-5	30.23	2.22 *	0.0270	0.0021	0.27	0.7890	1.81×10^{-5}	0.31	0.7600	-0.24	-5.24	**
t+5 : t-5	14.63	1.28	0.2020	-0.0073	-0.98	0.3270	-4.16×10^{-5}	-1.40	0.1610	-0.32	-8.11	**
	Mean volume for t-4 = 283.9068212			Mean return for t-4 = 0.006222			Mean volatility for t-4 = 0.00037029			Mean BAS for t-4 = 5.344876033		
t-3 : t-4	93.19	7.27 **	0.0000	-0.0101	-1.08	0.2810	1.48×10^{-4}	0.66	0.5090	-0.04	-1.08	
t-2 : t-4	67.20	6.16 **	0.0000	-0.0046	-0.61	0.5440	-3.37×10^{-5}	-0.84	0.4000	0.23	1.47	
t-1 : t-4	76.05	6.67 **	0.0000	-0.0029	-0.40	0.6930	-1.71×10^{-5}	-0.30	0.7670	0.05	0.45	
t : t-4	131.72	11.37 **	0.0000	-0.0096	-1.37	0.1710	-5.32×10^{-5}	-1.78	0.0750	0.05	0.47	
t+1 : t-4	62.58	6.55 **	0.0000	-0.0042	-0.52	0.6010	4.32×10^{-5}	0.44	0.6590	-0.03	-0.60	
t+2 : t-4	89.82	7.78 **	0.0000	0.0011	0.17	0.8670	-1.05×10^{-4}	-4.35 **	0.0000	-0.02	-0.50	
t+3 : t-4	120.13	9.33 **	0.0000	-0.0095	-1.34	0.1820	-4.61×10^{-5}	-1.28	0.2000	0.15	1.31	
t+4 : t-4	113.33	8.32 **	0.0000	-0.0027	-0.35	0.7290	-5.00×10^{-7}	-0.01	0.9930	0.05	1.04	
t+5 : t-4	97.74	8.52 **	0.0000	-0.0121	-1.63	0.1030	-6.02×10^{-5}	-2.03 *	0.0430	-0.04	-0.92	

Table 4 (Continued)

Period	Volume Mean Diff	Volume t-stat	Volume Sig.	Returns (%) Mean Diff	Returns (%) t-stat	Returns (%) Sig.	Volatility Mean Diff	Volatility t-stat	Volatility Sig.	BAS (%) Mean Diff	BAS (%) t-stat	BAS (%) Sig.
	Mean volume for t-3 = 377.1011351			Mean return for t-3 = -0.003864			Mean volatility for t-3 = 0.00051815			Mean BAS for t-3 = 5.304994481		
t-2 : t-3	-25.99	-2.38 *	0.0170	0.0055	0.72	0.4700	-1.82×10^{-4}	-4.54 **	0.0000	0.27	1.72	(
t-1 : t-3	-17.15	-1.50	0.1330	0.0072	0.96	0.3370	-1.65×10^{-4}	-2.85 *	0.0050	0.09	0.83	(
t : t-3	38.53	3.33 **	0.0010	0.0005	0.07	0.9460	-2.01×10^{-4}	-6.73 **	0.0000	0.09	0.85	(
t+1 : t-3	-30.61	-3.20 **	0.0010	0.0059	0.74	0.4620	-1.05×10^{-4}	-1.07	0.2860	0.01	0.28	(
t+2 : t-3	-3.38	-0.29	0.7700	0.0112	1.74	0.0830	-2.53×10^{-4}	-10.45 **	0.0000	0.02	0.54	(
t+3 : t-3	26.93	2.09 *	0.0370	0.0006	0.09	0.9300	-1.94×10^{-4}	-5.40 **	0.0000	0.19	1.67	(
t+4 : t-3	20.14	1.48	0.1400	0.0074	0.94	0.3460	-1.48×10^{-4}	-2.51 *	0.0120	0.09	1.93	(
t+5 : t-3	4.54	0.40	0.6920	-0.0020	-0.27	0.7900	-2.08×10^{-4}	-7.01 **	0.0000	0.00	0.10	(
	Mean volume for t-2 = 351.1085789			Mean return for t-2 = 0.001621			Mean volatility for t-2 = 0.00033661			Mean BAS for t-2 = 5.573592715		
t-1 : t-2	8.85	0.78	0.4380	0.0017	0.22	0.8230	1.65×10^{-5}	0.29	0.7750	-0.18	-1.76	(
t : t-2	64.52	5.57 **	0.0000	-0.0050	-0.72	0.4750	-1.95×10^{-5}	-0.66	0.5130	-0.18	-1.65	(
t+1 : t-2	-4.62	-0.48	0.6290	0.0004	0.05	0.9590	7.69×10^{-5}	0.78	0.4330	-0.26	-5.62 **	(
t+2 : t-2	22.61	1.96	0.0510	0.0057	0.89	0.3770	-7.18×10^{-5}	-2.96 **	0.0030	-0.25	-6.50 **	(
t+3 : t-2	52.93	4.11 **	0.0000	-0.0049	-0.69	0.4930	-1.24×10^{-5}	-0.35	0.7300	-0.08	-0.72	(
t+4 : t-2	46.13	3.39 **	0.0010	0.0019	0.24	0.8090	3.32×10^{-5}	0.56	0.5750	-0.18	-4.04 **	(
t+5 : t-2	30.54	2.66 **	0.0080	-0.0075	-1.01	0.3140	-2.65×10^{-5}	-0.89	0.3720	-0.26	-6.74 **	(
	Mean volume for t-1 = 359.9558858			Mean return for t-1 = 0.003283			Mean volatility for t-1 = 0.00035316			Mean BAS for t-1 = 5.391155954		
t : t-1	55.67	4.81 **	0.0000	-0.0067	-0.95	0.3410	-3.61×10^{-5}	-1.21	0.2270	0.00	0.04	(
t+1 : t-1	-13.47	-1.41	0.1590	-0.0013	-0.16	0.8760	6.04×10^{-5}	0.62	0.5380	-0.07	-1.62	(
t+2 : t-1	13.77	1.19	0.2340	0.0040	0.63	0.5320	-8.83×10^{-5}	-3.64 **	0.0000	-0.07	-1.72	(
t+3 : t-1	44.08	3.42 **	0.0010	-0.0065	-0.92	0.3570	-2.89×10^{-5}	-0.81	0.4210	0.10	0.90	(
t+4 : t-1	37.28	2.74 **	0.0060	0.0002	0.03	0.9760	1.66×10^{-5}	0.28	0.7790	0.00	0.01	(
t+5 : t-1	21.69	1.89	0.0590	-0.0091	-1.23	0.2180	-4.31×10^{-5}	-1.45	0.1470	-0.08	-2.09 *	(
	Mean volume for t = 415.6297448			Mean return for t= -0.003392			Mean volatility for t = 0.00031706			Mean BAS for t = 5.395845697		
t+1 : t	-69.14	-7.23 **	0.0000	0.0054	0.68	0.4990	9.65×10^{-5}	0.98	0.3260	-0.08	-1.72	(
t+2 : t	-41.91	-3.63 **	0.0000	0.0107	1.67	0.0960	-5.22×10^{-5}	-2.16 *	0.0320	-0.07	-1.84	(
t+3 : t	-11.59	-0.90	0.3680	0.0002	0.02	0.9830	7.20×10^{-6}	0.20	0.8420	0.10	0.86	(
t+4 : t	-18.39	-1.35	0.1770	0.0069	0.88	0.3770	5.27×10^{-5}	0.89	0.3730	0.00	-0.09	(
t+5 : t	-33.99	-2.96 **	0.0030	-0.0024	-0.33	0.7410	-7.00×10^{-6}	-0.24	0.8140	-0.09	-2.21 *	(

** significant at 1% level

* significant at 5% level

FIGURE 1 : Impact of Component Changes in Nikkei 225 Stock Index on Nikkei 225 Index Futures on SGX

Shown below is a summary of our hypotheses where we determine whether a component change in the Nikkei 225 stock index will have an impact on the microstructure in the Nikkei 225 stock index and subsequently an impact on the Nikkei 225 index futures on SGX.

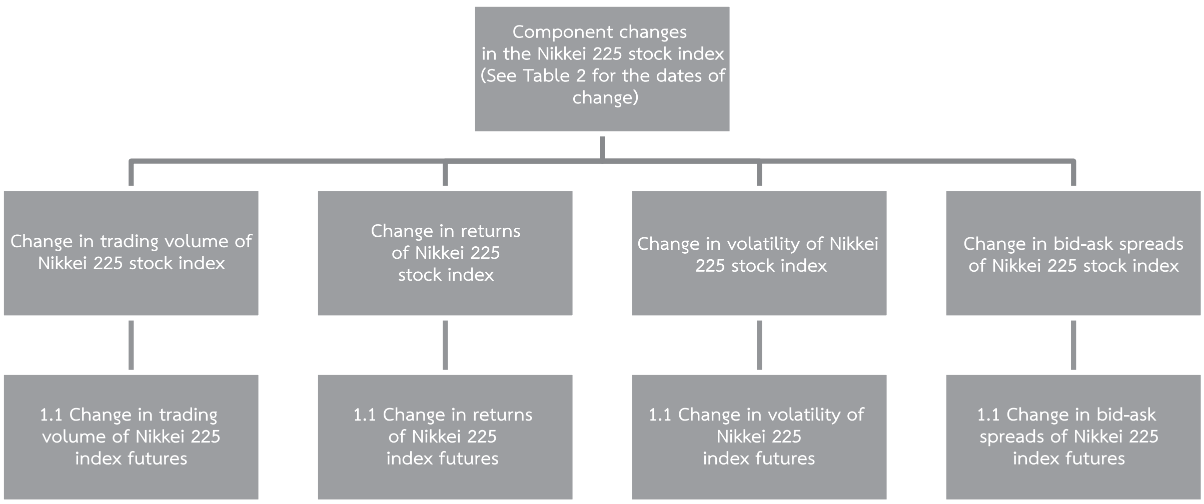


FIGURE 2 : Charts of Five-Minute Volume, Returns, Volatility, and BAS of Nikkei 225 Index Futures on SGX

Shown below are the five-minute patterns of the trading volume, returns, volatility and BAS of the Nikkei 225 index futures on SGX. We show the daily patterns for five days before the component change to five days after the component change.

Chart A suggests that volume on day t is the highest, compared to five days before and five days after the component change. Volume decreases sharply on day t-1 before gradually rising again. There is no observable pattern in the returns presented in Chart B and the volatility shown in Chart C, with both the returns and volatility randomly fluctuating throughout the ten days of observation. From Chart D, we observe that there is a general decrease in BAS after day t.

Chart A : Five-Minute Trading Volume of Nikkei 225 Index Futures on SGX

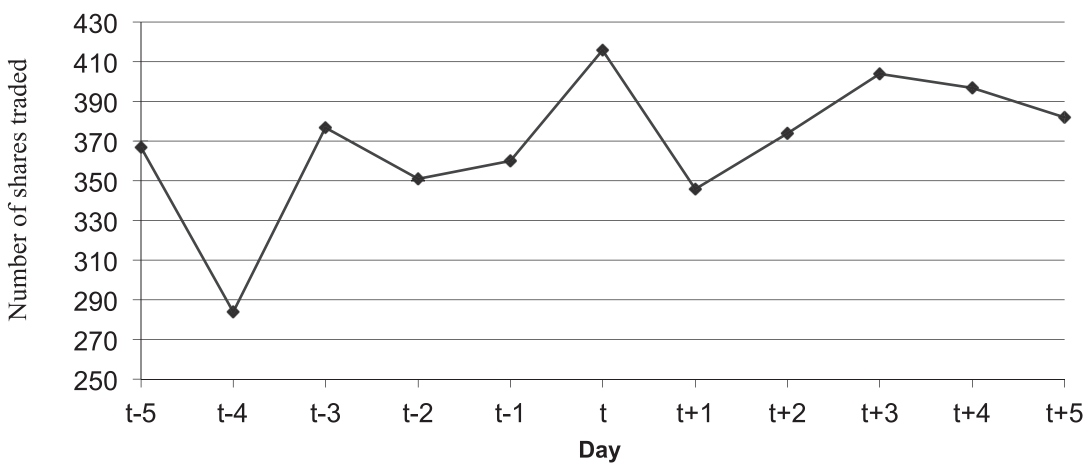


FIGURE 2 (Continued)

Chart B: Five-Minute Returns of Nikkei 225 Index Futures on SGX

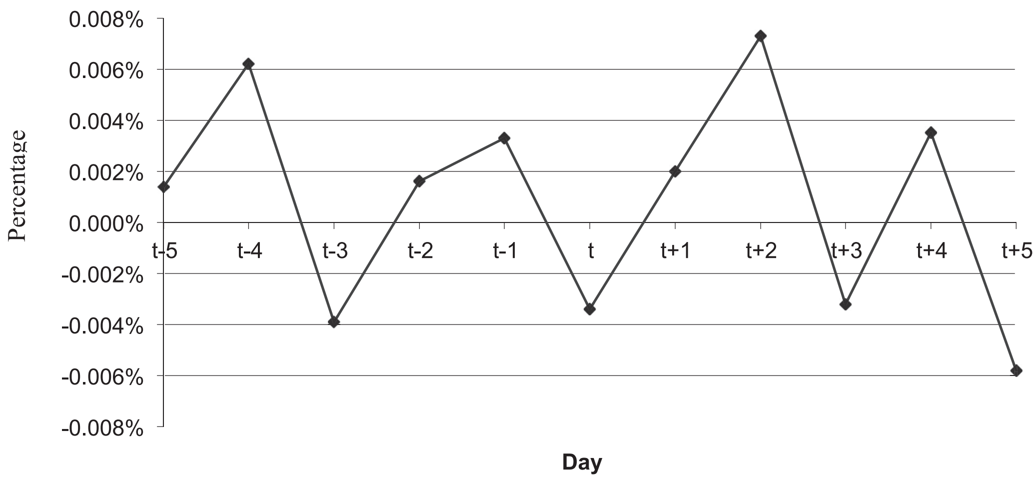


Chart C: Five-Minute Volatility of Nikkei 225 Index Futures on SGX

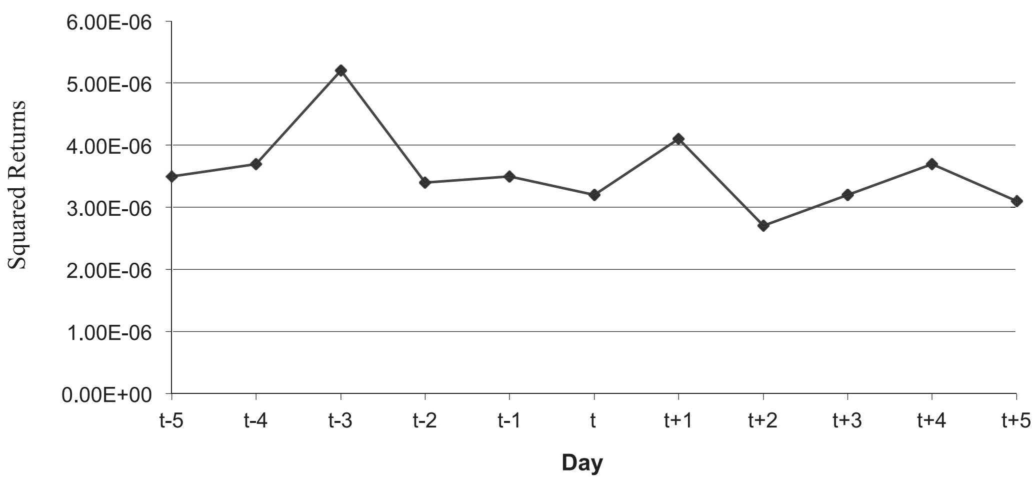
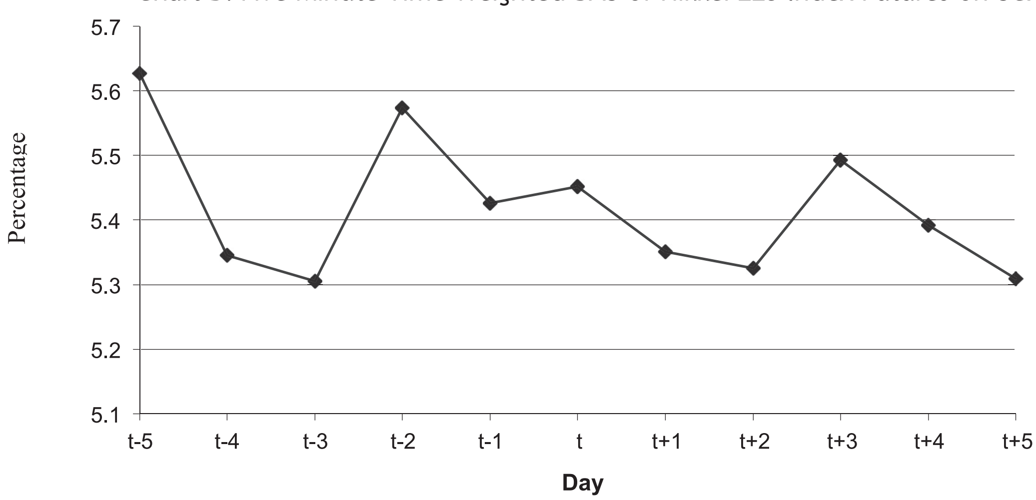


Chart D: Five-Minute Time-Weighted BAS of Nikkei 225 Index Futures on SGX



APPENDIX A

Daily Price limits & Special Quote Parameters

Listed below are the daily price limits set in terms of absolute yen values according to the price range of the stock. Also listed below are the Special Quote parameters which take effect whenever there is a major imbalance in the orders. The parameters are listed in absolute yen and they vary according to the price range of the stock.

Daily Price Limits		Special Quote Parameters	
Previous Day's Closing Price or Special Quote	Daily Price Limits (±)	Current Price	Parameters (±)
< ¥100	¥30	Less than ¥500	¥5
¥100 < ¥200	¥50	¥500 < ¥1000	¥10
¥200 < ¥500	¥80	¥1,000 < ¥1,500	¥20
¥500 < ¥1,000	¥100	¥1,500 < ¥2,000	¥30
¥1,000 < ¥1,500	¥200	¥2,000 < ¥3,000	¥40
¥1,500 < ¥2,000	¥300	¥3,000 < ¥5,000	¥50
¥2,000 < ¥3,000	¥400	¥5,000 < ¥10,000	¥100
¥3,000 < ¥5,000	¥500	¥10,000 < ¥20,000	¥200
¥5,000 < ¥10,000	¥1,000	¥20,000 < ¥30,000	¥300
¥10,000 < ¥20,000	¥2,000	¥30,000 < ¥50,000	¥400
¥20,000 < ¥30,000	¥3,000	¥50,000 < ¥70,000	¥500
¥30,000 < ¥50,000	¥4,000	¥70,000 < ¥100,000	¥1,000
¥50,000 < ¥70,000	¥5,000	¥100,000 < ¥150,000	¥2,000
¥70,000 < ¥100,000	¥10,000	¥150,000 < ¥200,000	¥3,000
¥100,000 < ¥150,000	¥20,000	¥200,000 < ¥300,000	¥4,000
¥150,000 < ¥200,000	¥30,000	¥300,000 < ¥500,000	¥5,000
¥200,000 < ¥300,000	¥40,000	¥500,000 < ¥1,000,000	¥10,000
¥300,000 < ¥500,000	¥50,000	¥1,000,000 < ¥1,500,000	¥20,000
¥500,000 < ¥1,000,000	¥100,000	¥1,500,000 < ¥2,000,000	¥30,000
¥1,000,000 < ¥1,500,000	¥200,000	¥2,000,000 < ¥3,000,000	¥40,000
¥1,500,000 < ¥2,000,000	¥300,000	¥3,000,000 < ¥5,000,000	¥50,000
¥2,000,000 < ¥3,000,000	¥400,000	¥5,000,000 < ¥10,000,000	¥100,000
¥3,000,000 < ¥5,000,000	¥500,000	¥10,000,000 < ¥15,000,000	¥200,000
¥5,000,000 < ¥10,000,000	¥1,000,000	¥15,000,000 < ¥20,000,000	¥300,000
¥10,000,000 < ¥15,000,000	¥2,000,000	¥20,000,000 < ¥30,000,000	¥400,000
¥15,000,000 < ¥20,000,000	¥3,000,000	¥30,000,000 < ¥50,000,000	¥500,000
¥20,000,000 < ¥30,000,000	¥4,000,000	¥50,000,000 or more	¥1,000,000
¥30,000,000 <¥50,000,000	¥5,000,000		
≥ ¥50,000,000	¥10,000,000		

Source: http://www.tse.or.jp/english/data/factbook/index.html

Tokyo Stock Exchange Fact Book 2006.

APPENDIX B

Trading Units

Listed below are the trading units (i.e. the minimum amount of which each stock may be traded) of domestic firms. It shows how many companies have their trading units set at, for example; 1, 10, 50...etc. First section stocks have the highest listing criteria. The second section consists of newly listed stocks. Also, the requirements on the second section are less strict. Lastly, Mothers consist of high growth and emerging companies.

Trading units of listed companies

(As of end 2005)

Trading Unit	Number of companies			
	First Section	Second Section	Mothers	Total
1 share	77	30	135	242
10 shares	10	1	1	12
50 shares	11	1	-	12
100 shares	653	155	10	818
500 shares	40	16	-	56
1,000 shares	875	303	4	1,182
3,000 shares	1	-	-	1
Total	1,667	506	150	2,323

* Figures do not include foreign listed companies

Source: http://www.tse.or.jp/english/data/factbook/index.html
Tokyo Stock Exchange Fact Book, 2006.