Issues In Stock Index Futures Introduction And Trading. Evidence From The Malaysian Index Futures Market.

Bacha, Obiyathulla I.; Abdul, Jalil O. and Othman, Khairudin
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Abdul Jalil Ibrahim*
Khairuddin Othman*
Obiyathulla Ismath Bacha**

Correspondence Address:
Management Center
Kulliyyah of Economics and Management Sciences
International Islamic University Malaysia
Jalan Gombak, 53100 Kuala Lumpur
**e-mail* : obiya@iiu.edu.my

**Candidate for MBA, Management Center, IIUM*
***Associate Professor, Corresponding Author*

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Abstract

This paper examines several issues related to the introduction and trading of stock index futures contracts in Malaysia. Issues related to volatility, pricing efficiency, systematic patterns and lead-lag relationships are examined. These issues were studied by way of addressing six research questions. We use two data sets. First, daily price data for 4 years and 2 years respectively for stock and futures markets and second, intraday, 15 minute interval data for 43 days (2 months) of futures trading.

Based on our results, we find no evidence of any increase in the volatility of the underlying market following futures introduction. If anything, the one year period following futures introduction had lower volatility. Intermarket comparison showed futures volatility to be higher. No evidence of any expiration day effect was found. We find frequent mispricing, with most of it being underpricing. Including transaction costs showed very little mispricing. Analysis of the 15 minute intraday data showed clear evidence of an overall U-shape in futures volume and volatility. However, a minor third peak at reopening following lunch break was also evident. We find no evidence of a lead-lag relationship, rather a contemporaneous one. Both markets appear to react simultaneously to information arrival.

INTRODUCTION

This paper examines several market microstructure issues related to the introduction and trading of stock index futures contracts in Malaysia. The regulatory stance preceeding the introduction of financial derivatives, had clearly been a hesitant one. This is not surprising given that derivatives were being blamed for stock market crashes and the huge losses incurred in fiascoes such as the Procter & Gamble, Orange County, Metallgeselschaft and Barings PLC. That the Barings collapse happened in Malaysia's neighbour, Singapore, right around when regulators were considering a private initiative to establish the country's first financial derivatives exchange did not help matters. Following tentative steps,[1] the government allowed the introduction of an index futures contract to be based on the Kuala Lumpur Composite Index (KLCI). Designated as FKLI, the Kuala Lumpur Composite Index Futures contract began trading on the country's first financial derivatives exchange, The Kuala Lumpur Options & Financial Futures Exchange (KLOFFE) in mid-December 1995. With the introduction, Malaysia was probably Asia's only truly emerging market with a financial futures contract. Thus far, experience with financial derivatives has been mixed at best. While the stock index futures contract has been relatively successful with volume averaging close to 2000 contracts per day,[2] an interest rate futures contract introduced in mid 1996 by yet another newly established exchange[3] has remained still born.

[1] *A Government commissioned World Bank study in the early 1990s had recommended against the introduction of derivatives as the capital market was not deemed sufficiently developed.*

[2] *Daily volume saw a drastic fall in the immediate period following the imposition of Capital controls on 1st Sept. 1998.*

[3] *The Malaysian Monetary Exchange (MME).*

The Malaysian stock index futures contract has as its underlying, the Kuala Lumpur Stock Exchange Composite Index (KLCI). The KLCI which is the most widely quoted index is a capitalization weighted index of 100 stocks listed on the main board. Chart 1 in Appendix outlines some of the key features of the futures contract's specifications. For economic reasons, the two derivative exchanges, KLOFFE and MME share a single clearinghouse. The trading system on KLOFFE is entirely screen based with electronic matching. Regulation of all cash settled derivative products come under the purview of the Futures Industry Act (FIA). The FIA was the result of major regulatory reform in 1993 to pave the way for introduction of cash settled derivatives. Though the Ministry of Finance is the ultimate regulatory authority, it has delegated all FIA enforcement to the Securities Commission.

MOTIVATION & RESEARCH QUESTIONS

Though there have been numerous studies on developed country futures markets, there have been few in-depth studies of such markets in emerging countries such as Malaysia. We are unaware of any published study of a comprehensive nature on the KLCI futures contract. Our objective is to examine the several issues related to the introduction and trading of stock index futures contracts. Aside from the need to understand these issues for future policy making, it will be interesting to examine the impact of index futures introduction in a market at a lower stage of development, with incomplete markets and tight short selling regulation.[4]

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[4]*Current Regulation prevents short selling of stocks. Though a select number of stocks have recently been designated for securities borrowing and lending, the cumbersome process has meant little stock lending activity.*

Given the objective of a comprehensive examination, this paper studies four broad areas related to index futures. The four areas being (a) issues related to volatility. (b) pricing efficiency, (c) systematic patterns in volatility and trading activity and (d) lead-lag relationships.

In doing this, we use two data sets. First, a set of daily data and second, a set of intraday transaction data based on 15 minute time intervals. In order to examine the four broad areas, we address a total of six main research questions. These research questions are as follows:

(1) What is the impact of futures introduction on underlying market volatility?

(2) How does the futures market volatility compare to stock market volatility?

(3) Is there any evidence of an expiration day effect on the underlying stock market?

(4) What is the extent of mispricing on the KLCI futures?

(5) Is there evidence of systematic patterns in intraday volatility and trading patterns in the futures market?

and

(6) Do the returns and volatility in the two markets exhibit any lead-lag relationship?

Though the above six questions constitute the main theme of this paper, we also analyze a number of minor issues/questions that may be related to these main research questions. This paper is organized as follows; *Section 2* below, provides an overview of the existing literature related to our research questions. *Section 3*, describes our data and research methodology. *Section 4*, provides the results and analysis. The final section, *Section 5* concludes.

***Section 2*: Literature Review**

This section provides an overview of existing literature relevant to our research questions. This review of previous work is organized sequentially in the order of the above mentioned six questions.

2.1 : Impact of Futures Introduction on Underlying Stock Market Volatility.

The impact of index futures introduction on underlying stock market volatility is well researched and documented; especially in the case of the US, UK, Japan and Hong Kong. Most of the studies find little or no evidence of increased stock market volatility following futures introduction. In the most recent of such studies, Pericli and Koutman (1997) examine S&P 500 returns over the period 1953 to September 1994. They find no incremental effect on underlying market volatility as a result of the introduction of index futures nor of options. This results appear to confirm the findings of Santori (1987) who used daily and weekly returns for S&P 500 over a 10 year period. Miller and Galloway (1997), examine the Mid Cap 400 index for evidence of volatility change following the introduction of a futures contract on the index. They find no evidence of any increased volatility, if anything, their results point to a possible *reduction* in underlying volatility.

Earlier studies on other US indices point to similar results. Choi and Subramaniam (1994) found no significant effect on returns volatility on the MMI following the introduction of an MMI futures contract. Edwards (1988a, 1988b) using daily data over a 15 year period, 1972 - 1987 for both the S&P 500 and the Value Line composite Index (VLCI),[5] examines volatility change following futures introduction on the respective indices.

[5] *The VLCI is a geometrically weighted index.*

Again, he too found no evidence of increased underlying market volatility following futures introduction. However, in contrast to these findings, Lockwood & Linn (1990) using daily intraday open-to-close returns for the DJIA over the 1964 - 1989 period, find higher volatility of the DJIA following introduction of VLCI futures contracts.

Studies on non US indices appear to point to similar results, Freris (1990) finds no volatility increase on Hong Kong's Hang Seng Index when futures contracts were introduced. Hogson & Nicholls (1991), examine the Australian All Ordinaries Index for the six year period surrounding futures introduction in 1983. They conclude that futures introduction had no impact on stock market volatility. In a multi-country study on futures introduction, Lee and Ohk (1992) examine daily return data for 2 years before and after the introduction of futures contracts in Australia, Hong Kong, Japan, the US and UK. The authors find no change in volatility in Australia and a decrease in volatility in Hong Kong, thereby confirming the results of Freris (1990) and Hogson and Nicholls (1991). They found evidence of increased volatility in Japan's Nikkei Index for the 2 years following futures introduction on SIMEX.[6] Evidence on the US and UK were mixed.[7] In yet another multi-country study but for the same futures contract, Bacha and Villa (1993) examined the impact of Nikkei futures introduction in Singapore (SIMEX), Osaka (OSE) and Chicago (CME) based on the Nikkei Stock Index of the Tokyo Stock Exchange.[8] They found increased volatility following the contract's first introduction on SIMEX, a *reduction* in volatility following the Osaka introduction and no change with CME listing.[9]

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[6] *Singapore International Monetary Exchange. The first futures contract on a Japanese Index was introduced on SIMEX.*

[7] *Volatility was found to be higher when different subperiods were used.*

[8] *The Nikkei futures contract was introduced on SIMEX in 1986, on OSE in 1988 and on the CME in 1990.*

[9] *There is a 15 hour time difference between Tokyo and Chicago, thus there is no contemporaneous trading.*

2.2: Relative Volatility

The volatility of futures contracts relative to the underlying stock market has been of major interest to researchers since the inception of futures contracts in 1982. Chu and Bubnys (1990) examine relative volatility using the natural logarithm of daily closing prices for the S&P 500 and the NYSE. For the six year period of their study ; 1982 to 88, they find futures volatility to be higher. A similar finding is made for a longer 10 year period by Koutmas and Tucker (1996). Using the Augmented - Dickey Fuller and the Engle Granger statistics, the authors also find that the volatility in both the futures and stock markets are highly persistent, are predictable on the basis of past innovation and have remarkably stable correlations. Yadav and Pope (1990) use volatility measured using the natural logarithm of daily close-to-close and open-to-open prices and the Parkinson Extreme Value Estimator to compare FTSE 100 index and futures volatility. They find futures volatility to be higher. A similar finding is made by Yau, Scheeweis and Yung (1990) for Hong Kong's Hang Seng Index and its futures contracts.

Studies on the Japanese index and its futures contracts has yielded interesting results. Brenner, Subramanyam and Uno (1990) examine daily closing prices of the Nikkei Futures contract traded on SIMEX and Osaka and compare it to the TOPIX index of the Tokyo Stock Exchange. They find higher futures volatility. Bacha and Villa (1993) use volatility measures similar to that of Yadav and Pope (1990) to compare volatility of the Nikkei Futures traded on SIMEX, Osaka and the CME with the Nikkei Stock Index. They found the volatility of the underlying Nikkei Stock index to be marginally higher than the futures contracts traded in Osaka but no different from that of SIMEX. The authors argue that this may be due to the much tighter regulatory framework on the OSE relative to SIMEX. These results appear to be confirmed by Choudry (1997) who studies short-run relative volatility on the Hang Seng, the Australian All Ordinaries and the Nikkei.

With the exception of the Nikkei, the other futures contracts were found to be more volatile than their underlying markets.

2.3: Futures Expiration Day Effect

Evidence of an expiration day effect on underlying market volatility appears mixed. Where an effect has been found, it appears mostly temporary and small in magnitude. Several studies have examined triple witching days in the US market. While, Stoll and Whaley (1987) and Edwards (1988) find no evidence of increased stock market volatility on futures expiration days, Feinstein and Goetzmann (1988), using a non-parametric test present evidence of extreme price movements on triple witching days. These results are supported by Hancock (1991) who finds an expiration day effect for the S&P 500.

Karakullukcu (1992) finds no expiration day impact on FTSE 100. This he argues, could be because the FTSE futures contracts' settlement prices are calculated based on mid morning rather than closing prices. Bacha and Villa (1993) arrive at similar results for the Nikkei stock and futures contracts. They find no evidence of an expiration day effect on the underlying Nikkei Index in Tokyo. They point out that these could be due to the staggered expiration dates and the use of different final settlement prices.

2.4: Evidence On Mispricing

A futures contract would be mispriced if its price deviates from its fair value adjusted for net carrying costs. The existence of index arbitrage should keep these deviations to a minimum. However, many studies have found significant arbitrage opportunities, especially in the early years of a contract. When adjusted for transaction costs, much of the mispricing appears to diminish. Still, the evidence of existing mispricing appears to be largely due to the presence of institutional barriers, uptick rules, restrictions on arbitrage activity, stale prices and execution risk or simply due to institutional inertia resulting from inexperienced traders, insufficient volume or an inadequate supply of arbitrage capital .[10] Studies on index futures traded in the US by Bhatt and Cakici (1990), Morse (1988), Billingsley and Change (1988) find deviations from fair-values that were sufficiently large, that transaction costs alone would not be sufficient to explain the deviations.

Studies on the S&P 500 that included transaction costs, such as those by Kipnis and Tsang (1984) and Arditti, Ayaydin, Mattu and Rigsbee (1986) found considerable mispricing. Though both over and underpricing were evident, there appeared to be a greater tendency for underpricing. This underpricing was particularly in evidence in the initial period of a contract. Though the inclusion of transaction costs creates a no-arbitrage bound resulting in less net mispricing, Klemkosky and Lee (1991) who also include indirect costs such marking to market and future taxes, found mispricing in about 5% of the sample.

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[10] *See: Charles M.S. Sutcliffe, (1992), Chapman & Hall Publishing.*

In the non US studies, Yadav and Pope (1990) find proportionate[11] underpricing for the FTSE 100. The mispricing however, reduces as the contract approaches maturity. A strong first order correlation in mispricing was also found. Yau, Scheewis and Yun (1990), in examining the Hang Seng index futures find futures to be overpriced even after adjusting for transaction costs in the period preceeding the 1987 crash. In the post-crash period, they found little mispricing.

Brenner, Subramanyam and Uno (1989b, 1990a) find significant underpricing for the Nikkei Stock Index futures over the 2 year period of their study 1986 - 1988. In approximately 42% of the observations, underpricing was found in excess of estimated transaction costs. The size of the underpricing however declined over time. A strong first order correlation in mispricing was found. Bacha and Villa (1993) replicated the Brenner et al study, but over a longer time period to include the Nikkei futures traded in Osaka and Simex[12]. Dividing their study into 3 subperiods, they find underpricing in the first subperiod, little mispricing in period 2 and near consistent overpricing in subperiod 3. The authors argue that this mispricing changes had to do with regulatory change in Japan. Brenner et al (1989b, 1990a) also point to regulatory relaxation in late 1989 for the reduction in underpricing noted in their results.

[11] *Proportionate mispricing refers to mispricing as a % of current index price.*

[12]*Brenner et. Al (1989b, 1990a) only examine the first two year when SIMEX alone had the Nikkei Futures contract.*

2.5: Patterns In Intraday Trading and Volatility

Analysis of timed interval intraday transactions data of stocks have shown systematic patterns in returns, trading volume and volatility. Typically, intraday volume and volatility have portrayed U-shaped patterns.[13] A number of researchers have presented evidence that these patterns exist in futures markets too. Among the early researchers were Kawaller, Koch and Koch (1990), Froot, Gammill and Perold (1990) and Cheung and Ng (1990). The latter two studies used 15 minute interval transactions data for the S&P 500 futures. Chan, Chan and Karolyi (1991), using five minute returns over a 5 year period of the S&P 500 futures find a U-shaped pattern within each day. Similar findings were made by Ekman (1992). The volatility of 15 minute logarithmic returns followed a U-shaped pattern within each day. Transaction volume showed a similar pattern.

In the most recent such study, Daigler (1997) examined the behaviour of S&P 500, MMI and T-bond futures over 15 minute and 5 minute intervals. Using standard deviation, number of ticks and the Garman-Klass volatility measure as measures for volatility, he reports the following findings; (I) volatility and trading activity display the basic U-shaped pattern (II) index futures volatility peaks at NYSE open (III) at end of day, the most volatile interval for index futures is not at NYSE close but approximately 30 minutes before NYSE close (IV) the results show little difference between the intraday patterns using the standard deviation or the Garman-Klass measure.

[13] *See: Chang, Kang and Rhee (1993) for a detailed analysis of the Malaysian Stock Market.*

2.6: Lead-lag Relationships In Returns And Volatility

Several previous studies, particularly of US markets have documented evidence of a lead-lag relationship between the futures and stock markets. Several reasons have been put forth to explain this relationship. Among these are (I) infrequent trading of stocks comprising the index; therefore the index reflects "stale" prices and so lags futures (II) differences in liquidity between the stock and futures markets, (III) informed traders may have a preference to trade in one market and not the other depending on whether the information is firm specific or systematic and (IV) due to market frictions such as transaction costs, capital requirements and short-selling restrictions that may make it more optimal to trade in the futures markets.

Ng (1987) tests for Granger causality between futures and underlying market returns for different underlying assets such as currencies, commodities and indices. The results suggest that futures prices generally lead spot prices. Kawaller, Koch and Koch (1987) using transaction data for a two year period, find that though the S&P 500 index and futures prices are highly correlated, futures leads the index by approximately 20 - 45 minutes. A similar result, although with a much smaller lead time was found[14] by Herbst, McCormack and West (1987) for the S&P 500. These results were further confirmed by Chan, Chan and Karolyi (1991), who, using five minute interval returns and a bivariate GARCH model found that futures lead spot by about 5 minutes. Stoll and Whalley (1990b) using 5 minute returns for a five year period and an ARMA model find that the S&P 500 and MMI futures lead their cash indices by about 5 minutes.

[14] *The lead was between zero to eight minutes with an average of 0.7 minutes.*

Interestingly this lead was not discernible in the Japanese markets. Lim (1992a and 1992b) examined the Nikkei futures traded on SIMEX and the underlying index in Tokyo over 5 minute intervals.[15] Based on his 20 day sample, he found no evidence of a lead-lag relationship. He argues that this may be due to the insignificant volume on SIMEX relative to the futures and cash market volume in Japan.

While the above studies provide evidence of a lead-lag relationship in returns, studies examining a lead-lag relationship in price volatility have found mixed results. While Kawaller, Koch and Koch (1990) find no systematic pattern in the S&P 500 for the 1984 - 86 period, Cheung and Ng (1990) find that the volatility of S&P 500 futures prices led that of the spot by 15 minutes. This latter study had adjusted for stale prices and GARCH effects. Chan, Chan and Karolyi (1991) find evidence of strong inter market linkages in volatility.

Based on these studies, it appears that while a lead-lag relationship in returns can be established there is weak evidence in the case of volatility. The volatility relationship appears to be much more time variant.

SECTION 3: DATA & METHODOLOGY

3.1: Description of Data

Daily price data of the Kuala Lumpur Composite Index (KLCI) for the 4 year period, January 1994 to end December 1997 is used.[16]   These were daily high, low,

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[15]*The Simex contract trades Simex Futures contemporaneously though Tokyo is one hour ahead of Singapore.*

[16]*The Composition of the KLCI was changed in on 15th April 1995. Index composition increased from 86 stocks to 100. We reconstructed the index for the preceeding period using weights (capitalisation) as of that date.*

open and close prices. Similarly, daily high, low, open and close prices for the KLCI futures contract for the two year period, 15th December 1995 to end December 1997 is used. For interest rates, we use daily quotations of the 3 month KLIBOR rate[17]. Dividend payment data (absolute Ringgit amounts) and payment dates for the two year period December 95 to December 97 were sourced from various issues of Investors Digest. The daily price and interest rate data were from Datastream.

Our fifth and sixth research questions required daily intraday data. Intraday data at 15 minute intervals is used for 2 different months, July and October 1998,[18] a total of 43 days. These were sourced from Bloomberg. The data set contains the time of transaction and the price for every futures transaction as well as the KLCI index level computed by Bloomberg every minute. Since, unlike the stock index, the futures price series is not uniformly spaced in time, the intraday price series were partitioned into 15 minute intervals. Based on these partitions, open, high, low and 'close' prices, volume and number of ticks for each 15 minute interval was determined. The entire data set consists of 1, 118 discrete intervals[19] consisting of 26, 15 minute intervals for each trading day.

3.2: Methodology

For ease of clarity, the description of our methodologies is arranged sequentially according to the earlier stated order of our six research question. In all cases, we study

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[17] *The Kuala Lumpur Interbank offer rate.*

[18] *Though these does not overlap with the earlier data set intraday data until mid 1998 was simply not available.*

[19] *26 intervals x 43 days*

only spot month contracts due to insufficient trading volume for distant contracts.[20] We use relatively standard methodologies/measures that have been used previously.

In addressing the first three questions which require volatility measures, we use three measures of volatility. Following Bacha and Villa (1993), we define the logarithmic return of daily closing prices as;

$$\ln(C_t / C_{t-1})$$

Where C_t is the closing price on day t. The variance of this return series is used as the measure of intraday volatility. The volatility second measure used is the Parkinson extreme value estimator. This is computed as the natural logarithm of the day's highest and lowest prices;

$$\ln(H_t / L_t)$$

The mean of this return series is used as our measure of trading period or intraday volatility.

Following Garman and Klass (1980), whose work further refined the Parkinson extreme value estimator to include additional information (the closing prices), for a statistically superior measure of volatility, we use the Garman - Klass Volatility (GKV) measure where necessary.[21]

This third measure is computed as;

$$\text{Var (GK)} = \tfrac{1}{2} [\ln (H_t) - \ln (L_t]^2 - [2 \ln(2) - 1] [\ln (O_t) - \ln (C_t)]^2$$

[20] *We track a contract beginning the last 10 trading days (2 weeks) of the previous month and until the day before its expiration. Thus, each spot month contract would be tracked for approx. 30 trading days Excluding the overlaps, our total sample period of futures is 506 trading days.*

[21] *Wiggins (1992) finds that both the Parkinson and GKV measures show little downward bias and are much more efficient than the close-to-close volatility measure.*

Where, H_t, L_t, O_t, and C_t are day t's high, low, open and close prices.

In examining the impact of futures introduction on underlying market volatility, we compare the average of the daily volatility before and after futures introduction. In addition to the overall period, we examine a ± 30 and ± 60 day window surrounding KLCI futures introduction on 15th December 1995. The question of relative volatility in the stock and futures markets is determined by comparing the volatility measures on a contemporaneous basis. We determine statistical significance using two test statistics. These are the F-ratio (parametric) and the non-parametric Wilcoxon - Z statistic.

To test for the existence of an expiration day effect, we use Feinstein and Goetzmann's (1988) non-parametric median test. Using all non-expiration days in our sample, the median and interquartile ranges of stock market volatility is determined using our first two volatility measures. Next, the volatility measures for expiration days is determined. Since by construction half of the non expiration days should fall within the interquartile range and half outside, we want to see if the expiration days deviate from this pattern. As in Feinstein and Goetzman (1988), we use the cumulative binomial distribution to test the likelihood that expiration day volatility is different from that of non-expiration days.

In addressing the fourth research question; i.e. the extent of mispricing on the KLCI futures; we compute mispricing, M_t, as the difference between the theoretical and actual prices divided by the theoretical price.

$$M_t = (F_t - F_t^*) \diagup F_t^*$$

Where; F_t is the actual or observed futures price on day t. F_t^* is the theoretical price or fair value. F_t^* is computed using the standard cost of carry model on an annualized basis as ;

$$F_t^* = S_t^* (1 + r\text{-}d)^{t,T}$$

Where S_t is the price of the stock index on day t, r is the 3 month annualized KLIBOR rate on day t, d is the annualized dividend yield[22] and t,T is the time remaining to maturity: $(T - t) \,/\, 360$.

We carry out 2 sets of mispricing analysis; with and without transaction costs. In order to include transaction costs,[23] we define C^+ as the cost of a cash and carry strategy and C^- as cost of a reverse cash and carry. We estimate a higher cost for a reverse cash and carry transaction and so add an additional 0.10% to C^+ to arrive at C^-. Using these notations, we define the upper and lower bounds of the no-arbitrage bounds as follows:-

$$F_t^+ = S_t (1 + C^+) (1 + r - d)^{t,T}$$

$$F_t^- = S_t (1 + C^-) (1 + r - d)^{t,T}$$

Using these bounds, we compute mispricing inclusive of transaction cost as m_t:

$$m_t = \frac{F_t - F_t^t}{F_t^t} \quad \text{if} \quad F_t > F_t^t$$

$$= 0 \quad \text{if} \quad F_t^- \leq F_t \leq F_t^t$$

$$= \frac{F_t - F_t^t}{F_t^t} \quad \text{if} \quad F_t < F_t^-$$

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[22]*the daily dividend yield is computed as* $\sum_i^n \left[\frac{(d_{i,t} \times w_{i,t}) + (d_{j,t} \times w_{j,t}) ....(d_{n,t} \times w_{n,t})}{IndexValue_{t-1}} \right]$

[23]*Transaction costs are estimated for a typical RM10 million transaction. While the commissions are straight forward listed amounts, the bid-ask spreads were estimates made by discussions with brokers.*

Our last two research questions are addressed using the 15 minute interval data. In examining for evidence of systematic patterns in intraday futures volatility and volume, we use the earlier mentioned 15 minute data. In measuring volatility, all three of the above-mentioned volatility measures, standard deviation, the Parkinson Extreme value estimator and Garman-Klass (GKV) measures are used. The only difference here being that the measures are based on each of the 15 minute partitions. The intervals begin at 9.00 am when both the futures and stock market begin trading and ends at 5.15 pm when the futures market closes. The stock market has two trading sessions; from 9.00 am to 12.30 pm and 2.30 - 5.00 pm. The futures market on the other hand, has trading sessions from 9.00 to 12.45 pm and 2.30 - 5.15 pm. Thus there are two 15 minute intervals; 12.30 - 12.45 pm and 5.00 - 5.15 pm when only the futures market is trading. These two intervals are therefore of special interest.

The mean values for each of these volatility measures for each 15 minute interval across all 43 days is determined. We then plot these mean values to check for evidence of a U-shaped pattern. Additionally, we also test for statistical differences among intervals of interest based on the plots.

In seeking evidence of patterns in trading activity, we use two measures for each of the 15 minute intervals. These are volume traded and the number of ticks. Previous studies appear to point at the number of ticks as being a better indicator of trading activity. Harris (1987) shows that the number of ticks for stocks are highly correlated with volume for the NYSE. Additionally, Karpoff (1986) and Varian (1989) also note that for given a time interval, the number of ticks is superior to volume as a measure of information arrival. Again, the mean volume and number of ticks for each interval across the 43 days is determined, plotted and select intervals tested for significance.

Our final research question involves examining the returns and volatility in the stock and futures markets for evidence of a lead-lag relationship. We do these by use of cross correlations and regression analysis. First, using the 15 minute return series of cash and futures indexes we compute the cross correlation coefficients of futures and cash returns for 10 lag and lead intervals. Theoretically[24], the contemporaneous rate of return of the futures and the stock market should be perfectly, positively correlated with the non-contemporaneous returns uncorrelated. Thus, a lead-lag relationship should not exist. In addition to cross-correlation returns, we also determine the cross-correlation of squared returns. Daigler (1997), has shown that this measure can be used as a crude indicator of the volatility link between the two indexes.

Cross-correlation coefficients however, do not provide information about whether the observed relationship reflects a simple cause-effect relationship or other complex relationships. As such, in order to determine the nature of the lead-lag relationship between stock and futures returns, regression analysis is used.

Following Abhyankar (1995) and Fortenbery and Zapata (1997), we use the following regression equation:

$$\Gamma_{c,t} = a + \sum_{k=-n}^{k=n} bkr_{f,t-k} + \in_{c,t} \text{ ....} (1)$$

where $\Gamma_{c,t}$ denotes stock market/cash return at time t, $r_{f,t}$ futures return at time t, n denotes the number of leads or lags used and $\in_{c,t}$ the error term. Based on our earlier tests which showed that cross correlations at longer leads and lags are

[24] *Assuming perfect markets and non-stochastic interest rates and dividend yields.*

insignificant, we restricted the regression to 5 lead and lag intervals. The regression test involves regressing stock market returns on lead, contemporaneous and lagged KLCI futures returns[25]. The coefficient with negative subscripts is the lead coefficient while a positive subscript a lag coefficient. If the lead coefficients are significant, then cash leads the futures and if the lag coefficients are significant than cash lags futures. Feed back exists when both situations prevail. Standard t-tests are used to determine significance.

We examine for potential lead-lag relationship in volatility between the two markets by revising the above regression equation as:[26]

$$V_{c,t} = a + \sum_{j=-n}^{j=n} bjV_{f,t-j} + \in_t \quad \text{.................... (2)}$$

Where $V_{c,t}$ and $V_{f,t}$ are the volatilities of the cash and futures respectively at time t, n the number of leads and lags and $\in$ the error term. As in the case of returns, we examine 5 leads and lags.

SECTION 4: EMPIRICAL RESULTS

In this section, we provide the results and analysis for our six research questions. Recall, that the first four questions were addressed using daily data while the last two questions with 15 minute interval transaction data.

4.1: Impact of Futures Introduction on Underlying Market

In analyzing the impact of futures introduction on the underlying stock market, we begin with an examination of Figure 1. Figure 1, plots daily movements in the stock

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[25] *In this case, b1 represents t - 1, which is the first lag of the difference between contemporaneous cash and futures levels, b - 1 represents t + 1, the first lead of the difference.*
[26] *See: Abhyankar (1995)*

market KLSE index; the 3 month KLIBOR and the cash market volatility measure, In$\left(C_t / C_{t-1}\right)$ for the four year period 1994 to 1997. The introduction of the Index futures contract on KLOFFE in December 1995 is also indicated. Visual examination of the volatility plot appears to show 3 segments. A first segment of high volatility from early 1994 to approximately July 1995. This is followed by segment 2; a period of relatively low volatility until about end April 1997. The final segment, has some of highest volatility. This third segment was the onset of the currency crisis. As is evident from the Figure 1, KLOFFE's opening appears to have had no impact on underlying stock market volatility. It appears that interest movements dictate stock market volatility. Segment 2, which witnessed very stable interest rates saw minimal stock market volatility eventhough index futures contracts were introduced early in the segment. Figures 2 and 3 which plot the daily volatility measures In$\left(C_t / C_{t-1}\right)$ and In$\left(H_t / L_t\right)$ for the stock market tells the same story. We confirm these casual observations with statistical significance tests. Table 1, shows the effect of futures introduction on stock market volatility for several window periods before and after. Both the 30 and 60 day periods show marginally higher volatility post introduction by both volatility measures. However, none of these are statistically significant, implying no change in volatility in the period immediately following introduction. Extending the window period obviously introduces any number confounding effects and would therefore be less reliable. Still, it is interesting to note the results. The one year period following futures introduction shows ***lower*** volatility. This is significant even at the 1% level. The 2 year window however has significantly higher volatility post introduction. The cause of this apparent contradiction is obvious from Figures 1, 2 and 3. The last 6 month period, from July 1997 onwards had the highest volatility plots. This was due to the onset of the currency crisis. Dropping that six month period and calculating the 1 ½ year window, again shows significantly lower volatility post futures introduction. A result consistent with that of the one year window.

Based on the more reliable 30 and 60 day windows, one can only conclude that futures introduction had no meaningful impact on stock market volatility. Overall, there certainly has not been any increase in volatility.

4.2: Relative Volatility; Futures Vs. Stock Market

Results of our volatility comparison between futures and stocks are shown in tables 2A, 2B and 2C. Table 2A shows the same day volatility by month for the stock market and the spot month futures contract on a daily basis using the close to close volatility measure. Table 2B, for the $\ln\left(H_t / L_t\right)$ measure. By the first measure, futures volatility is higher for 17 of the 24 month periods. Of these 4 are significant. Futures volatility is lower for only 7 contract periods, none significantly. By the second volatility measure, (Table 2B), futures volatility is higher for 13 of 24 periods. Of these, 8 significantly so. Futures volatility is lower for 11 month periods but only 5 are significantly lower. The GKV measure in Table 2C shows similar results. Futures volatility is lower for 9 contracts and significantly for 4. 15 futures contracts however have higher volatility. 9 of which are significant.

For the total period of 2 years or 506 daily observations, futures volatility is significantly higher by all three measures. It appears from these results, that daily volatility on the futures market is higher than that of the underlying stock market. A result that is consistent with earlier studies in other countries.

4.3: Expiration Day Effect

The settlement value of KLCI futures at expiration is determined as the average value of the stock index for the last half hour of trading (4.30 - 5.00 pm) on expiration day, after excluding the highest and lowest prices. This settlement value determination is quite different for example from that of the Nikkei or FTSE 100.

The results of our test for whether there is an expiration day effect is shown in Figs. 4 and 5 and Table 3. The figures show the median and the interquartile ranges for all non-expiration days. The distribution of expiration day volatility using the respective volatility measures is shown. In determining whether the expiration day volatility is statistically different from that of the sample non-expiration days, we examine probabilities. The probability that the observed expiration day would occur in a sample of non-expiration days is determined using the cumulative binomial distribution. A low probability would indicate a significantly different event and thus denote expiration days as unusual. The cumulative probabilities as shown in Table 3 are 15.4% and 72.9% respectively for the two volatility measures. These probabilities are much higher than the 5% (or 10%) levels used to establish significance. We conclude therefore that stock market volatility is no different on futures expiration days relative to normal non-expiration days. There appears to be no evidence of an expiration day effect.

4.4: Extent of Mispricing

Figure 6, shows the extent of daily mispricing for the overall period. The mispricing shown is exclusive of transaction costs. The figure shows a number of interesting features. First, there clearly appears to be much more frequent underpricing than overpricing. Second, the percentage and magnitude of underpricing is larger. Overpricing is not only less frequent but appears to be of a lower magnitude. Third, there appears to be stretches of very little or no overpricing, one example being the period June to August 1996. A final interesting factor is the overall trend. Unlike findings elsewhere, Brenner et al (1989b), Bacha and Fremault (1993), etc; which report reduced mispricing over time, Figure 6 seems to show quite the opposite. Mispricing is clearly higher in the latter periods of the study. Even if one ignores the period from the onset of the currency crisis, there clearly is no declining trend in mispricing over the 1½ year period preceeding crisis.

The patterns noted in Figure 6 are confirmed in Tables 4A, B and C. Table 4A shows the summary statistics of daily mispricing by each spot month contract. 19 of the 24 contracts studied had mean underpricing. 15 of these were significantly so. Only five contracts had mean overpricing, of these three were not significant. The standard deviation of mispricing shows a steady increase especially for the latter contracts. Our earlier observation from Figure 6 of the much higher frequency of underpricing is borne out in Table 4B. Clearly the proportion of days with underpricing is much higher than that of overpricing for all except a few contracts. Several sequential contracts have very few days of overpricing.

While transaction costs would effect arbitrageable opportunities on both sides:- i.e., both over and underpricing, the huge preponderance for underpricing that we have thus far observed needs to be explained. We believe this has partly to do with the regulatory framework. In essence, the regulation is biased against Reverse Cash and Carry arbitrage. While short selling of stocks are prohibited, there is no rule against shorting the futures contracts. When a futures contract is underpriced, the index arbitrage strategy would be to long futures and short the underlying index of stocks. The regulation however prevents this. On the other hand, when futures are overpriced there is no hindrance whatsoever to going short futures and long stocks. We believe the short selling regulation is a major reason for the preponderance of futures underpricing.

4.5 : Pattern in Intraday Volatility and Trading Activity

Summary statistics of the 15 minute intraday transaction data for KLCI index futures for the 43 sample days is provided in Table 6. The table shows the mean interval measures for the three measures of volatility, volume and number of ticks. Volume and number of tick is used as representative of trading activity/intensity. Previous studies have shown the existence of U-shaped volatility and volume patterns. To check for the existence of such a pattern, we plot the summary statistics of Table 6. The results are shown in Figures 7 to 11. Figures 7, 8, and 9 plot the three volatility measures. With the exception of the $\ln(C_t / C_{t-1})$ measure, the other 2 volatility measures show an overall U-shape. Such a shape is also evident for the trading activity measures, volume and number of ticks. (Figs. 10, 11)

Though we find an overall U-shape, one difference found here is the existence of a minor third peak. The two normal peaks; at opening (9.00 - 9.15 am) and a closing peak (5.00 - 5.15 pm) are clearly evident. This is consistent with Brock and Kleidon (1992) who propose that volume and volatility would be higher at opening and closing. Our findings however are different from that of Daigler (1997) who finds that volatility peaks not at the closing interval but approximately 30 minutes earlier.[27] Our findings are also different in that we find a clear third peak during the 2.30 - 2.45 pm interval. This is when the market reopens for the afternoon trading session following lunch break. To confirm whether the observed peaks at the specific 15 minute intervals are statistically

[27] *See; Daigler (1997), study using 15 minute interval data for S&P 500 futures.*

significant we did a pair wise t-test of each interval with its preceeding interval. The results for the three peaks were significantly different from its paired interval.[28] Table 7, shows the results for the comparison of select intervals.

Overall, the KLCI futures market does display U-shaped volatility and trading pattern. The one notable difference in this study is the clear evidence of a third peak when the market opens for the afternoon session. By and large these findings are consistent with the findings of Chan et.al (1991), Froot et.al (1990) and Cheung and Ng (1990) for the S&P 500 futures. The latter two studies had also used 15 minute interval data.

4.6: Test for Lead-lag Relationship

Our examination of possible lead-lag relationship in intraday returns between stocks and futures used cross correlations and regression. The result of the cross correlations between the returns of the stock index and futures for the 15 minute intervals for 10 lead/lag intervals is shown in Table 8. The contemporaneous relationship between futures prices and the index is quite strong at 0.7062. However, there is no statistical significance. The coefficients for all 10 of the lead and lagged intervals are much smaller. Table 9 shows the squared cross correlation of the return series. Squared cross correlation serves as a crude indicator of the volatility links (Daigler, 1997) between the two markets. Once again only the contemporaneous relationship is high. It is also the only coefficient that is significant. These results imply a positive contemporaneous relationship in volatility and a slightly weaker one in returns.

[28] *The results are not shown for want of space. The results are available on request from the authors.*

The cross correlation results are confirmed by the result of the regression equation (1), Table 10 panel (A). The contemporaneous coefficient is the highest. It is positive and significant, implying a contemporaneous relationship in returns. The lead coefficients for 3 intervals are all significant, however the size of the coefficients are small.

Testing for lead-lag relationship in the volatility of returns using regression equation (2) provided results shown in Table 10, Panel (B). The contemporaneous coefficient, though significant is very small. All the coefficients are small and none of the others are significant. There appears to be no evidence of any systematic relationship other than a marginally contemporaneous one in the volatility of returns.

Based on these results, we can only conclude that there is no evidence of a lead-lag relationship. The relationship is largely contemporaneous in nature. Both markets appear to react simultaneously to information arrival.

SECTION 5 : SUMMARY AND CONCLUSION

This paper examined several issues related to the introduction and trading of stock index futures contracts in Malaysia. Issues related to volatility, pricing efficiency, systematic patterns and lead-lag relationships were examined. These issues were studied by way of addressing six research questions. (i) What is the impact of futures introduction on underlying market volatility? (ii) How does futures volatility compare to stock market volatility? (iii) Is there any evidence of an expiration day effect? (iv) What is the extent of mispricing? (v) Are there systematic patterns in intraday volatility and trading? and (vi) Do the returns and volatility exhibit any lead-lag relationship? We use two data sets, daily price data for the 2 year period of futures trading and intraday 15 minute interval data for a total of 43 days.

Replicating previously used methodologies to test our data, we find no evidence of any increase in the volatility of the underlying stock market index as a result of futures introduction. If anything, the one year period following futures introduction had lower volatility. Comparison of relative volatility between the futures and stock index show higher futures market volatility. Our test for expiration day effect, showed no evidence of increased stock market volatility on futures expiration days. As has been the case in other newly introduced markets, we find frequent mispricing. Most of the deviations were in the form of underpricing. Overpricing was both less frequent and of smaller magnitude. Including transaction costs, we find much less mispricing. Of the remaining, underpricing was still dominant.

Using intraday 15 minute data, we find clear evidence of an overall U-shaped pattern in futures volatility and trading activity. In addition to peaks at the opening and closing intervals, our plots exhibit a minor third peak at market reopening after lunch break. Tests for the presence of a lead-lag relationship showed no evidence of such a relationship. Our results point to a relationship that is largely contemporaneous in nature. Both markets appear to react simultaneously to information arrival.

In conclusion, two points should be kept in mind. First, by our transaction cost estimates, a round trip cash and carry strategy would cost 2.22% whereas a reverse cash and carry strategy 2.32%. These are obviously high when compared to costs in developed markets. Estimating market impact costs, particularly bid-ask spreads has been difficult. We have also not included the possibility of quasi-arbitrage and negotiated commissions which have recently been made possible for certain categories of players.

A second point, is the relative size of the futures market to the underlying stock market. The Ringgit value of trading volume in the futures market relative to stock market volume though not insignificant, is still small. We would estimate it at an average 20 - 25% of stock market Ringgit volume. That there was no impact of futures introduction on stock market volatility and no evidence of an expiration day effect should not be surprising given the perspective of size. The lack of a lead-lag relationship but a largely contemporaneous one and a U-shaped pattern is also consistent. Chang, Kang and Rhee (1993), had established the existence of a U-shaped pattern in the Malaysian Stock Market. It appears from our results that the futures market given its small size may merely be following and not dictating trends in the underlying market.

REFERENCE

1. Abhay Abyankar, "Linear and Nonliner Granger causality: Evidence from the U.K. Stock Index Futures Market", The Journal of Futures Markets, 1998, volume 18, No. 5, pp 519-540.

2. Abhay H. Abhyankar, "Return and Volatility Dynamics in the FT-SE 100 Stock Index and Stock Index Futures Markets", The Journal of Futures Markets, 1995, volume 15, No. 4, pp 457 - 488.

3. Antoniou A, Holmes P and Priestly R. (1998), "The Effects of Stock Index Futures Trading on Stock Index Volatility: An Analysis of the Asmmetric Response of Volatility to News", 18 pp 151 - 166.

4. Arditti F.D., Ayaydin S., Muttu R.K. and Rigsbee S. (1986), "A Passive Futures Strategy That Outperforms Active Management", Financial Analyst Journal, 42, pp 63-67.

5. Bacha O. and Villa F. (1993a), "Multi-Market Trading and Price-Volume Relationship: The Case of the Nikkei Stock Index Futures Markets", Working Paper 92-93, Boston University.

6. Bacha O. and Villa F. (1993b), "Futures Markets, Regulation and Volatility: The Case of the Nikkei Stock Index Futures Markets", Working Paper 92-93, Boston University.

7. Brenner M., Subramanyam M. And Uno J. (1989), "The Behaviour of Prices in the Nikkei Spot and Futures Market", Journal of Financial Economics, 23, pp 363 - 384.

8. Brenner M., Subramanyam M. And Uno J. (1990), "Arbitrage Opportunities In The Japanese Stock and Futures Markets", Financial Analyst Journal, 46, pp 14-24.

9. Brown-Hruska S. And Kuserk G. (1995), "Volatility, Volume, and The Notion of Balance in the S & P 500 Cash and Futures Markets", Journal of Futures Markets, 15, pp 677 - 689.

10. Chang, Kang and Rhee (1993), "The Behaviour of Malaysian Stock Prices". Working Paper No. WP9302, PACAP Research Center. The University of Rhode Island.

11. Choi H. And Subramanyam A. (1994), Using Intraday Data to Test For Effects of Index Futures on The Underlying Stock Markets", Journal of Futures Markets, 14, pp 293 - 322.

12. Choudry T. (1997), "Short-Run Deviations and Volatility in Spot and Futures Stock Returns: Evidence From Australia, Hong Kong and Japan", Journal of Futures Markets, 17, pp 689 -705.

13. Chu C.C. and Bubnys E.L. (1990), "A likelihood Ratio Test of Price Volatilities: Comparing Stock Index Spot and Futures", Financial Review, 46, pp 1791 -1809.

14. Dahrat A.F. and Rahman S. (1995), "Has Futures Trading Activity Caused Stock Price Volatility?", Journal of Futures Markets, 15, pp 537 -557.

15. Edwards F.R. (1998a), "Does Futures Trading Increase Stock Market Volatility?", Financial Analyst Journal, 44, pp 63-69.

16. Edwards F.R. (1998b), "Futures Trading and Cash Market Volatility: Stock Index and Interest Rate Futures", Journal of Futures Markets, 8, pp 421 - 439.

17. Feinstein S.P. and Goetzmann W.N. (1988), "The Effect of the "Triple Witching Hour" on the Stock Market Volatility", Economic Review, September - October, pp2 - 18.

18. Freris A. F. (1990), "The Effects of The Introduction of Stock Index Futures on Stock Prices: The Experience of Hong Kong 1984 - 1987", Pacific Basin Capital Market Research, pp409-416.

19. Gregory Koutmos and Michael Tuckers, "Temporal Relationships and Dynamic Interactions Between Spot and Futures Stock Markets", The Journal of Futures Markets, 1996, volume 16, No. 1 pp 55-69.

20. Hancock G.D. (1991), "Futures Options Expiration and Volatility in The stock Index Futures Market", Journal of Futures Markets, 11, pp 319 -330.

21. Hodgson A. and Nicholls D. (1991), "The Impact of Index Futures Market on Australian Share Market Volatility", Journal of Business Finance and Accounting, 18, pp 267 - 280.

22. Karakullukcu M. (1992), "Index Futures : Expiration Day Effects in The UK and prospects in Turkey, Mimeo, London School of Economics, May, pp36.

23. Kipnis G.M. and Tsang S. (1984), "Arbitrage in Stock Index Futures", (ed F.J. Fabozzi and Kipnis G.M.) Dow-Jones Irwin, pp 124 -141.

24. Koutmas G. And Tucker M. (1996), "Temporal Relationship and Dynamic Interactions Between Spot and Futures Stock Markets", Journal of Futures Markets, 16, pp 55 -69.

25. Lee S.B. and Ohk K.Y. (1992), "Stock Index Futures Listing Structural Change In Time Varying Volatility", Journal of Futures Markets, 12, pp 493 -509.

26. Miller M.J. and Galloway T.M. (1997), "Index Futures Trading and Stock Return Volatility: Evidence From The Introduction of MidCap 400 Index Futures", The Financial Review, 32, pp 845 - 866.

27. Pericli A. and Koutmas G. (1997), "Index Futures and Options Market Volatility", Journal of Futures Markets, 17, pp 957 - 974.

28. Robert T. Daigler, "Intraday Futures Volatility and Futures Theories of Market Behaviour", The Journal of Futures Markets, 1997, volume 17, pp 45-74.

29. Sharon Brown-Hruska and Gregory Kuserk, "Volatility, Volume and the Notion of Balance in the SPP 500 Cash and Futures Markets", The Journal of Futures Markets, 1995, volume 15, No. 6, pp 677-689.

30. Stoll H.R. and Whalley R.E. (1991), "Expiration Day Effect: What Has Change?", Financial Analyst Journal, 47, pp 58 -72.

31. Taufik Choudry, "Short Run Deviations and volatility in Spot and Futures Stock Returns Evidence From Australia, Hong Kong and Japan", The Journal of Futures Markets, 1997, volume 17, No. 6, pp 689-705.

32. T. Randall Fortenbery, "An Evaluation of Price Linkages Between Futures and Cash Markets for Cheddar Cheese", The Journal of Futures Markets, 1997, volume 17, No. 3, pp 279-301.

33. Twite G.J. (1991), "The Pricing of Share Price Index Futures Contracts With Taxes and Transaction Costs", University of South Wales, Working paper, 40 pp.

34. Yadav P.K. and Pope P.F. (1990), "Stock Index Futures Arbitrage: International Evidence", Journal of Futures Markets, 10, pp 573 - 604.

35. Yau J., Schneeweis T, and Yung K. (1990), "the Behaviour of Stock Index Futures Prices in Hong Kong: Before and After the Crash", Pacific Basin Capital Market Research, pp 357 -378.

Chart 1

Contract Specification

Contract Specifications Kuala Lumpur Stock Exchange Composite Index Futures Contract	
Contract Code	FKLI
Underlying Instrument	Kuala Lumpur Stock Exchange Composite Index ("KLSE CI")
Contract Size	KLSE CI Futures multiplied by RM100.00
Minimum Price Fluctuation	0.1 index point valued at RM10.00
Daily Price Limits	20% per trading session for the respective contract months except the spot month contract. Matched trades which exceed the price limits are not valid.
Contract Months	Spot month, the next month, the next two calendar quarterly months. The calendar quarterly months are March, June, September and December.
Trading Hours	First trading session: Malaysian 08.45 hours to 12.45 hours, Second trading session: Malaysian 14.30 hours to 17:15 hours.
Final Trading Day and Maturity Date	The last Business Day of the contract month.
Final Settlement Day	Prior to the start of Business Day following the Final Trading Day
Final Settlement	Cash Settlement based on the Final Settlement Value
Final Settlement Value	The Final Settlement Value shall be the average value, rounded upwards or downwards to one decimal point (0.005 being rounded upwards) of the KLSE on the Final Trading Day excepting the highest and lowest values.
Margins	Initial Margin: RM6,000 per contract Spot Month Spread Margin: RM1,500 Back Month Spread Margin: RM1,250.

Source: KLOFFE Handbook On Business Rules.

Table 6 : Summary Statistics Of Volatility And Trading Activity Measures.

	Volatility Measures			*Trading Activity Measures.*	
Time	In(Ct/C t-1)	In(Ht/Lt)	GKV.	Number of ticks	Volume
09:00 - 09:15		0.0112	0.0058	50.6429	172.9048
09:15 - 09:30	0.0061	0.0083	0.0033	42.0000	92.6905
09:30 - 09:45	0.0048	0.0060	0.0018	34.2093	87.5814
09:45 - 10:00	0.0051	0.0052	0.0014	29.6744	75.8605
10:00 - 10:15	0.0032	0.0046	0.0010	28.7907	61.3256
10:15 - 10:30	0.0033	0.0041	0.0009	24.8095	72.2381
10:30 - 10:45	0.0042	0.0045	0.0009	24.1429	55.2143
10:45 - 11:00	0.0041	0.0046	0.0011	23.8049	68.1463
11:00 - 11:15	0.0033	0.0039	0.0007	20.5476	43.9286
11:15 - 11:30	0.0026	0.0040	0.0007	22.3095	73.1429
11:30 - 11:45	0.0030	0.0040	0.0007	20.9268	73.0976
11:45 - 12:00	0.0036	0.0039	0.0007	21.8095	50.3571
12:00 - 12:15	0.0031	0.0039	0.0007	23.7857	56.3333
12:15 - 12:30	0.0049	0.0044	0.0008	19.2857	54.1905
12:30 - 12:45	0.0023	0.0027	0.0003	15.2857	33.4762
14:30 - 14:45	0.0060	0.0061	0.0017	34.5250	80.6000
14:45 - 15:00	0.0049	0.0051	0.0012	27.8049	61.3171
15:00 - 15:15	0.0036	0.0047	0.0010	25.5750	66.0250
15:15 - 15:30	0.0041	0.0050	0.0012	27.4615	61.1538
15:30 - 15:45	0.0053	0.0051	0.0012	25.0732	66.9762
15:45 - 16:00	0.0045	0.0049	0.0012	27.8333	57.6190
16:00 - 16:15	0.0054	0.0050	0.0012	26.7619	64.4286
16:15 - 16:30	0.0033	0.0043	0.0009	26.7674	66.0465
16:30 - 16:45	0.0032	0.0042	0.0009	28.1395	61.7674
16:45 - 17:00	0.0039	0.0047	0.0011	32.8837	84.0698
17:00 - 17:15	0.0047	0.0063	0.0020	55.3721	149.0698

This table reports the of the volatility and trading activity measures for KLCI Futures.
Summarizes the 15 minute interval data across all 43 days.
GKV, refers to Garman-Klass Volatility.

Table 7 : Test Of Significance For Select 15 Minute Intervals

Volatility : ln (Ct/Ct-1)

Intervals Compared		t statistics	p ratio	significant
09:00 - 09:15	12:30 - 12:45	4.0427	0.0015	**
09:00 - 09:15	14:30 - 14:45	0.5944	0.2834	
09:00 - 09:15	17:00 - 17:15	2.3590	0.0213	*
17:00 - 17:15	12:30 - 12:45	3.2334	0.0052	**
17:00 - 17:15	14:30 - 14:45	-1.3487	0.1052	
16:15 - 16:30	16:45 - 17:00	-1.4534	0.0900	
16:15 - 16:30	17:00 - 17:15	-0.7190	0.2452	

Volatility : ln (Ht/Lt)

Intervals Compared		t statistics	p ratio	significant
09:00 - 09:15	12:30 - 12:45	11.8572	0.0000	**
09:00 - 09:15	14:30 - 14:45	4.9208	0.0004	**
09:00 - 09:15	17:00 - 17:15	5.1542	0.0003	**
17:00 - 17:15	12:30 - 12:45	6.2375	0.0001	**
17:00 - 17:15	14:30 - 14:45	0.1815	0.4300	
16:15 - 16:30	16:45 - 17:00	-0.9192	0.1910	
16:15 - 16:30	17:00 - 17:15	-2.8394	0.0097	**

Trading Activity: Number Of Ticks

Intervals Compared		t statistics	p ratio	significant
09:00 - 09:15	12:30 - 12:45	6.5248	0.0001	**

09:00 - 09:15	14:30 - 14:45	2.5509	0.0157	*
09:00 - 09:15	17:00 - 17:15	-1.3094	0.1114	
17:00 - 17:15	12:30 - 12:45	8.6796	0.0000	**
17:00 - 17:15	14:30 - 14:45	3.3445	0.0043	**
16:15 - 16:30	16:45 - 17:00	-2.5122	0.0166	*
16:15 - 16:30	17:00 - 17:15	-7.9931	0.0000	**

Trading Activity: Volume

Intervals Compared		t statistics	p ratio	significant
09:00 - 09:15	12:30 - 12:45	4.0804	0.0014	**
09:00 - 09:15	14:30 - 14:45	2.7754	0.0108	*
09:00 - 09:15	17:00 - 17:15	3.5454	0.0031	**
17:00 - 17:15	12:30 - 12:45	4.0333	0.0015	**
17:00 - 17:15	14:30 - 14:45	2.5259	0.0162	*
16:15 - 16:30	16:45 - 17:00	-2.2879	0.0240	*
16:15 - 16:30	17:00 - 17:15	-4.4374	0.0008	**

The above tables highlight the statistical significance tests for the volatility and volume measures.The selection of intervals is to confirm the significance of the opening, closing and re-opening peaks.

I) opening interval with mid day, re-opening and closing interval.
ii) closing interval with mid day and re-opening interval
iii) 4.15 -4.30 interval with last two 15 minute intervals.

Note : * sign.at 5% level, ** sign. at 1%.

Table 8: Cross-Correlations ;KLCI Index and Futures Returns.

	coefficient	t statistics	p value	significant
Cash Leads				
10	0.0277	-0.0063	0.4975	
9	-0.0172	-0.0081	0.4968	
8	0.0061	-0.0067	0.4973	
7	-0.0015	0.0152	0.4939	
6	0.0668	0.0226	0.4910	
5	0.0565	0.0175	0.4930	
4	0.0142	0.0247	0.4901	
3	0.0402	-0.0052	0.4979	
2	0.0102	-0.0134	0.4947	
1	0.1106	-0.0136	0.4946	
O	0.7062	-0.0078	0.4969	
Cash Lags				
(1)	-0.0963	-0.0122	0.4951	
(2)	-0.0094	-0.0053	0.4979	
(3)	-0.0018	-0.0137	0.4945	
(4)	0.0188	-0.0238	0.4905	
(5)	0.0469	-0.0508	0.4798	
(6)	0.0497	-0.0425	0.4831	
(7)	0.0223	-0.0497	0.4802	
(8)	-0.0135	-0.0513	0.4795	
(9)	0.0119	-0.0563	0.4775	
(10)	0.0039	-0.0552	0.4780	

Note : * denotes sign.at 5% level; ** sign. at 1%

Table 9: Squared Cross-Correlations; KLCI Index And Futures Returns.

	coefficient	t statistics	p value	significant
Cash leads				
10	-0.0091	-1.4290	0.0767	
9	-0.0077	-1.4297	0.0765	
8	0.0152	-1.4441	0.0745	
7	-0.0048	-1.4282	0.0768	
6	-0.0006	1.4305	0.0764	
5	0.0115	-1.4377	0.0754	
4	0.0056	-1.4344	0.0759	
3	0.0075	-1.4386	0.0753	
2	-0.0055	-1.4300	0.0765	
1	0.0010	-1.4341	0.0759	
O	0.7062	-2.6025	0.0047	*
Cash lags				
(1)	0.0078	-1.4376	0.0754	
(2)	0.0022	-1.4350	0.0758	
(3)	0.0063	-1.4362	0.0756	
(4)	-0.0079	-1.4273	0.0769	
(5)	-0.0031	-1.4277	0.0768	
(6)	-0.0057	-1.4266	0.0770	
(7)	-0.0024	-1.4291	0.0766	
(8)	-0.0066	-1.4265	0.0770	
(9)	-0.0068	-1.4266	0.0770	
(10)	-0.0011	-1.4301	0.0765	

Note : * denotes sign.at 5% level; ** sign. at 1%

Table 10: Results Of Linear Regression ; 15 Minute Intervals

Panel A: Index Returns with Lead -lags of Futures Returns. (Eq. 1)

	X-coefficient	t statistics	p value	significant
b - 5	0.0053	0.3169	0.7514	
b - 4	-0.0093	-0.5495	0.5828	
b - 3	-0.0107	-0.6298	0.5290	
b - 2	-0.0020	-0.1159	0.9078	
b -1	-0.0103	-0.6068	0.5441	
b 0	0.5926	35.0298	0.0000	**
b 1	0.1652	9.7520	0.0000	**
b 2	0.0449	2.6537	0.0081	**
b 3	0.0431	2.5475	0.0110	*
b 4	0.0047	0.2775	0.7814	
b 5	0.0207	1.2312	0.2185	

Panel B: Volatility of Index Returns with Lead -lags of Futures Return Volatility. (Eq. 2)

	X-coefficient	t statistics	p value	significant
b - 5	-0.0024	-0.1338	0.8936	
b - 4	0.0118	0.6263	0.5312	
b - 3	0.0101	0.5329	0.5941	
b - 2	0.0082	0.4248	0.6711	
b -1	-0.0017	-0.0910	0.9275	
b 0	-0.0705	3.6739	0.0002	
b 1	-0.0010	-0.0524	0.9582	
b 2	-0.0035	-0.0178	0.8582	
b 3	0.0050	0.2594	0.7953	
b 4	-0.0008	-0.0432	0.9656	
b 5	-0.0066	-0.3501	0.7263	

Note : * denotes sign.at 5% level; ** sign. at 1%

The coefficients with negative and positive subscripts are the lead and lagged coeficients, respectively. If the lead coefficients are significant, the cash index leads the futures index and vice versa. Feedback exists when both the situations prevail, that is returns of cash and futures indexes lead or lag each other.