INTRADAY ANALYSIS OF FUTURES VOLATILITY AND RETURN DYNAMICS BETWEEN THE KUALA LUMPUR COMPOSITE INDEX (KLCI) AND KLCI FUTURES

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ABSTRACT

This paper studies intraday futures volatility and lead-lag relationships between KLCI and KLCI Futures. For intraday futures volatility, the study compares the different volatility measures to determine the consistency of their results and whether the results exhibit the U-shaped patterns. For lead-lag relationships, the study investigates the relationship between returns and volatility of returns of KLCI and KLCI Futures. The relationships are also examined under different market conditions. Finally, the relationship between closing prices or returns and volume of KLCI Futures are studied to determine whether there is a causal relationship running between the two variables.

The results of the volatility tests on KLCI Futures returns show that all volatility measures, with the exception of standard deviation, show the classic U-shaped volatility patterns. However, instead of the normal 2 peaks, the study exhibits the existence of 3 peaks. The tests of relationships between returns of cash and futures indexes show that there is a contemporaneous relationship between the two indexes. Futures market also leads the cash market for certain lagged intervals. On lead-lag relationships in volatility of returns, there seems to be no clear pattern of one market leading the other. The study on relationship between returns or closing prices and volume shows that past volume has no influence on returns or closing prices. However, futures returns or closing prices have predictive power on futures volume.

1. INTRODUCTION

The existence of intraday U-shaped curves in volatility, volume and bid-ask spreads has resulted in the development of several theories to explain the U-shaped patterns. The curves are characterised by significantly higher volatility of the variables at the opening and closing of trading as compared to other times within the trading day. Researchers attribute this pattern to various theories, such as the information theory where informed and uninformed traders concentrate their trading activities during certain time. Their choice to trade during these periods creates periods of high volatility and trade activity. Others relate the U-shaped curve to the market maker or closure theory that creates high volatility and trading volume at the open and close of cash and futures markets.

Another equally interesting area that has attracted the attention of many researchers is the linkages and interactions between the returns and volatility of returns of stock index futures and underlying cash markets. Most studies tend to focus on the nature of the lead-lag relationship between the two markets and whether any markets exhibits a price discovery function; where the movements of returns in one market can predict the movements for those in the other market. A number of studies find that the futures market generally leads the stock market.

As stock index futures contracts are usually priced using the forward pricing model or cost of carry model, the contemporaneous rate of returns of stock index futures contract and the underlying stock portfolio should be perfectly correlated. Hence, the arrival of new information should affect both markets so that the movement of price in one market will not lead or lag movements of prices in the other market. However, due to imperfections in the market place, empirical tests have shown the presence of lead-lag relationship between the two markets. Recent studies have also focussed on the nature of the relationship under different market conditions and the relationship in the volatility of returns between stock and futures markets.

The relationship between assets price variability and trading volume has also been an area of intense empirical investigations. These studies are important as the causality tests can provide useful information on whether knowledge of past trading volume enhances the predictability of current and futures prices and vice versa.

The objectives of this study are to examine several issues relating to the trading of stock index futures contracts and to enhance the understanding of the dynamics of futures markets by providing empirical answers for a number of questions as follows:

- Whether the intraday volatility and trading patterns in the futures market exhibit the U-shaped curves,

- Whether movements in returns and volatility of returns in futures markets lead the movements in cash markets, and
- Whether return and trading volume of futures market exhibits any lead-lag relationship.

For intraday futures volatility, the study compares the three different measures of volatility; the standard deviation, Parkinson's extreme value estimator and Garman-Klass volatility measures and trading activity (volume and number of ticks) to examine the consistency of the results between these different measures. The study employs the observations for the 15-minute time intervals to examine the behaviour of the Kuala Lumpur Composite Index Futures returns.

For the lead-lag relationship between returns and volatility of returns of cash and futures indexes, first, the study investigates the relationship of returns using 15-minute intervals and hourly observations. Second, the study examines the nature of the relationship under periods of 'good', 'normal' and 'bad' news[1], high and low volatility, different trading activity and different stock market performance. Third, the study investigates the relationship between the volatility of cash and futures markets.

[1] Periods of 'good', 'normal' or 'bad' news are defined based on the sign and size of the cash index returns. The cash and futures indexes are stratified into the three groups with the cash index returns from the highest to the lowest as the proxies for the arrival of 'good', 'normal' or 'bad' news.

Finally, the relationship between the lead-lag in the volatility between the two markets is examined under periods of 'good' and 'bad' news, low and high volume, high and low volatility and different stock market performance.

The study proceeds as follows. The next section provides a review of the theoretical and empirical work on the previous studies that has been done on the relevant subjects. This work serves as a foundation for the current study. Then, the methodology used in this study is discussed together with the methods of interpreting the results. The description of the data, the sources and the background of KLCI and KLCI Futures are presented after the methodology. The next section provides a complete discussion of the empirical results obtained from the various tests. The final section closes the study by discussing the implications of the results and suggestions for future research.

2. LITERATURE REVIEW

This section is devoted to the review of the existing literature on the research issues, that is the intraday futures volatility, lead-lag relationship between the futures and spot returns and relationship between returns / closing prices and volume of futures market.

2.1 Intraday futures volatility and theory of U-shaped curves

2.1.1 Theoretical background

Many studies have been carried out on intraday futures volatility to examine the pattern and to determine the factors causing the pattern. Certain researchers also attempted to study the behaviour of futures market when the underlying cash market is closed or open. Most of the findings of intraday futures volatility show U-shaped curves, which are characterised by higher values of the volatility measures at the opening and closing of markets as compared to other periods within the trading day.

There are various theories explaining the U-shaped pattern, such as the strategic interaction of informed and uninformed traders, the bid-ask bounce by market makers, idiosyncratic opening procedures, the asymmetric capacity of traders to bear risk and the loss of price discovery (Frino, Hill, Jarnecic and Toner, 1998). Admati and Pfleiderer (1988) have developed the information theory. The theory states that the interaction of informed and uninformed traders resulted in the execution of their trades at the same time and hence, creates a period of high volatility and trade activity. Brooke and Kleidon (1992) develop the market maker power or market closure theory. The theory stipulates that the opening and closing times for both the underlying cash and futures markets will have large volume and

high volatility as a result of the liquidity demand from traders re-balancing their portfolio before and after the market closes.

Daigler (1997) has outlined the potential reasons for heavy trading at the open and close for the underlying markets, which are related to the type of investors and their strategies, as follows:

At the open and close

- The higher volatility, trading volume and spreads registered when the markets close is due to the expectation of portfolio traders that pricing behaviour will change overnight that will ultimately affect investors' optimal portfolios. Thus, portfolio based traders will trade actively at the open and close due to the change from a closed market to continuous trading and vice versa.

At the open

- The arrival of information during the closed period and the accumulation of demand generate higher trading at the open. The information will create different perceptions between the traders and thus, creating greater volatility and the potential for larger trading volume.

At the close

- Index mutual fund managers need to trade at the closing price for purchases and redemption and their activities initiate trading at the close.
- Short sellers have to close out their positions before the end of the day.
- Depending on their positions, hedgers often hedge their open positions since they cannot monitor or change their positions overnight.

The theories discussed above only relate to volatility of the underlying market. However, whether the futures markets exhibits similar pattern of volatility to the underlying markets depends on whether the factors influencing price pattern of underlying and futures assets are similar. As the derivative markets are generic in nature and the trading mechanism differs, the influencing factors may be different. The main differences in the trading mechanism between futures and stock markets in the United States are that the trading of futures contracts are executed in pits and the presence of a large number of market makers. These market makers, or commonly called scalpers, influence both volume and bid-ask spread of these markets.

Another significant difference between futures and the underlying cash markets is the time period over which the futures market opens for business. Stock index futures cease to trade 15 minutes after the stock market closes (12.45 p.m. and 5.15

p.m.). This difference enables the examination of price dynamics of futures market especially when the cash market closes its business.

Examining the interday and intraday prices can indicate the effect of market closure on futures markets. The theory for futures, however, has to be adjusted because of two reasons. First, it is necessary to accommodate the presence of various categories of market players and second, due to the additional uses of derivative markets for risk management purposes. This amended concept has been labeled as the "extended market closure model" for futures markets by Daigler. The market players comprise mainly the scalpers and day traders who close their positions before the market close for the day and cash market dealers who sometimes hedge their portfolio with futures shortly before the futures markets close. However, both markets must open for the arbitrageurs to match their futures trades with trades in the underlying assets.

Another area that has been extensively studied is the behaviour of futures markets when the underlying market is closed or open. King and Wadhwani (1990) construct a model of market behaviour both when the related market is open at the same time and when it is not. They found that the traders form their expectations from watching the price behaviour of the underlying markets. As such, the price behaviour in one market affects the price behaviour of the other related markets and the price volatility declines upon the closing of an associated market. This

concludes that trading is an important contributor of volatility as the volatility is much larger when the underlying market is open than closed.

2.1.2 Empirical tests

Through the development of an asymmetric information model, Admati and Pfleiderer (1988) explain the strategic trading behaviour of the different group of traders and the impact of their behaviour on volatility and trading volume. The informed traders prefer to time their trades to obtain minimum costs or maximum advantage. Even though there is a difference in their time preference, the model found that all strategic traders choose to trade in the same time periods. Even though the model could not determine the exact periods, Admati and Pfleiderer believe that the opening and closing of the market will attract higher volume and volatility due to high non-discretionary liquidity demand.

Through the use of a continuous trading model, Brock and Kleidon (1992) show that large bid-ask spreads at the open and close and U-shaped patterns in volume and volatility liquidity are created through the action of traders re-balancing their portfolios before and after the market closures. Brock and Kleidon name this theory as a market maker power or market closure theory.

By examining foreign exchange trading in New York and London, Hsieh and Kleidon (1994) found the two markets exhibit U-shaped volatility and bid-ask spreads. Two possible reasons are given for these patterns, first, it reflects the price patterns and market activity of retail customers in the interbank market and second, it could be the result of an inventory model effect.

The tests and observations mentioned above are based on underlying markets. For futures markets, the researchers who found U-shaped pattern on volatility, volume and bid-ask spread are Jordan et al (1988), Lee and Linn (1994) and Ekman (1990,1992). Jordan et al, Lee and Linn, and Ekman found U-shaped patterns in volatility and trading activity for soya bean futures, S&P 500 futures, and Eurodollar futures, respectively.

On the other hand, by using futures audit trail data for foreign exchange futures, Ferguson, Mann and Schneck (1993) found convex U-shaped intraday patterns for volume and spreads. They also find that the closure of spot market affects volatility and this contradicts discretionary liquidity model and market closure model.

In a more recent study, Daigler (1997) examined the behaviour of S&P 500, MMI and T-bond futures for 15-minute and 5-minute intervals and found the market possess the basic U-shaped pattern for volatility and trading activity. Daigler uses

standard deviation, number of ticks and Garman-Klass volatility measure as measures of volatility and the findings are:

- The 15-minute results show the dominance of the cash market over the futures market.[2] The overall results show that when the cash market is open, both stock index futures and the T-bond contracts are more volatile than when the cash market is closed. For the 5-minute intervals, the results show a peak for stock index futures at the NYSE open and the T-bond futures spike at 8.30 a.m.
- Even though, theoretically, the Garman-Klass measure is a better method of estimating volatility as it includes more information, the results show little difference between the intraday patterns using the standard deviation or the Garman-Klass measure. As the tests of significance provide higher values for the standard deviation measure, the standard deviation is more likely indicates statistical significance.
- The closing cash market interval for stock index futures is not the most volatile time interval near the close. The most volatile time interval is approximately 30 minutes before the NYSE close.

[2] Daigler explained the theory of dominance as the behaviour of futures market when the cash market is closed or opens. If futures market is more volatile or active when the cash market is closed than when it is open, then the futures market dominates the cash market at the close. However, in this case, as the futures market is less volatile when the cash market is closed, then the cash market dominates the futures market.

Frino, Hill, Jarnecic and Toner (1998) analyse intra-night pattern in price volatility, volume and quoted spreads to examine the behaviour of the futures market when its underlying market is closed. Their findings are that in the absence of US macro-economic releases, volume and volatility are found to follow a classic U-shaped curve whilst quoted spreads drift upward through the night, narrowing towards the close. US macro-economic release results in the elevation of volume and volatility and a widening of spreads across all the major contracts.

Overall, despite the common perception of the U-shaped curve, empirical studies for intraday futures volatility do not consistently exhibit a U-shaped curve in all research results.

2.2 Lead-lag relationship

2.2.1 Theoretical Background

Many studies have explained the price relationship between stock index futures and the underlying assets in terms of arbitrage behaviour. Futures prices normally vary relative to spot prices within ranges that are not sufficient to trigger arbitrage. A number of studies have attempted to measure the arbitrage trading boundaries and noted that the future and cash price differential should fall within the

boundaries as determined by the cost of carry. [3] The forward pricing or cost of carry model explains the relationship between the futures and cash prices. The model, which is normally used in the pricing of stock index futures contracts, is represented by the following equations:

$$F_t = C_t \exp(r - d)(T - t)$$

$$r_{c,t} = (r - d) + r_{f,t}$$

where F_t = index futures prices at time t; C_t = spot index prices at time t; $r_{c,t} = \ln C_t/C_{t-1}$; $r_{f,t} = \ln F_t/F_{t-1}$; $r - d$ = net cost of carrying the underlying stocks in the index and $T - t$ = time remaining to the expiration date (T) of the futures contract. From the above equations, it can be implied that the contemporaneous rates of return of the futures and the cash indexes must be perfectly correlated while the non-contemporaneous rates of return are non-correlated. Hence, lead-lag relationship should not exist.

The model assumes that the markets are perfect. However, as the markets are imperfect, a lead-lag relationship will occur between the index futures and cash market returns due to the following reasons:

[3] The difference between both returns is the cost of carry, that is the storage cost plus the interest that is paid to finance the asset less the income earned on that asset.

- Infrequent trading of the stocks making up the cash index will result in the lead-lag relationship between the two markets. The futures index is computed instantaneously when the trade takes place while the cash index is computed every minute. Hence, if a constituent stock is not traded when the cash index is calculated, its value then will be represented by its last transaction price. Therefore, the cash index reflects "stale" prices and will lag the futures prices that reflect current information.
- Differences in liquidity between the spot and futures markets could also induce a lead-lag relationship between the two markets.
- The presence of market frictions such as transaction costs, capital requirements, and short-selling restrictions may influence certain traders to invest in the futures market rather than the cash market (Stephan and Whaley (1990), and Miller (1990)). Informed traders with private information can trade based on that information at a lower cost in the futures market than in the spot market. This will also result in a lead-lag relationship between futures and cash prices.
- Informed traders may also prefer to trade in the spot market rather than in the futures market depending on whether the information is firm specific or systematic. If firm specific, it would be better to trade that specific shares rather than trading the index futures. In this case, the transmission of information runs from the spot to the futures market.

2.2.2 Empirical tests

There are numerous studies that attempt to explain the temporal relationship between the index futures and cash index returns and its causality. By using a variety of stock indices, currencies and agriculture commodities, Ng (1987) tests for causality between returns of cash and futures indexes and finds that futures prices generally lead spot prices. Similarly, Kawaller et al. (1987) find that the S&P 500 futures lead the S&P 500 index returns by 20 to 45 minutes, while the lead from cash to the futures only lasts for about one minute. Chatrath and Song (1998) also find that the Japanese Yen futures markets tend to lead the spot markets. Their result shows that the futures markets play an important role of price discovery as the markets react more efficiently to new information. Abhyankar (1998) also reports similar findings, where FTSE 100 index futures tends to lead the cash index by about 5 to 15 minutes.

Other researchers who find that the futures market leads the cash market are Iihara et al. (1996) and Pizzi et al. (1998). Iihara et al, find that the NSA futures returns lead the Nikkei Stock Average returns strongly for approximately 20 minutes while the cash returns weakly lead the futures returns by 5 minutes. Pizzi et al, use a cointegration approach to test whether there is a causal relationship between S&P 500 and 3-month and 6-month futures contracts. Their results show that both futures contracts lead the spot market by 20 minutes. However, the spot

market only leads the 3-month futures for 3 minutes while the 6-month futures by 4 minutes.

On the other hand, using cash and futures markets for cheddar cheese, Fortenberry and Zapata (1997) test for a long run equilibrium relationship in terms of pricing behaviour between the two markets and find no evidence of a stable long run relationship between cash and futures markets for cheddar cheese.

The above studies test the existence of lead-lag relationship between returns of cash and futures indexes. Recent studies have been extended to focus on the lead-lag relationship in the volatility of returns of the cash and futures indexes based on the concept of causality in variance. Kawaller et al. (1990) use intraday data on the S&P 500 Index and Index futures to examine the relationship between the futures price volatility and index volatility using unconditional variance estimators. They fail to find a systematic pattern for futures volatility leading index volatility. Iihara et all (1996), however, report that the intermarket relationship of return shocks on volatility in the other market in significant in the futures to cash direction, but not in the opposite direction. Chan et al. (1991), using a bivariate AR(1)-GARCH(1,3) model to study the S&P 500 index futures and cash returns, find a much stronger bi-directional dependence with past volatility of futures price changes identified as an important predictor of the future volatility of the cash price changes.

The overall findings of the above studies provide empirical evidence to the existence of lead-lag relationship between the two markets. Most studies note that the returns in the futures market seem to lead the cash market and a weak evidence of predictive ability from cash to futures. On the variability of returns, many researchers fail to find the evidence of the relationship between the two markets. The relationship appears to be much more timing variant.

2.3 Return-Volume Relationship

2.3.1 Theoretical Background

It is widely known that the arrival of new information and subsequent revision of expectation by investors induced trading in asset markets. The trading volume reflects the information about the changes and agreement in investors' expectation. A thorough examination of contemporaneous and temporal relationships between volume and returns might reveals valuable information on different aspects of activity in futures markets.

Numerous studies have been carried out to determine the causal linkage between assets price or returns and trading volume. There are four main hypothesis explaining the relationship: