Multi-scale Lead-Lag Relationship between the Stock and Futures Markets: Malaysia as a Case Study

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Abstract

There is a considerable literature relating to a lead-lag relationship between the stock index (spot) and stock index futures markets in developed countries compared to emerging countries. The analysis of this relationship in an emerging market based on a different investment horizon is significant for both academic and trading purposes. In this study, we analyze the lead-lag relationship between stock index and stock index futures in Malaysia. We use a new approach based on the Continuous Wavelet Transform (CWT) and the Discrete Wavelet Transform (DWT). The results show variability of the lead-lag relationship across frequency ranges and time scales, and also occasional in-phase behaviour between both markets. The relationships between stock index and stock index futures are shown to evolve over time with non-homogeneous trends across different time scales. Some strong correlations have been found in lead-lag interactions between the markets. The result from this study would provide a better picture of a current derivatives market in emerging countries, specifically in Malaysia. Hopefully it will shed some light in furthering the development of Islamic equity futures within the Islamic capital market, therefore will encourage Islamic asset managers to use derivatives as a hedging tool to protect their funds' value.

Keywords: Stock Index, Stock Index Futures, Lead-Lag Relationship, Continuous Wavelet Transform, Discrete Wavelet Transform

1. Introduction

Derivative instruments in their current form are relatively new instruments compared to other financial assets such as stocks and bonds. According to Bacha and Mirakhor (2013), derivatives are important financial instruments for risk management since derivatives permit flexibility in asset management, they may however, have an adverse effect if applied inappropriately. In Malaysia, derivatives instruments are traded on Bursa Malaysia Derivatives Bhd (BMD) which is currently Malaysia's only derivatives exchange. The instruments of derivatives traded on BMD are:

1. Commodity derivatives such as Crude Palm Oil Futures (FCPO), USD Crude Palm Oil Futures (FUPO), and Crude Palm Kernel Oil Futures (FPKO).
2. Equity derivatives such as FTSE Bursa Malaysia Kuala Lumpur Composite Index Futures (FKLI), FTSE Bursa Malaysia Kuala Lumpur Composite Index Options (OKLI), and Single Stock Futures (SSFs).
3. Interest rate derivatives such as Three-month Kuala Lumpur Interbank Offered Rate Futures (FKB3), Three-year Malaysian Government Securities Futures (FMG3), and Five-year Malaysian Government Securities Futures (FMG5).

As equity derivative instrument, FTSE Bursa Malaysia Kuala Lumpur Composite Index Futures contracts (FBMKLCI futures or known as FKLI) are traded based on the underlying FBMKLCI constituents (FBMKLCI spot). Details of the FKLI contract specification are shown in Appendix 1.

Malaysian derivatives market with the current level of liquidity and volatility is still underdeveloped. The lack of a comprehensive derivatives market poses a challenge to increasing liquidity and connectivity between different market segments and assets classes, which leads to pricing inefficiencies (Fung, et al, 2010). As stated in Malaysia Capital Market Master Plan 2 (CMP2), inefficiency in pricing increases transaction costs and reduces trading activities due to high costs associated with hedging and arbitrage (Securities Commission Malaysia, 2011). Mohamad and Hassan (2007) and Bacha and Mirakhor (2013) alluded to the Malaysian derivatives market being one of the lowest ranking in the world, as well as in the region in terms of trading volume. The latter reported that as at end-2010, Malaysia's Bursa Derivatives ranked 42nd by traded volume compared to Korea Exchange, which ranked 1st. Bursa Malaysia's liquidity ranking in Asia dropped from the 3rd place in 1996 to 14th in 2010 and at 13 percent volatility. Furthermore, the Malaysian government's think-tank for national transformation reported that Bursa Malaysia was the least volatile exchange in the region compared to other Asian capital markets like Singapore at 25 percent volatility, Hong Kong at 22 percent and Japan at 23 percent PEMANDU (2010). The performance of other markets which started at about the same time as the Malaysian market, but were already attracting global players with good liquidity like Hong Kong and Korea motivated Mohamad et al., (2007) to high-list a number of key issues that were required in order to make the Malaysian derivatives market globally significant for foreign investors.

The Malaysian government, via its regulatory bodies such as Bank Negara Malaysia and Securities Commission has firmly set its commitment to develop the country's capital market. One of the growth strategies in the CMP2 is to facilitate the efficiency of price discovery from underlying cash markets to derivatives markets, and making it conducive to pricing

efficiencies and flexibilities for hedging. Consecutively, the development of Malaysian derivatives market is vital in order to strengthen the industry learning curve, retain risk product specialists and build up risk intermediation capabilities (Securities Commission Malaysia, 2011). On 20 September 2010, Bursa Malaysia stepped up as one of the pioneer emerging market countries to migrate its derivatives products to the CME GLOBEX electronic trading platform. Following the migration, Bacha and Mirakhor (2013) reported that foreign participation in the Malaysian derivatives market rose 57% in 2011, demonstrating how global trading platforms can enhance liquidity in domestic markets.

Apart from developing the capital market, one of the Securities Commission's (SC) main agendas is the development of the Islamic capital market in Malaysia[1]. The *Shari'ah* Advisory Council (SAC) is tasked with the responsibility of ensuring compliance to *Shari'ah* principles. The SAC functions as a *Shari'ah* advisor to the SC on all matters pertaining to the Islamic capital market development. In addition, the SAC also functions as a centre of domestic reference and they are regarded as the highest authority for issuing *fatwas* for all Islamic capital market issues in Malaysia.

The Securities Commission of Malaysia (2009) reported that they have adopted two approaches when introducing Islamic capital market products. The first approach was to study the validity of conventional instruments used by the Malaysian capital market from the *Shari'ah* perspective. The study concentrated on the composition, procedure and usage of the instruments to determine whether they were against *Shari'ah* principles. The second approach involved formulation and development of new *Shari'ah* compliant financial products.

In line with the SC's main agenda to develop the Islamic capital market in Malaysia, the Malaysia International Islamic Financial Centre (MIFC) was launched in August 2006 to position Malaysia as an international Islamic financial hub. It is set to strengthen Malaysia's role as a scholarly centre for Islamic finance. The MIFC consists of a group of financial and market regulatory authorities, government departments and agencies, financial institutions, human capital development institutions, and professional services companies in the Islamic financial industry. As an avenue for *Shari'ah* compliant investment opportunities, it aims to position the country into an attractive financial investment destination for those surplus units with excess funds and those deficit units who seek to raise funds.

Supported by the *Shari'ah* governance and legal frameworks and experts in the field, Islamic finance in Malaysia could well be poised for growth with a comprehensive Islamic financial system. Malaysia is well positioned to act as a gateway to facilitate and enhance greater international linkages and market integration in Islamic finance between the Asian region and the rest of the world as indicated in the report by Ernst & Young, (2011). At present, Malaysia is the biggest hub with Saudi Arabia in the next position. Malaysia's global brand is synonymous with its capabilities in Islamic finance, expectedly the wealth management industry is one of the fastest growing financial services sector in Malaysia and Southeast Asia.

The impacts of derivatives on the capital market and on the economic system have been well documented in academic literature and debated amongst economic scholars and practitioners. While there have been many studies on equity futures derivatives in developed countries such

[1] This agenda to develop Islamic capital market in Malaysia was incorporated into the Malaysian Capital Market Masterplan which was launched on 22 February 2001. One of the main objectives set by this plan is to establish Malaysia as an international hub for Islamic finance.

as US, Japan and Europe very few studies have been done in emerging markets like Malaysia. Mohamad, et. al., (2007) highlighted a limited documented evidence on Malaysian derivatives market and call for a considerable research to be conducted. They also suggested that further validation of the results from previous researches could be done by using better models, larger samples and longer time periods.

Critics argued that derivatives were the culprits behind financial bubbles and crisis, however, as evidenced from empirical studies, results were mixed, as discussed in texts by Sutcliffe (2006), Bacha (2012) and Bacha and Mirakhor (2013). Krichene (2013) discussed that although derivatives were traded in capital markets around the world, they remained a controversial topic in Islamic finance. There is an excellent compilation and discussion on the differences in *Shari'ah* scholars' views pertaining to the issues of derivatives in Islamic finance by Bacha and Mirakhor (2013). Subsequently, there is a need to understand the keys issues related to the interaction between spot and futures markets in emerging markets, as in the case of Malaysia, for future policy making.

This paper extends previous literature in the following important aspects. First, this study attempts to analyze the multi-scale lead-lag relationship between the stock index and the stock index futures in Malaysia by using a longer period of datasets, which consist of daily data and high frequency intraday data. Gallegati (2008) stressed that the capital market provided an example of a market in which the participants involved consisted of heterogeneous investors making decisions over different time horizons (from minutes to years) and operating at each moment on different time scales (from speculative to investment activity). In this way, the nature of the relationship between the stock index and the stock index futures might vary across time scales according to the market participants' investment horizon, as the smaller time scales might be linked to speculative activity while the common scales to investment activity. Therefore, the use of high frequency intraday data allows identification of different market participants' behaviour at different trading horizons.

Second, this study employs a useful analytical tool represented by wavelet analysis, based on the Continuous Wavelet Transform (CWT) and the Discrete Wavelet Transform (DWT). The use of this new approach in studying the multi-scale lead-lag relationship between the stock index and the stock index futures in Malaysia may be justified in two different aspects: firstly, wavelet analysis can be used to overcome the problems due to non-stationarity of the time series data; and secondly, wavelet analysis can be a very practical technique for analyzing financial relations especially when there are distinctions between different investment horizons. To the best of our knowledge, our work is the first attempt to study the multi-scale lead-lag relationship between the stock index and the stock index futures markets in an advanced emerging country using the wavelets.

Our main finding posits that the stock index and the stock index futures in an emerging market like Malaysia shows strong dynamics in co-movement in the time domain during various investment horizons. Our results, consistent with discussions by Kamali (1999a) and Kamali (1999b), support further development of Islamic equity futures as a hedging instrument that the Islamic asset managers can use to protect their funds' value. The results suggest that when looking at the dependence between the stock and futures markets, market participants should always keep in mind its time-varying nature, thus, looking at the various investment horizons according to their different investment objectives.

The paper is organized into five sections. In section 1 we have provided an introduction to the study. Section 2 provides a literature review of the stock index futures according to the Islamic law of contract, and the existing empirical studies on the lead-lag relationship between the stock index (FBMKLCI) and the stock index futures (FKLI). Section 3 explains the data and techniques on continuous wavelet and discrete wavelet. Section 4 provides an analysis and discussion of the findings, and section 5 provides the summary and concluding remarks.

2. Literature Review

2.1. Stock index futures according to Islamic law of contract

Developing an Islamic capital market requires a deep understanding of the operations of the current capital market and contemporary analysis of *Shari'ah* principles. A thorough study regarding the permissibility of futures contract and prospects for developing Islamic derivatives as financial instruments in Malaysia had been undertaken by Kamali, (1999a) and Kamali, (1999b).

Tan Sri Sheikh Ghazali Haji Abdul Rahman, Chairman of the Securities Commission *Shari'ah* Advisory Council postulated that there might be several disagreements between the SAC resolutions in Malaysia and the opinions of *Shari'ah* experts in other countries, due to contextual difference and their needs to exist. Such diverse doctrinal views, according to him, were not unusual among the founders in the history of the development of Islamic legislation. He quoted that even the founder of the *Shafi'i Mazhab* namely Imam Shafi'i, had two different opinions on a single particular issue depending on whether it existed in a different environment, background, time and place (Securities Commission of Malaysia, 2009).

Similarly, Shaharuddin et. al., (2012) highlighted that disagreements in the opinions of *Shari'ah* experts had been occurring since the first generation of Muslims. They noted that these disagreements were allowed in Islam if they occurred within the standard ethical norms and appropriate behaviour. These disagreements might be motivated by the pursuit of knowledge and truth.

There are several *Shari'ah* issues pertaining to stock index futures. Most of the remaining reviews of the relevant literature are based on the resolutions made by the SAC.

The issue of common plight (umum balwa)

Umum balwa is an unfavourable common situation affecting many persons and is hard to avoid. The SAC, at its 2nd meeting on 21 August 1996, when discussing the issue of a benchmark for *haram* elements in a mixed company[2], resolved that the situation categorized

[2] Securities Commission of Malaysia (2009) defined a mixed company as a company where its main activities involve in permissible (*halal*) elements, but its sub activities involve a small portion of prohibited (*haram*) elements. The considerations by the SAC for mixed companies for its inclusion in the list of *Shari'ah*-compliant securities are as follows:
(a) the company's main activities must be in compliance with *Shari'ah* principles and the *haram* elements must be very marginal compared to the main activities;
(b) the company must have a good reputation in terms of public perception of the company's image; and

as *umum balwa* needed to be considered in determining the status of a mixed company. They argued that there were a number of maxims of Islamic jurisprudence that excuse Muslims trapped in *umum balwa* situations. The aim of such an excuse was to facilitate the carrying out of daily activities. Without such an allowance, the interest (*maslahah*) of the public would be affected especially in an economic field that involves the control of assets (*mal*) and trades as well as social stability (Securities Commission of Malaysia, 2009).

The issue of price fixing based on futures pricing

Price is a very important element in a sales and purchase according to *Shari'ah* principles. A majority of Islamic scholars argued that any sales and purchase contract done without determining the price is invalid. This was the general guideline that needed to be complied because *Shari'ah* specified the need to know the price to avoid dispute (*niza*) and uncertainty (*gharar*). There were different methods in determining the price, SAC opined that if both parties to the contract agree on the mechanism for determining the price, then the issue of dispute and uncertainty could be solved (Securities Commission of Malaysia, 2009).

FTSE Bursa Malaysia Kuala Lumpur composite index futures (FKLI) contract

A composite index futures contract is one of the instruments categorized as a financial futures contract. It is an instrument for managing risks in portfolio investment management. Although there are some similarities with the *Shari'ah* concepts such as *salam* and *istisna*, the instrument is not fully compatible with those concepts. The SAC had studied this new contract and resolved that it did not contradict *Shari'ah* principles, provided the index components comprised of all *Shari'ah* compliant securities. Therefore, stock index trading was allowed as long as it was *Shari'ah* compliant, and this could be done by ensuring that the underlying index component was made up of *Shari'ah* compliant securities. However, in its decision on FKLI contract, the SAC concluded that this contract was not permissible by *Shari'ah* because it was based on the underlying index where some of its components were securities of companies that had not been approved by the SAC. Nevertheless, in the perspective of risk management, the SAC agreed on the importance of discussing the extent to which the stock index mechanism was permissible according to *Shari'ah* principles (Securities Commission of Malaysia, 2009).

The concept of asset (mal)

The recognition of *mal* is necessary in determining whether something can be traded according to Islamic law of contract. In their argument, the SAC quoted the views of Imam Suyuti who outlined the concept of *mal* as something that had a value that could be bought and sold, and could be compensated for its damage. Based on this guideline, they confirmed the position of a futures contract as *mal*. The SAC argued that the instrument had a value within a specific period and was traded on its own market. In a composite index futures contract, it was of value until the maturity date, after which the contract could not be traded. However, the contract holder still benefited from the difference in the buying and selling price upon maturity (Securities Commission of Malaysia, 2009).

(c) the company's main activities have value and general benefit to the Muslim community and the country, and the *haram* element is very minor and involves matters such as common plight (*umum balwa*), custom (*urf*) and the rights of the non-Muslim community which are accepted by Islam.

The issue of buying something that does not exist (bay ma'dum)

The SAC asserted that Ibn Qayyim had studied the issue of *bay ma'dum* and clarified that the prohibition of *bay ma'dum* was actually due to presence of an element of uncertainty in delivering the assets sold. In the case of *bay ma'dum*, such transactions could take place regardless of whether the assets existed or not. Nevertheless, they said that this type of sale involved something that existed and the seller could obtain it or in the form that could be made tangible. They argued that this situation often occurred in *Shari'ah* based transactions, such as forward sale (*salam*) and contract of manufacture (*istisna*). Therefore, the SAC concluded that *bay ma'dum* was prohibited because of the element of *gharar* rather than the element of something that did not exist. In their arguments the SAC stated that the above situation did not occur in the crude palm oil and index futures markets. The contract could be settled in cash before the due date or settlement by delivery on the due date. In addition, the delivery and settlement of transactions had been guaranteed by the clearing house. Therefore, in this case the element of *gharar* either did not exist or was insignificant (Securities Commission of Malaysia, 2009).

In the context of index futures contract, there is actually no physical delivery on the due date. This is unlike the crude palm oil futures trading where physical delivery could take place. As a solution, the SAC concluded that a substitution of physical delivery for cash could be accepted in accordance with *Shari'ah* principles and was not an innovation in Islam. They quoted the work by Al Baghdadi[3]. Based on that, they held that such settlements were carried out when physical delivery could not be made possible (Securities Commission of Malaysia, 2009). This provides a solution on the issue by using a cash value according to the current market value, without causing any kind of interference[4] in the market.

Customs specifically occurring in economic activities (urf iqtisadi khas)

Customs or common practices recognized by the local people either in action or verbally in their daily lives are known as *urf*. The composite index futures contract is an instrument applicable to fund managers and other market participants to manage risks in market price. The SAC argued that in principle, the instrument was a valid common practice specifically occurring in economic activities (*urf iqtisadi khas*) that did not contradict *Shari'ah* principles. What needed to be corrected was that the index component should consist of *Shari'ah* compliant securities (Securities Commission of Malaysia, 2009).

The issue of no exchange of assets (iwadh)

Iwadh refers to the exchange in buying and selling. The SAC discussed the issue of *iwadh* in the case of crude palm oil futures contract. However, this issue is also applicable to composite index futures contract. The SAC remarked that the issue of *iwadh* raised by modern *Shari'ah* scholars referred to the situation where a purchase of assets did not take place. Therefore, there was no increase in real economic value. However, the SAC argued that this situation did not occur in crude palm oil futures transactions. They contended that market participants actually benefited in terms of value increment from the transaction. The SAC stated an example, when producers of crude palm oil hedged their position they were actually attempting to reduce their costs. As a result, this would indirectly contribute to their

[3] According to the SAC, discussion on the relevant issues had been done by Al Baghdadi in his book entitled Majma' al Dhamanat.
[4] Means any manipulative act to increase or decrease the market price.

products' competitiveness and improve their business returns (Securities Commission of Malaysia, 2009). Based on this instance, similarly we argue that when fund managers hedge their portfolio, they actually reduce the risk of their investment portfolio. As a result, fund investors would benefit in case there is a sudden drop in the securities market and so a reduction in their investment value could be minimized. This is in line with one of the objectives of *Shari'ah* (*maqasid Shari'ah*) on the protection and preservation of *mal*. A detailed explanation of the concept and approaches of *maqasid Shari'ah* in Islamic finance had been discussed by Lahsasna, (2013).

The issue of gambling (qimar)

Besides the issues discussed earlier, the issues of gambling (*qimar*), uncertainty or deception (*gharar),* ignorance or lack of knowledge (*jahalah),* and speculation are among the main issues emphasized by modern *Shari'ah* scholars who do not permit composite index futures contracts. The SAC asserted that buying and selling of index was different with gambling because there was no similarity to losing by chance. In gambling, the player lost all his money if the result was against his guess, in mathematical sense, the loss would be 100%. This did not happen in composite index futures transactions as the total index points had their own intrinsic value. In an actual scenario, the investor would experience a change in the value depending on the demand for the total number of securities that comprised the index component. Therefore, they concluded that index trading did not involve any element of gambling.

Another argument discussed by the SAC was on the requirement imposed on the market participants to place a deposit as a margin of payment before they began trading. This action was regarded by some *Shari'ah* scholars as a prohibited bet. The SAC resolved that such a trading activity did not represent gambling, instead, the fluctuation in the value was due to the change in the market's demand and supply, a common phenomenon in trading. The SAC held that it was not appropriate to judge a contract whose value fluctuated due to the changing market demand and supply as a gambling activity as the latter depended solely on luck and were not determined by forces in market demand and supply (Securities Commission of Malaysia, 2009).

The issue of uncertainty and deception (gharar)

Gharar refers to uncertainty and deception. In the case of futures contracts, the issue of *gharar* relates to the uncertainty in getting the assets that have been bought and in receiving potential returns. Similarly, the SAC defined *gharar* as something dangerous (*khatar*) and they also agreed that the term meant cheating (*khida')*[5]. In terms of terminology, they defined *gharar* as elements of uncertainty that could expose market participants to danger. For example, a sale and purchase contract which did not state its price was said to possess an element of *gharar* as cheating in price could occur in the transaction. The SAC derived three main definitions of *gharar* according to the opinion of a majority of *Shari'ah* scholars. First,

[5] With reference to forward buying and selling of a product that had not been seen by the buyer. This referred to the context of the buyer's exposure to uncertainty which was based on the *Syafi`i Mazhab* who defined *gharar* as uncertainty with high risks. However the *Hanafi Mazhab* defined *gharar* as uncertainty with minimum risks. The *Syafi`i Mazhab* was seen to be stricter in guarding the interest of the buyer. The SAC held that based on the different views of the *Syafi`i* and the *Hanafi Mazhabs* different interpretations of *gharar* had different impact on the relevant rulings. However, the two *mazhabs* had indifferent views on steps taken to avoid the risks of cheating in a sale and purchase contract.

they concluded that *gharar* was ignorance (*jahalah)* about the products. Second, g*harar* was suspicion (*syak*) of the possibility that the assets might not eventually exist. Third, they concluded that *gharar* referred to something with an unknown result. The SAC opined that in business or market, returns[6] were common factors although market participants desired to earn positive returns[7]. Thus market participants should seek to minimize their losses by taking some risk management actions. They resolved that the existence of *gharar* in the main activity of a listed company on Bursa Malaysia could result in the exclusion of the company's securities from the list of *Shari'ah* compliant securities approved by the SAC[8].

The SAC divided *gharar* into three, namely small or slight (*gharar yasir*), moderate (*gharar mutawassit*) and excessive or huge (*gharar fahisy*). The SAC stated that *Shari'ah* scholars generally opined that *gharar yasir* did not give any effect on the contract while *gharar fahisy* could invalidate the contract. However, they had differences of opinions on *gharar mutawassit*. Since it was impossible for the buyer and seller to avoid the element of *gharar* completely, the SAC concluded that there were three conditions where the element of *gharar* could be excused. The first condition occurred when the *gharar* element was minor and small. The second condition occurred when such transaction was needed by the public. The third condition was when the *gharar* element could not be avoided without hardship (*masyaqqah*) that was recognised according to *Shari'ah* principles. The SAC explained the issue of *gharar* mostly in the case of crude palm oil futures contract. However, this issue is also applicable to composite index futures contract. They held that this contract did not contain elements of *gharar* and *jahalah* as it was traded in clear quantities with standardized pricing. There was no ambiguity in price and quantity, and the market determined the price based on the forces of demand and supply. The SAC concluded that when a futures contract was offered, specifications such as price, quantity, type, and delivery date were made known to the market players. Therefore there was no element of *gharar* in the contract. All specifications were made clear in the contract, and surveillance and regulation were provided to ensure that there was no element of misrepresentation and cheating in the contract (Securities Commission of Malaysia, 2009).

The issue of negative element that can affect the validity of aqd (ghalat)

The SAC held that another important element in the transaction of a futures contract was the negative element of *ghalat*. They argued that this should be clarified as there was confusion between the issue of *gharar* and *ghalat*. Unlike *gharar* which had been generally defined as elements of uncertainty and deception, the SAC defined the term *ghalat* as an error in perception. The SAC held that *ghalat* existed in a situation where the assumption or expectation made by a buyer turned out to be otherwise. The SAC stated that *ghalat* meant that market players were given the freedom to conduct transaction on a basis of a mutual

[6] Returns can be either positive (profit) or loss (negative).

[7] The SAC quoted two verses from the *Quran* that described the fear of incurring negative returns in business transaction namely *Surah al Fatir* verse 29 which means "For them, they secretly and openly hope for a commerce that will never fail." and *Surah al Taubah* verse 24 which means *"... the commerce in which you fear a decline."*

[8] As an example, the SAC categorized business activity of conventional insurance companies as *gharar* because when the buyer bought the insurance policy and there was uncertainty as to whether the item bought was obtainable or not. The bought policy would only be claimed if the insured peril happened, but in actual case it might or might not happen. Therefore, the SAC held that it was uncertain if the bought policy would materialize.

consent and mutual trust in their transactions in order to ensure efficient market operation (Securities Commission of Malaysia, 2009).

The SAC held that *ghalat* element caused by a market participant's wrong assessment could not be used as a basis for termination of a contract. An example is where market participants bought certain stock and shares with expectations of getting positive returns, however, the market turned against their expectations and the shares price dropped. As a result, they ended up getting negative returns. This case was categorized as the buyers' personal error in their assessment. This error did not allow the party to withdraw from the contract. Except for this kind of *ghalat* element, the contract did not contain any *gharar* element. On the other hand, the *ghalat* elements that could invalidate a contract involved the elements that could distract the market operations such as fraud and manipulation. The SAC argued that *ghalat* could impact and invalidate a contract if it affected the type and feature of the traded object[9](Securities Commission of Malaysia, 2009).

The issue of speculation

Speculation is one of the issues that shed some doubts on the permissibility of futures contract according to *Shari'ah* principles. Speculation refers to the act of obtaining a huge return based on the fluctuation in the price of assets, be it real or financial assets. Oxford Dictionary of Finance and Banking defined speculation as follows:

"Speculation is the purchase or sale of something for the sole purpose of making a capital gain. For professional speculators the security, commodity, and foreign exchange markets are natural venues as they cater for speculation as well as investment and trading. Indeed, speculators help to make a viable market and thus smooth out price fluctuations. This is particularly true of futures and option markets".

The above definition of speculation indicates that speculation exists in all forms of business and is not only limited to futures transactions only, as pointed out by the SAC. The concern is whether it is excessive or conducted under normal circumstances. The SAC, at its 10th meeting on 16-17 October 1997, and 11th meeting on 26 November 1997, discussed the issue of crude palm oil futures and resolved that to a certain extent speculation was permissible under Islamic jurisprudence (Securities Commission of Malaysia, 2009).

Similar to the issue of *iwadh*, the issue of speculation is also applicable to composite index futures contract. In its arguments that support the permissibility of speculation, the SAC maintained that speculation was never discussed by past Islamic scholars because it was a term used in the modern world of finance. The SAC also asserted that speculation was present in all forms of trading and was not limited to the securities market. The securities market was an avenue that permitted shareholders to dispose their ownership of shares to other investors in order to gain liquidity. The suspicions whether it was speculative or not depended on the motives and the conducts of the market participants who entered and exited the market. They also argued that well informed market participants, namely institutional investors, entered the market with careful consideration. Therefore, the SAC concluded that this act was in line with *Shari'ah* principles as there was a reduction in their exposure to risk

[9] The SAC stated examples where *ghalat* pertaining to a type of object was when someone bought something assumed to be gold but he found out later that it was only gold-plated copper. On the other hand, *ghalat* pertaining to feature was when someone bought something assumed to be a branded watch, but he found out later that it was only imitated brand.

compared to uninformed market participants who entered the market exclusively based on luck. What was undoubtedly prohibitive according to *Shari'ah* principles were fraud and manipulation in the market. The SAC suggested that market surveillance and monitoring needed to be conducted to ensure that fraud and manipulation did not take place. The objective to create a fair and transparent market was in line with *Shari'ah* principles, as demand and supply in the market was determined by market forces without any element of cheating.

The SAC argued that profit making from price differences was not a hindrance in Islamic jurisprudence. Auction sale (*Bay muzayadah)* and mark-up sale (*bay murabahah)* were used as a basis in their argument in permitting speculation provided that it was not against *Shari'ah* principles. They also argued that *bay muzayadah* is associated with behavioural finance on the behaviour of market participants to gain returns from differences in the market price. In their argument, the SAC defined *bay muzayadah* as the selling of assets for sale in a market by a trader with a number of interested buyers who competed to offer the highest price. This process ended with the seller selling the goods to the highest bidder which is similar to auction (Securities Commission of Malaysia, 2009).

As with *iwadh*, the issue of speculation is also relevant to composite index futures contract.

Interpretation based on secrets and reasons for a ruling (Ta'wil based on hikmat tasyri'iyyah)

According to the SAC, interpretation (*ta'wil*) based on secrets and reasons for a ruling (*hikmat tasyri`iyyah)* was vital. They concurred with the work of Prof. Dr. Fathi al Duraini who emphasised that an interpretation based on secrets and reasons was stronger and more accurate because a *mujtahid*[10] used his understanding of an explicit legal text (*nas*) in implementing a ruling. Likewise, the decision made by the SAC had not deviated from certain evidence or an indicative legal text (*dalil)* as their expertise rendered them able to understand the *nas* comprehensively. Thereby, the SAC argued that interpretation based on secrets and reasons for a ruling was relevant to the stock index futures. And as a hedging instrument it benefits the economic system at large and the traders or investors in particular, creating *maslahah* for them (Securities Commission of Malaysia, 2009).

Based on their studies, the SAC concluded that issues like no exchange of goods, uncertainty, buying of a non-existent product, and speculation did not occur in the Malaysian crude palm oil futures and the composite index futures markets. The SAC thus resolved that these crude palm oil and equity index futures contracts were in accordance with *Shari'ah* principles, provided that they were free from the element of *riba*, gambling and the components in the underlying index were *Shari'ah* compliant securities (Securities Commission of Malaysia, 2009). Therefore, *Shari'ah* compliant investors in the Malaysian financial market could benefit from these instruments for a risk management purpose.

[10] According to the SAC of the SC, *mujtahid* is a *Shari'ah* scholar who formulates independent tradition--based opinions in legal or theological matters while the *Shari'ah* Advisory Council of Bank Negara Malaysia defined the term *ijtihad* as rigorous thinking and efforts by scholars who had attained the degree of *mujtahid* in order to issue certain *Shari'ah* ruling definitely in a matter which is not clearly provided in *al-Quran* or *Sunnah*. Shaharuddin et al., (2012) asserted that a *mujtahid* in Islamic finance matters must have a strong understanding of the objectives of the *Shari'ah* regarding wealth and have a thorough knowledge and good understanding with modern practices. However, they realised that the qualifications of a *mujtahid* put forward by the classical jurists are tough for current scholars to achieve.

2.2. Relationship between stock index and stock index futures

If the stock index futures market reacts to new information faster than the spot market, the futures prices will lead the spot prices. The stock index futures may react to new information faster because of the ease of trading in its market and as such, futures usually provide a leading indicator of the movements in spot prices.

There are a number of reasons for expecting faster adjustments of the futures prices compared to the spot prices. Bacha (2012) stated that it seemed that stock index futures market was usually the first to react to news and the stock market then followed. He further identified several reasons to explain this relationship as follows:

i. Infrequent trading of stocks comprising the index; therefore the index reflected stale prices and so lagged futures;
ii. Differences in liquidity between the stocks and futures markets;
iii. Informed traders might have a preference to trade in one market and not the other depending on whether the information was firm-specific or systematic;
iv. Due to market frictions such as transactions costs, capital requirements and short-selling restrictions that might make it more optimal to trade in the futures markets.

There is much casual evidence of lead-lag relationship between the stock index (spot) and stock index futures markets. A study by Sutcliffe (2006) documented considerable evidence of a lead-lag relationship between spot and stock index futures markets in many different countries. Kawaller et al., (1987) examined the intraday price relationship between S&P 500 futures and the S&P 500 index using minute-to-minute data on the prices of nearby S&P 500 futures contracts and the S&P 500 index for all trading days during 1984 and 1985, to determine whether movements in the futures prices provided predictive information regarding subsequent movements in the index and/or vice versa. They employed time series regression analysis to identify the nature of this intraday dynamic relationship and to test whether a systematic lead-lag relationship exists. Their result suggested that S&P 500 futures prices and the index were simultaneously related on a minute-to-minute basis throughout the trading day. Significant lag coefficients suggested that the lead from futures to cash prices extended between twenty and forty five minutes, while the lead from cash prices to futures prices, though significant, rarely extended beyond one minute. The length of the lead from futures to the index partially reflected inertia in the stock market. They concluded that stocks were not traded as readily as futures.

Stoll and Whaley (1990) investigated the time series properties of 5-minute intraday returns of stock index and stock index futures contracts to model empirically the temporal relation between the price movements of index futures contracts and stocks. They found that S&P 500 and MM index futures returns tend to lead stock market returns by about 5 minutes, on average, but occasionally as long as 10 minutes or more, even after stock index returns had been purged of infrequent trading effects. However, the effect was not completely unidirectional, with lagged stock index returns having a mild positive predictive impact on futures returns. Overall, the returns in the futures market lead those in the stock market, even after they made adjustment for the infrequent trading of stocks. The evidence also demonstrated that the lead had diminished through time.

Hasan (2005) examined the lead–lag relationship between stock indices and stock index futures markets in the US and UK. He found that linear Granger causality tests exhibited evidence of a contemporaneous relationship and a bidirectional relationship between the spot

and the futures returns which were equally supportive of the theoretical predictions of the cost-of-carry model and the efficient market hypothesis.

Pati and Rajib (2011) used 5-minute intraday prices to study the relationship between the National Stock Exchange (NSE) S&P CNX Nifty futures and its underlying spot index in terms of both return and volatility. They employed bivariate GARCH (1, 1) model with Baba, Engle, Kraft and Kroner (BEKK) parameterization, and found evidence of bidirectional volatility spillovers between spot and futures markets. However, there was a distinct spillover effect of a previous shock and volatility from the futures market to spot market. They concluded that futures prices lead spot prices and futures market largely contributed to price discovery.

There is a mix evidence of a lead-lag relationship between the spot and futures markets in Malaysia. For examples, Ibrahim et al., (1999) studied a lead-lag relationship in intraday returns between the stocks and the futures using cross correlations and regression. Overall, they found no evidence of a lead-lag relationship and they concluded that both markets reacted simultaneously to information arrival. On the other hand, a study by Abdullah et al., (2002) showed a different result. They investigated the temporal relationship between the spot and the futures prices from 15 December 1995 to 31 December 2000 (a five-year period) to observe the price co-movement pattern under different volatility levels. Using a multiple regression model, their study found that the futures market tend to lead the spot market by one day during the periods of stable market, and there was a mix lead-lag relationship between the two markets during the period of highly volatile market. Similar studies by Yakob (2004) and Yakob (2005) also found that the futures market lead the spot market in Malaysia.

There are number of insightful texts on wavelet analysis, such as Percival and Walden (2000), Addison (2002), Gencay, et.al., (2002), Walnut (2004) and In and Kim (2013). In particular, Percival and Walden (2000) emphasised on the filter development of wavelets whilst Gencay, et.al., (2002) and In and Kim (2013) provided a detailed exposition on the wavelet analysis with application in economics and finance. Ramsey (2002) and Crowley (2007) also published some additional insights on how the wavelet analysis can be applied in economics and finance.

The applications of wavelet analysis in economics and finance had been recently discussed, for examples, studies conducted by Ramsey and Lampart (1998) highlighted the importance of timescale decomposition and used the wavelet-based method in analyzing economic relationships; Gencay, et.al., (2001) proposed a method for the filtering out of intraday periodicities in exchange rate time series using the maximal overlap discrete wavelet transform; In, et. al., (2007) proposed a new approach for investigating the performance of managed funds using the wavelet analysis and applied it to an Australian dataset; Fernandez (2008) presented a model to select the optimal hedge ratios of a portfolio composed of an arbitrary number of commodities where returns dependency and heterogeneous investment horizons were accounted for by the copulas and the wavelets; Gallegati (2008) investigated the relationship between the stock market returns and economic activity using the signal decomposition techniques based on the wavelet analysis; Masih, et. al., (2010) applied the wavelet analysis to estimate systematic risk at different time scales in the context of the emerging GCC equity markets; Bruzda (2010) examined the process of European equity market integration using the continuous wavelet transform; Naccache (2011) addressed issue of the oil price and macroeconomy relationship using world data and a time scale

decomposition based on the theory of wavelets; Vacha and Barunik (2012) studied co-movement of energy commodities markets and its dynamics in the time-frequency domain using a wavelet tool known as the wavelet coherence; and Madaleno and Pinho (2012) explored the time-varying pattern of price shock transmission and stock market linkages using the continuous time wavelet methodology.

In studying a lead-lag relationship between the spot and futures markets, Lin and Stevenson (2001) employed a wavelet analysis to reconstruct data based on subset of information that differentiated the two fundamentally related time series namely spot and futures indices. Their findings showed that the lead-lag relationship still existed between both index prices. When more detailed information was used for price reconstruction, the relationship was more persistent. They suggested that if market imperfection was to be blamed for non-contemporaneous relationship between the spot index and the futures index, researchers should focus exclusively on those imperfections that occur within very short time horizons. In and Kim (2006b) studied the lead-lag relationship, correlation, and the hedge ratio for portfolio management by decomposing the relationship between the stock and the futures markets over different scales using the wavelets. They found that the stock and the futures markets showed a feedback relationship regardless of the time scale. According to the assumption of the cost-of-carry model, this could imply that the two markets were perfectly efficient and frictionless and acted as perfect substitutes. This result also implied that a profitable arbitrage did not exist between the two markets, regardless of the time scale. Bruzda (2009)'s assessment showed that there was no arbitrage relationship in the Warsaw Stock Exchange (WSE) FW20 futures contracts. However a lead-lag relationship was present, which was inconsistent with the standard cost-of-carry formula, moreover, market efficiency hypothesis was not directly examined in the study due to a lack of information, such as transaction costs and dividends.

3. Data and Methodology

3.1. Datasets

Analysis of the lead-lag relationship between Malaysian stock index (FBMKLCI) and stock index futures (FKLI) are undertaken by using two datasets. As most trading in the FKLI occurs in the nearest expiry month, we use the FKLI time series based on the near contract.

Daily Return Data

The first dataset consists of daily FBMKLCI and FKLI data from 15 December 1995 to 12 October 2012. The data are obtained from Bloomberg which is one of the Authorised Information Vendors subscribing to Bursa Malaysia's Real Time Equities and Derivatives Market Information. Daily close-to-close (CTC) return with n = 4,164 observations for each of the two time series are calculated as follow:

$$\text{Daily close-to-close (CTC) Return} = LN\left(CP_t/CP_{t-1}\right) \quad (1)$$

Where; CP_t = Closing price at time t

CP_{t-1} = Closing price at time t-1 or previous day closing price

Intraday Return Data

The second dataset consists of 15-minute intraday data from 15 April 2009 to 12 October 2012. The data are obtained from Telequote which is another one of the Authorised Information Vendors subscribing to Bursa Malaysia's Real Time Equities and Derivatives Market Information. The Malaysian stock index futures market opens 15 minutes earlier at 8.45 am and closes 15 minutes later during the first trading session at 12.45 pm compared to stock index which opens at 9.00 am and closes at 12.30 pm during the first trading session. In the second trading session, both markets open at 2.30 pm, however futures market closes 15 minutes later at 5.15 pm compared to its underlying market which closes at 5.00 pm. Following the same procedure by Lin and Stevenson (2001), we discard the first and the last 15-minute interval for the first session and the last 15-minute interval for the second session from our stock index futures data to account for non synchronous trading session. This procedure gives 14 intervals for the first trading session (from 9.00-9.15 am to 12.15-12.30 pm) and 10 intervals for the second trading session (from 2.30-2.45 pm to 4.45-5.00 pm) for each trading day for both markets. Details of 15-minute intervals used in this study are shown in Appendix 2. Days with any missing series or with uneven series of intervals for both markets are completely removed from the list.

Intraday close-to-close (CTC) return based on closing price of each 15-minute interval with n = 20,640 observations for each of the two time series are calculated as follow:

$$\text{Intraday close-to-close (CTC) Return} = LN\left(CP_t/CP_{t-1}\right) \quad (2)$$

Where; CP_t = Closing price at interval t
CP_{t-1} = Closing price at interval t-1 or previous interval closing price

In order to get a better picture of intraday returns without overnight information, we further calculate intraday open-to-close (OTC) return based on opening and closing price of each 15-minute interval with n = 20,640 observations for each of the two time series are calculated as follow:

$$\text{Intraday open-to-close (OTC) Return} = LN\left(CP_t/OP_t\right) \quad (3)$$

Where; CP_t = Closing price at interval t
OP_t = Opening price at interval t

Lastly we calculate the mispricing of returns (differences between intraday OTC return of the FBMKLCI and FKLI) based on Equation (3) as follow:

$$\text{Mispricing, } M_t = \text{Intraday OTCR}_{FBMKLCI,\,t} - \text{Intraday OTCR}_{FKLI,\,t} \quad (4)$$

Where; $\text{Intraday OTCR}_{FBMKLCI,\,t}$ = intraday open-to-close returns of the FBMKLCI at interval t
$\text{Intraday OTCR}_{FKLI,\,t}$ = intraday open-to-close returns of the FKLI at interval t

3.2 Methodology based on Wavelet Analysis

Wavelet analysis represents a powerful tool for analyzing time series from the two perspectives of frequency and time simultaneously. Wavelets possess many desirable properties, which are useful for application in the field of economics and finance. Wavelet analysis has significant advantages because of its ability to deal with non-stationary data, its localization in time, and its ability to decompose and analyze data fluctuation over time (Percival and Walden, 2000) and (Gencay, et.al., 2002).

In general, there are two main classes of the wavelet transform, namely the continuous wavelet transform (CWT) and the discrete wavelet transform (DWT). We deal with the CWT and the DWT in our study.

Continuous Wavelet Transform (CWT)

Following In and Kim (2013), the continuous wavelet transform (CWT) is defined as the integral over all time of the signal multiplied by scaled, shifted versions of the wavelet function ψ (scale, position, time):

$$C(scale, position) = \int_{-\infty}^{\infty} x_t \psi(scale, position, t) dt \qquad (5)$$

The results of the CWT are many wavelet coefficients C, which are a function of scale and position. The scale and position can take on any values compatible with the region of the time series,x_t. Multiplying each coefficient by the appropriately scaled (dilated) and shifted wavelet yields the component wavelets of the original signal. If the signal is a function of a continuous variable and a transform that is a function of two continuous variables is desired, the continuous wavelet transform(CWT) can be defined by (In and Kim, 2013):

$$F(a, b) = \int x_t \psi(\frac{t-a}{b}) da\, db \qquad (6)$$

with an inverse transform of

$$x_t = \iint F(a, b)\, \psi(\frac{t-a}{b}) da\, db \qquad (7)$$

where $\psi(t)$ is the basic wavelet and $a, b \in R$ are real continuous variables. To capture the high and low frequencies of the signal, the wavelet transform utilizes a basic function (mother wavelet) that is stretched (scaled) and shifted. See In and Kim (2013) for further details on scale of wavelets, shifting of wavelets and what conditions must wavelets satisfy.

Cross-Wavelet Analysis: Transform, Power, Coherency, and Phase-Difference

The cross-wavelet analysis is used in different field of studies in analysing, discovering and measuring relationships between two time series, for examples, studies conducted by Torrence and Compo, (1998), Torrence and Webster (1999), Grinsted, et. al., (2004), Aguiar-Conraria and Soares (2010), Gonzalez-Concepcion, et. al., (2012), Madaleno and Pinho (2012) and Vacha and Barunik (2012). Gonzalez-Concepcion, et. al., (2012) highlighted that the concepts of cross-wavelet power, wavelet coherency and wavelet phase-difference were natural generalizations of the basic wavelet analysis tools that permitted us to deal with the

time-frequency dependencies between two time series. Following Gonzalez-Concepcion, et. al., (2012), the cross-wavelet transform of two series, x and y is defined as:

$$W_{xy} = W_x W_{*y} \tag{8}$$

and the cross-wavelet power as:

$$|W_{xy}| \tag{9}$$

which can be interpreted as the local covariance between these time series at each time and frequency. They noted that when y = x, we obtain the wavelet power spectrum. If S denotes a smoothing operator in both time and scale, the complex wavelet coherency between x and y is defined by (Gonzalez-Concepcion, et. al., 2012):

$$\frac{S(W_{xy})}{[S(|W_x|^2)[S\left(|W_y|^2\right)]^{\frac{1}{2}}} \tag{10}$$

Smoothing is necessary because otherwise, coherency would be identically one at all scales and times (Gonzalez-Concepcion, et. al., 2012). Then, their module is called the wavelet coherency and their angle is called the phase-difference. Aguiar-Conraria and Soares (2010) clearly illustrated phase-difference circle in explaining the lead-lag relationship between two time series based on this continuous wavelet transform. In summary, a phase-difference of zero indicates that the time series move together at the specified time-frequency; a phase-difference located in the first quadrant indicates that the series move in phase, but the time series y leads x, while one located in the fourth quadrant indicates that x is leading. On the other hand, a phase-difference of π or $-\pi$ indicates an anti-phase relationship, a phase-difference located in the second quadrant indicates that the series move out of phase, but the time series x leads y, while if located in the third quadrant it indicates that y is leading.

In this study, we analyse the Malaysian stock index and stock index futures from 18 December 1995 to 04 July 2012 using daily return data. The total number of data points is equal to 4,096 (in respecting the rule, number of observations equal to 2^{12}). Similarly we perform the same analysis for the Malaysian stock index and stock index futures by using 15 minutes intraday return data from 15 April 2009 to 12 October 2012. However in order to do this we need to divide these intraday return data into two chunks. The first chunk starts from 9.30 am 15 April 2009 to 3.15 am 25 January 2012 while the second chunk starts from 11.15 am 29 December 2009 to 5.00 am 12 October 2012. Both chunks are made up of 16,384 data points (respecting the rule, number of observations equal to 2^{14}).

We then separate out each return into its constituent multi-scale (multi-horizon) components. In our study, we sample the daily return series at different scale crystals (j) as follows: d1 (1-2 days), d2 (2-4 days), d3 (4-8 days), d4 (8-16 days), d5 (16-32 days), d6 (32-64 days) and s6 (> 64 days) and intraday return series at different scale crystals (j) as follows: d1 (1-2 intervals), d2 (2-4 intervals), d3 (4-8 intervals), d4 (8-16 intervals), d5 (16-32 intervals), d6 (32-64 intervals) and s6 (> 64 intervals), where 1-2 intervals = 15-30 minutes, 2-4 intervals = 30-60 minutes or 30 minutes-1 hour, 4-8 intervals = 60-120 minutes or 1-2 hours, 8-16 intervals = 120-240 minutes or 2-4 hours, 16-32 intervals = 240-480 minutes or 4-8 hours, 32-64 intervals = 480-960 minutes or 8-16 hours, and > 64 intervals = > 16 hours.

Discrete Wavelet Transform (DWT)

The transformed return series *r (t)* is represented as a linear combination of wavelet functions as follows:

$$r(t) = \sum_k s_{J,k}\,\phi_{J,k}(t) + \sum_k d_{J,k}\,\psi_{J,k}(t) + \sum_k d_{J-1,k}\,\psi_{J-1,k}(t) + \cdots + \sum_k d_{1,k}\,\psi_{1,k}(t) \quad (11)$$

where:

J is the number of scale crystals (intervals or frequencies)
k ranges from 1 to the number of coefficients in the specified component

$\phi_{J,k}(t)$ and $\psi_{J,k}(t)$ are the father and mother orthogonal wavelet pair that are given respectively by

$$\phi_{J,k}(t) = 2^{-\frac{J}{2}}\phi\left(\frac{t-2^J k}{2^J}\right) \quad (12)$$

$$\psi_{j,k}(t) = 2^{-\frac{j}{2}}\psi\left(\frac{t-2^j k}{2^j}\right) \quad (13)$$

Father wavelets represent the low-frequency (smooth) parts of the series, whereas mother wavelets represent the high-frequency (detailed) parts of the series. $S_{J,k}$ and $d_{J,k}$ are wavelet coefficients that are approximated by the following integrals:

$$\int \phi_{J,k}(t) f(t) dt \approx s_{J,k} \quad (14)$$

$$\int \psi_{j,k}(t) f(t) dt \approx d_{J,k} \quad (15)$$

$S_{J,k}$ are the 'smooth' coefficients that represent the underlying smooth behaviour of the series, while $d_{J,k}$ are the 'detail' coefficients that represent the scale deviations from the smooth process. These coefficients are measures of the contribution of the corresponding wavelet function to the total series. After decomposing the return series into *J* crystals, the crystals d_J are recomposed into a time domain. The entire return series is replicated in multi-resolution decomposition as follows:

$$\hat{r}^J = D_1 + \ldots\ldots\ldots\ldots\ldots\ldots + D_J + S_J \quad (16)$$

D_J is the recomposed series in the time domain from the crystal d_J and S_J is the recomposed series of the residue. The reconstituted return series $\hat{r}^J$ contain the separate components of the original series at each frequency *j*. D_J represents the contribution of frequency *j* to the original series.

The wavelet correlation coefficient, $\tilde{\rho}_{XY}(\lambda_j)$ provides a standardized measure of the relationship between the two time series subjected to multiple timescales whereby the unbiased estimator of the wavelet correlation for timescale *j* is defined by (Gencay, et.al., 2002):

$$\tilde{\rho}_{XY}(\lambda_j) = \frac{\tilde{\gamma}_{XY}(\lambda_j)}{\tilde{\sigma}_X(\lambda_j)\tilde{\sigma}_Y(\lambda_j)} \quad (17)$$

Where $\tilde{\sigma}_X(\lambda_j)$ and $\tilde{\sigma}_y(\lambda_j)$ are the unbiased estimators of the wavelet variances while $\tilde{\gamma}_{XY}(\lambda_j)$ is the unbiased estimator of the wavelet covariance. Following Gencay, et.al., (2002) for a simple wavelet-based approach to test for significant difference. We will test whether wavelet correlation coefficients on a scale-by-scale basis between any two pair variables are significantly different. The null hypothesis can be rejected when 95% approximate confidence intervals are non-overlapping (Gencay, et.al., 2002). For lead-lag relationships at different timescales, we apply the wavelet cross-correlation which allows the wavelet variance and wavelet covariance to vary with lag τ whereby Gencay, et.al., (2002) defined the wavelet cross-correlation as:

$$\rho_X\tau(\lambda_j) = \frac{\gamma_{X,\tau}(\lambda_j)}{\sigma_1(\lambda_j)\sigma_2(\lambda_j)} \qquad (18)$$

A modified version of Discrete Wavelet Transform (DWT) is known as Maximum Overlap Discrete Wavelet Transform (MODWT). Percival and Walden (2000) stated that MODWT were essentially the same as the transforms that had been discussed in the wavelet literature under the names "undecimated DWT", "shift invariant DWT", "wavelet frames", "translation invariant DWT", "stationary DWT", "time invariant DWT", and "non-decimated DWT".

Gencay, et.al., (2001) proposed the MODWT filtering method which was translation invariant, with the ability to decompose an arbitrary length series without boundary adjustments associated with a zero-phase filter and was circular. They stressed that being circular helped to preserve the entire sample unlike other two-sided filters where data loss occurred from the beginning and the end of the studied sample. According to the authors, MODWT was easy to calculate and did not depend on a particular model selection criterion or model specific parameter choices.

We use the non-decimated orthogonal Maximum Overlap Discrete Wavelet Transform (MODWT) as a wavelet function to obtain a multi-scale decomposition of the return series. The Maximum Overlap Discrete Wavelet Transform (MODWT) is used due to the advantage on the data length flexibility (not requiring the integral power of two), as well as the time invariant property. We then separate out each return into its constituent multi-scale (multi-horizon) components. In our study, we sample the daily return series at different scale crystals (j) as follows: d1 (1-2 days), d2 (2-4 days), d3 (4-8 days), d4 (8-16 days), d5 (16-32 days), d6 (32-64 days) and s6 (> 64 days) and intraday return series at different scale crystals (j) as follows: d1 (1-2 intervals), d2 (2-4 intervals), d3 (4-8 intervals), d4 (8-16 intervals), d5 (16-32 intervals), d6 (32-64 intervals) and s6 (> 64 intervals), where 1-2 intervals = 15-30 minutes, 2-4 intervals = 30-60 minutes or 30 minutes-1 hour, 4-8 intervals = 60-120 minutes or 1-2 hours, 8-16 intervals = 120-240 minutes or 2-4 hours, 16-32 intervals = 240-480 minutes or 4-8 hours, 32-64 intervals = 480-960 minutes or 8-16 hours, and > 64 intervals = > 16 hours.

4. Analysis and Discussion

4.1. Data Plots

In analysing real data with a large number of observations in datasets, an important component is a thorough graphical study of the data. Ogden (1997) stated that it was not uncommon for graphical data analysis to turn up some interesting or even essential aspect of the dataset that might be completely overlooked by applying some statistical inference

procedure. Here, we describe some of the plots that have been performed using daily and intraday returns data.

Daily Return Data Plot

Plots of these daily close-to-close (CTC) return data from 18 December 1995 to 12 October 2012 are shown in Figure 1. We observe that there are similarities in the behaviour and magnitude of daily returns for the Malaysian stock index (FBMKLCI) and stock index futures (FKLI). However, the FKLI has a slightly larger magnitude of daily CTC return.

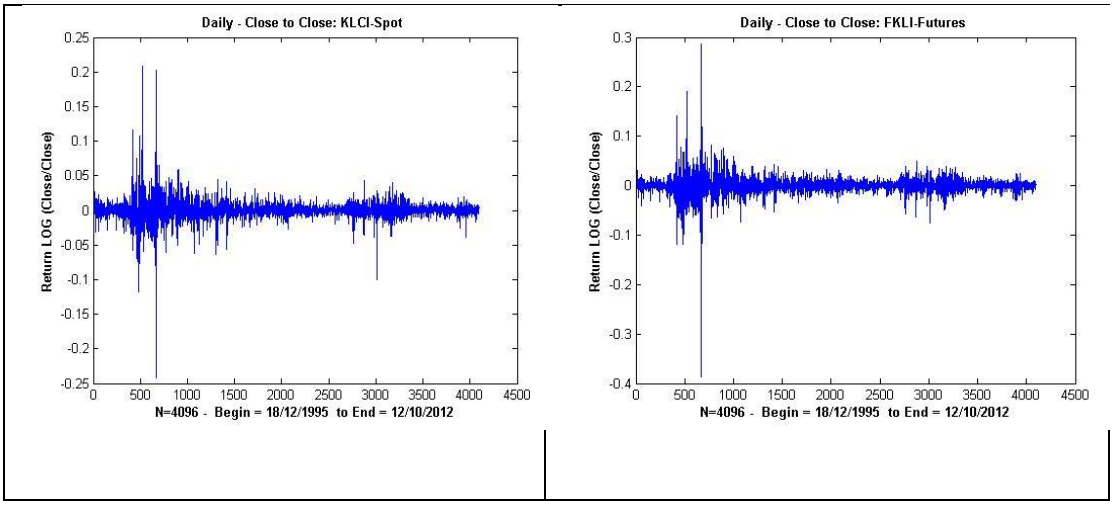

Figure 1: Daily CTC Returns of the FBMKLCI and the FKLI

Intraday Return Data Plot

Plots of these intraday close-to-close (CTC) return data from 15 April 2009 to 12 October 2012 are shown in Figure 2. Here we observe that there are not many differences in the behaviour and magnitude of intraday CTC returns for the Malaysian stock index (FBMKLCI) and stock index futures (FKLI)**.** Unlike the daily CTC return, the FBMKLCI shows a slightly larger magnitude of intraday CTC return.

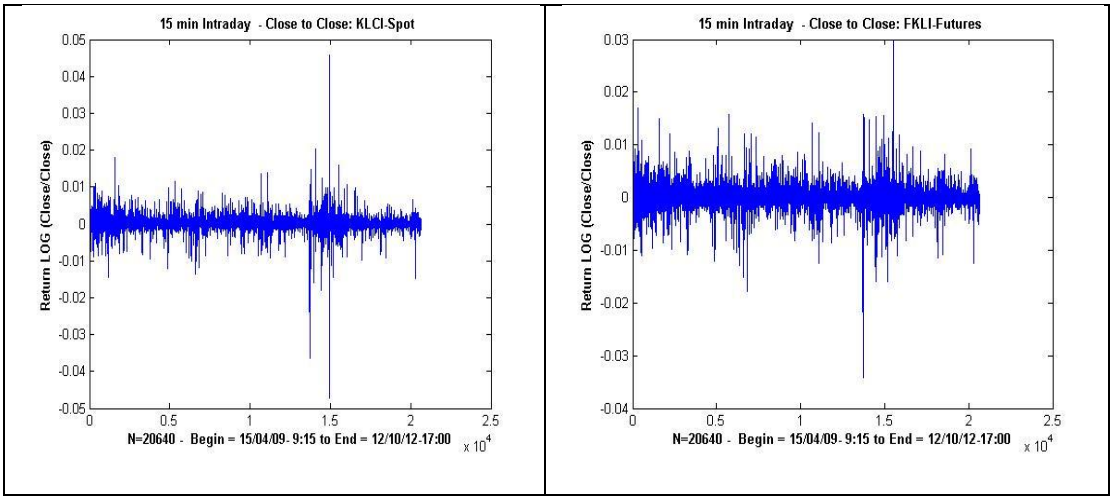

Figure 2: Intraday CTC Returns of the FBMKLCI and the FKLI

Different results that we get from different datasets i.e. daily CTC and intraday CTC returns data motivate us to investigate the intraday open-to-close (OTC) return. Plots of intraday OTC return from 15 April 2009 to 12 October 2012 are shown in Figure 3, where we observe a similarity in the behaviour and magnitude between the Malaysian stock index (FBMKLCI) and stock index futures (FKLI). Similar to the case of intraday CTC return, the FBMKLCI has a slightly larger magnitude of intraday OTC return. In comparison, the mispricing (differences) between the two series become larger as we exclude the overnight information.

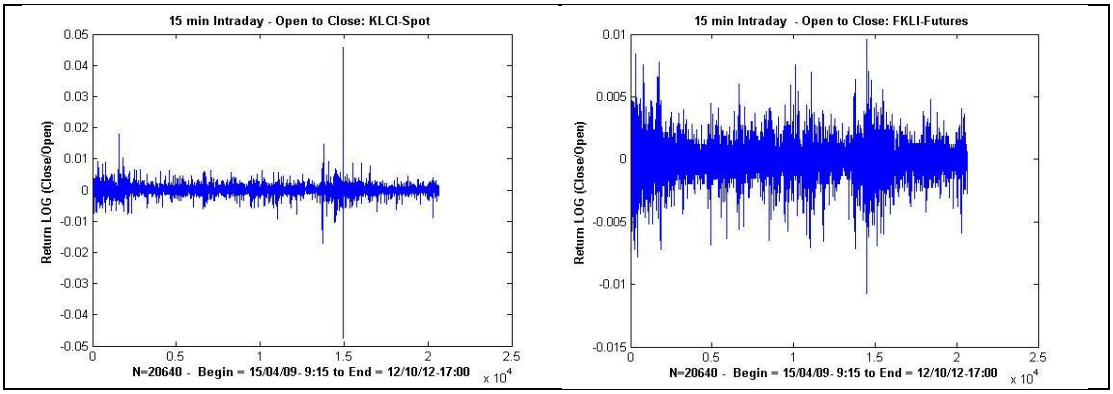

Figure 3: Intraday OTC Returns of the FBMKLCI and FKLI

Plots of the differences between intraday OTC returns for the FBMKLCI and the FKLI from 15 April 2009 to 12 October 2012 are shown in Figure 4. We observe five points of interest labelled with arrows where the behaviour between these two markets seems to be quite abnormal.

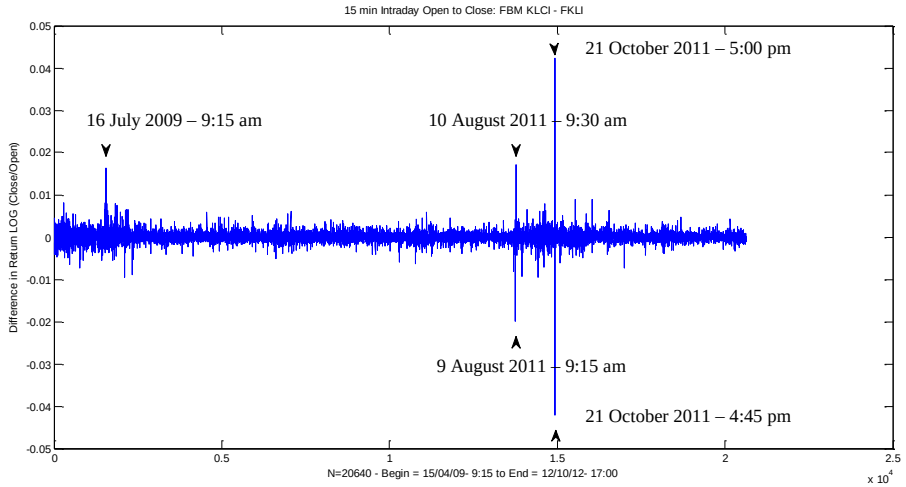

Figure 4: Difference between Intraday Open-to-close Return of the FBMKLCI and Intraday Open-to-close Return of the FKLI

Mispricing and News

i. Positive Mispricing at 9.15 am on 16 July 2009

At this date and time, the FBMKLCI opened at 1097.24 and closed at 1117.29. The FKLI opened at 1116.5 and closed at 1118.5. Both OTC returns of the FBMKLCI and the FKLI were positive but the latter's value was smaller compared to the first.

By far the most important news for Malaysian stock index and index futures prices were external news about regional markets and major economies. Bursa Malaysia (2009) reported that the local market remained sidelined when the Prime Minister announced further measures to stimulate investment and liberalize the capital market featuring the deregulation of Foreign Investment Committee guidelines on 30 June 2009. On 6 July 2009, FBMKLCI replaced the benchmark KLCI. KLCI's enhancement to FBMKLCI did not have an immediate effect on the local capital market as the market remained sidelined until 13 July 2009 when Bursa Malaysia implemented the multi-currency securities framework. From the period onwards including 16 July 2009 to end July 2009, the market showed further improved sentiment which was in tandem with its regional peers following better-than-expected US corporate earnings report and positive second quarter 2009 GDP figures in major economies.

ii. Negative Mispricing at 9.15 am on 9 August 2011

At this date and time, the FBMKLCI opened at 1468.4 and closed at 1443.47. The FKLI opened at 1435.5 and closed at 1439.5. OTC return of the FBMKLCI was negative while the FKLI's OTC return was positive. In terms of absolute value the FBMKLCI's return was bigger than the FKLI's return.

On 8 August 2011, there was an official announcement by Bank Negara Malaysia on the passing of Bank Negara Malaysia Deputy Governor, Dato' Mohd Razif bin Abd. Kadir, whose contribution to central banking and Malaysia had been commensurable[11]. However, this news did not have much impact on the local capital market. As previous, it was the external news that contributed to the negative market performance. In its review of market performance, Bursa Malaysia (2011) reported that the falling value of FBMKLCI on 8 and 9 August 2011 were in line with heavy regional falls after the S&P cut the United States's credit rating from AAA to AA+. The FBMKLCI plunged 1.8% on 8 August 2011 and 1.66% on 9 August 2011.

iii. Positive Mispricing at 9.30 am on 10 August 2011

At this date and time, the FBMKLCI opened at 1472.14 and closed at 1493.95. The FKLI opened at 1486.5 and closed at 1483. OTC return of the FBMKLCI was positive and the FKLI's OTC return was negative. In terms of absolute value, the FBMKLCI's return was bigger than the FKLI's return.

On 10 August 2011, Bursa Malaysia notified that the index value for all FTSE Bursa Malaysia indices including the FTSE Bursa Malaysia Kuala Lumpur Composite Index (FBMKLCI) could not be disseminated since 9:00 am but would continue to trade as usual. Later, on the same day, Bursa Malaysia updated the market that the values for all FTSE Bursa Malaysia indices were available as normal[12]. The markets stabilized on 10 August 2011 after

[11] For further details please refer to http://www.bnm.gov.my/index.php?ch=en_press&pg=en_press_all&ac=2308&lang=en.

[12] Notification: FTSE Bursa Malaysia indices not available; FBMKLCI values will be disseminated periodically via Bursa Malaysia website. For further details visit http://www.bursamalaysia.com/corporate/media-centre/media-releases/686. and Notification 3: Values for FTSE Bursa Malaysia indices now available. For further details visit http://www.bursamalaysia.com/corporate/media-centre/media-releases/685.

the United States Federal Reserve pledged to keep interest rates near zero for another two years (Bursa Malaysia, 2011).

iv. Negative Mispricing at 4.45 pm on 21 October 2011

At this date and time, the FBMKLCI opened at 1441.12 and closed at 1374.4. The FKLI opened at 1438.5 and closed at 1431. Both OTC returns of the FBMKLCI and the FKLI were negative with the latter having a smaller value.

In a report by Reuters a few hours later, Bursa Malaysia said a sharp drop in the FBMKLCI was due to broker trades, particularly due to trade keyed in on selected index component stocks by a broker. Bursa Malaysia did not say if the trades were made intentionally or by accident. The FBMKLCI dropped 4.8 percent at 4:41 pm (0841 GMT) to 1,371.92 points from 1,440.52 points before recovering 10 minutes later. The FBMKLCI closed lower by 0.2 percent for the day at 1,438.83 points[13].

v. Positive Mispricing at 5.00 pm on 21 October 2011

At this date and time, the FBMKLCI opened at 1374.52 and closed at 1438.83. The FKLI opened at 1431 and closed at 1436. Both OTC returns were positive but The FBMKLCI's return was bigger than FKLI.

On 21 October 2011, Bank Negara Malaysia (BNM) released a statement that the international reserves of BNM stood at RM427.9 billion (USD134.4 billion) as at 14 October 2011. This reserves position was sufficient to finance 10 months of retained imports and was 4.6 times the short-term external debt.

In all of the above five points, the magnitude (absolute value) of OTC returns for the FBMKLCI were always higher than OTC returns for the FKLI. During these dates, there was no Unusual Market Activity (UMA) query to any listed companies made by Bursa Malaysia[14]. This demonstrated that events or fundamental news contributed to the price behaviour during the time.

Our preliminary observations show that:

1. There are similarities in daily and intraday returns and volatility behaviour of the Malaysian underlying stock index (FBMKLCI) and stock index futures (FKLI). Given that the FKLI is a derivative instrument of the FBMKLCI, both are subjected to the same impact from changes in market fundamentals. This shows that there is a stable relationship between the FBMKLCI and the FKLI.
2. In terms of daily return, the FKLI has a slightly larger magnitude.
3. In terms of intraday return, the FBMKLCI has a slightly larger magnitude.
4. The magnitude of intraday return of the FBMKLCI becomes larger compared to the FKLI when we exclude overnight information in the intraday returns.

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[13] Available at http://www.reuters.com/article/2011/10/21/bursa-idUSL3E7LL1MV20111021.

[14] For further details please refer to http://www.bursamalaysia.com/corporate/media-centre/media-releases#/?year=2009&subject=All&page=1 and http://www.bursamalaysia.com/corporate/media-centre/media-releases#/?year=2011&subject=All&page=1.

5. There are five points of interest in relation to the exact time and date where the mispricing behaviour between these two markets seems quite abnormal. The abnormality is due to certain fundamental events or news taking place.

4.2. Lead-lag Relationship between the FBMKLCI and the FKLI: Continuous Wavelet Transform (CWT)

We employ the wavelet coherence and MATHLAB Package to examine the multi-horizons nature of lead-lag relationship between the stock index (FBMKLCI) and the stock index futures (FKLI). Time is shown on the horizontal axis while time scales or frequency is shown on the vertical axis. The red color shows a high correlation between the FBMKLCI and the FKLI. Coherency ranges from blue (low coherence) to red (high coherence). Above the parabolic line (cone of influence), shows the significant level at 95% using the Monte Carlo simulation. Arrows on the coherence plots show the phase difference between the two series. Following Aguiar-Conraria and Soares (2010), Barunik et al., (2011), Gonzalez-Concepcion, et. al., (2012) and, Vacha and Barunik (2012), a zero phase difference means that the examined time series move together at a particular scale, s. Arrows pointing to the right when the time series are in-phase means they are positively correlated. Arrows pointing to the left when the time series are anti-phase (out-of-phase) means they are negatively correlated. Arrow pointing straight up indicates that the FBMKLCI leads the FKLI by 90^o, arrow pointing straight down indicates that the FKLI leads the FBMKLCI by 90^o.

Results from Daily Return Data

We analyse the Malaysian stock index and stock index futures from 18 December 1995 to 04 July 2012 using daily return data. The total number of data points is equal to 4,096 (respecting the rule of 2^{12}).

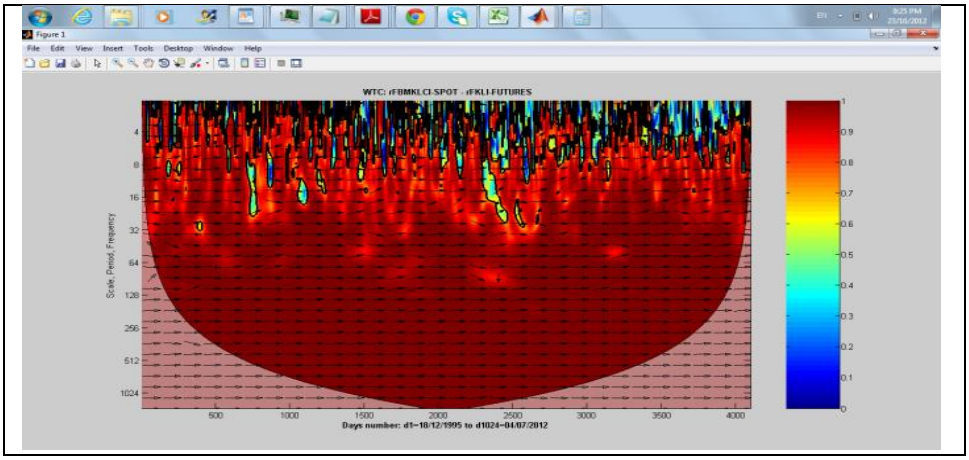

Figure 6: Daily Close-to-Close (CTC) Return of the FBMKLCI and the FKLI

Our findings reveal that there is a very high correlation (red zones) between the FBMKLCI and the FKLI as shown in Figure 6. In the long run the two markets are in-phase (close to perfectly positively correlated), moving instantly together. In the short run (scales 16 days and below), we can see a small and medium blue blocks (alternate between blue and red areas) showing co-movement between the two markets, this happens at different scales and in non-homogeneous manner. It could be related to different information arrivals at different moments which may influence the investments objectives of short term participants in the

market. However, from time to time (in the short term), the arrows are heterogeneously changing, pointing in different directions.

We note that during the date of *Ringgit de-peg against US$ on 21 July 2005* (see in the graph data point number 2366) the level of correlation is slightly lower. For example, the angle representing anti-phase trend (phase shift) is equal to 45^{o} during the short term (scales from 8 to 32 days). The findings show that the FKLI is leading the FBMKLCI by 3 hours (360^{o} / 45^{o} = 8, which is equivalent to 24 hours/8 as we use daily data).

Also, during the *global financial crisis on 16 September 2008* (data point number 3146) and the *European sovereign debt crisis on 20 July 2010* (data point number 3600), the anti-phase trend is equal to 30^{o} during the short term (from 8 to16 days). Since we use daily data this means that the FKLI is leading the FBMKLCI by 2 hours (360^{o} / 30^{o} = 12, which is equivalent to 24 hours/12 as we use daily data).

Overall, we have a mixture of positions that in some cases the FBMKLCI leads while in other cases the FKLI leads.

Results from Intraday Return Data

Similarly we perform the same analysis for the Malaysian stock index and stock index futures by using 15-minute intraday return data from 15 April 2009 to 12 October 2012. In order to do this we divide these intraday return data into two chunks. The first chunk starts from 9.30 am 15 April 2009 to 3.15 am 25 January 2012 while the second chunk starts from 11.15 am 29 December 2009 to 5.00 am 12 October 2012. Both chunks are made up of 16,384 data points (respecting the rule of 2^{14}).

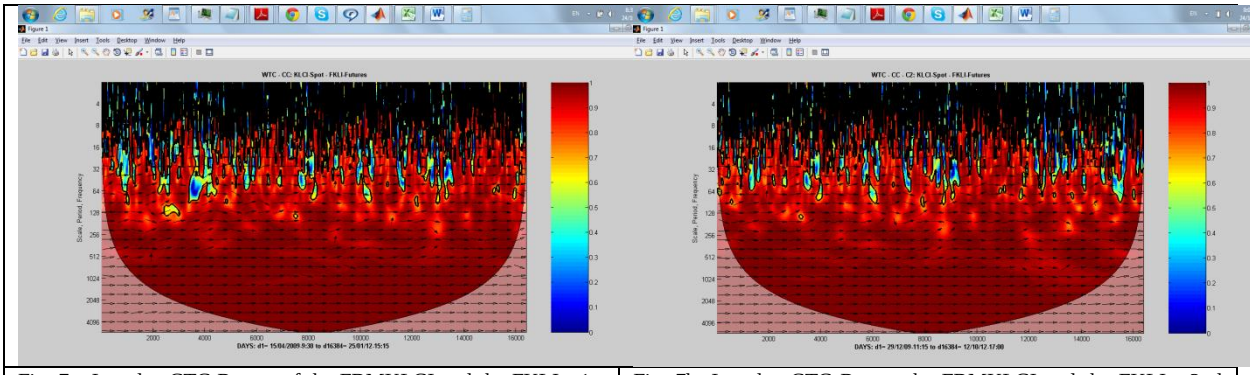

Fig. 7a: Intraday CTC Return of the FBMKLCI and the FKLI - 1st chunk

Fig. 7b: Intraday CTC Return the FBMKLCI and the FKLI - 2nd chunk

Figure 7: Intraday Close-to-Close (CTC) Return of the FBMKLCI and the FKLI

Similar to the results from the daily returns, findings from the intraday returns reveal that both the correlation and the in-phase trend seem to be consistent in the long run as shown in Figure 7. Interestingly, the use of 15-minute intraday data, gave us a more accurate information about the scale of 64 which is equivalent to 2 days plus $2/3^{rd}$ day. In the scales lower than 64 (in less than 2.67 days), we observe many small blue blocks (alternate between blue and red islands) showing co-movement between the FBMKLCI and the FKLI, this happens at different scales and in a non-homogeneous manner. It could be related to different information arrivals at different moments which may influence the investments objectives of short term players in the market. However, from time to time (in the short term), the arrows

are heterogeneously changing, pointing in different directions. Overall, we have a mixture of positions that in some cases the FBMKLCI leads while in other cases the FKLI leads.

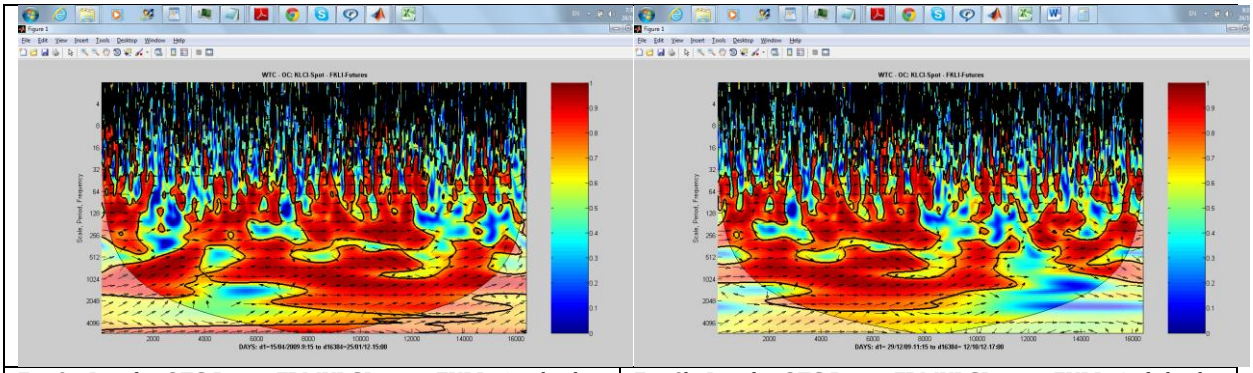

Fig. 8a: Intraday OTC Return FBMKLCI versus FKLI - 1st chunk

Fig. 8b: Intraday OTC Return FBMKLCI versus FKLI - 2nd chunk

Figure 8: Intraday Open-to-Close (OTC) Return of the FBMKLCI and the FKLI

Our findings in Figure 8 show the very high correlation (red zones) and in-phase trend between the FBMKLCI and the FKLI from the previous daily and intraday close-to-close returns have been reduced. In the long run the two series at certain time are in-phase (close to perfectly positively correlated). There are also times where anti-phase takes place with the FKLI in the leading trend. In the short run (scales 64 intervals and below), we can see a small and medium blue blocks (alternate between blue and red areas) showing co-movement between the two series, this happens at different scales and in a non-homogeneous manner. This could be related to the exclusion of some real time information from the previous close to the next open interval, which goes to show that the two series are less correlated (more blue islands) compared to the results from intraday close-to-close returns. It could be related to certain information that had been excluded which may influence the less informed investors with different objectives and horizons. Overall, we have a mixture of positions that in some cases the FBMKLCI leads while in other cases the FKLI leads.

4.3. Lead-lag Relationship between the FBMKLCI and the FKLI: Discrete Wavelet Transform (DWT)

We employ the Maximal Overlap Discrete wavelet Transform (MODWT) and we use the R Package to examine the multi-scale nature of lead-lag relationship between the stock index (FBMKLCI) and the stock index futures (FKLI). Time at different time scales is shown on the horizontal axis while the cross correlation at different time scales is shown on the vertical axis. The black lines represent a cross correlation between the FBMKLCI and the FKLI at different lags. The red lines represent upper and lower bounds at 95% confidence interval. The MODWT cross correlations in Figure 10 and Figure 12 present time lags from -24 to +24. Details of these lags in its numerical value (up to 5 lags only, from -5 to +5) are shown in Appendix 5 and Appendix 6. These represent the lead-lag relationship between the two series. Following Gallegati (2008), a zero phase difference means that the examined time series move together at a particular scale, s. The relative lead-lag relationship is shown as: asymmetric towards left hand side: first series leads second series; asymmetric towards right hand side: second series leads first series; symmetric: bi-directional causality. The wavelet cross correlation will decompose the co-movement into six different timescales as follow; level 1 = d1, level 2 = d2, level 3 = d3, level 4 = d4, level 5 = d5, level 6 = d6. Since the results obtained from intraday close-to-close (CTC) return and intraday open-to-close (OTC) return are similar, we just report the results from the first intraday return.

Results from Daily Return Data

We analyse the Malaysian stock index and stock index futures from 18 December 1995 to 12 October 2012 using daily close-to-close (CTC) return data. The total number of data points is equal to 4164. Results from the Wavelet Correlation and the Wavelet Cross Correlation, are shown in Figure 9, and Figure 10, respectively.

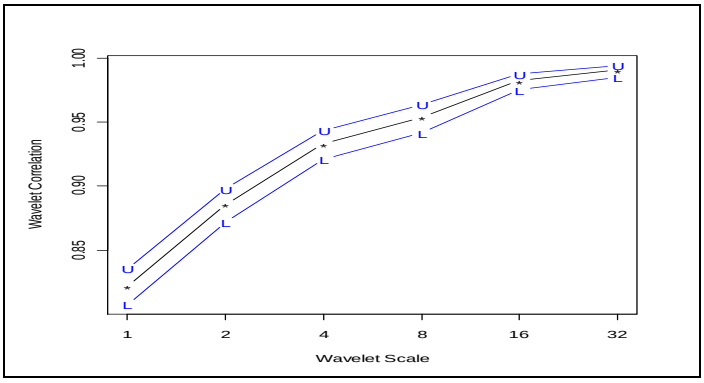

Figure 9: Wavelet Correlation - Daily Close-to-Close (CTC) Return of the FBMKLCI and the FKLI. A line with "U" denotes the upper bound and "L" denotes the lower bound, for the approximate 95% confidence interval assuming a non-Gaussian process.

Figure 9 shows that the correlation between daily returns of the stock index (FBMKLCI) and the stock index futures (FKLI) becomes increasingly correlated as the time scale increases. Overall, we can say that the two series are highly correlated in the short run and in the long run. Details of these time scale correlations in its numerical value are shown in Appendix 4.

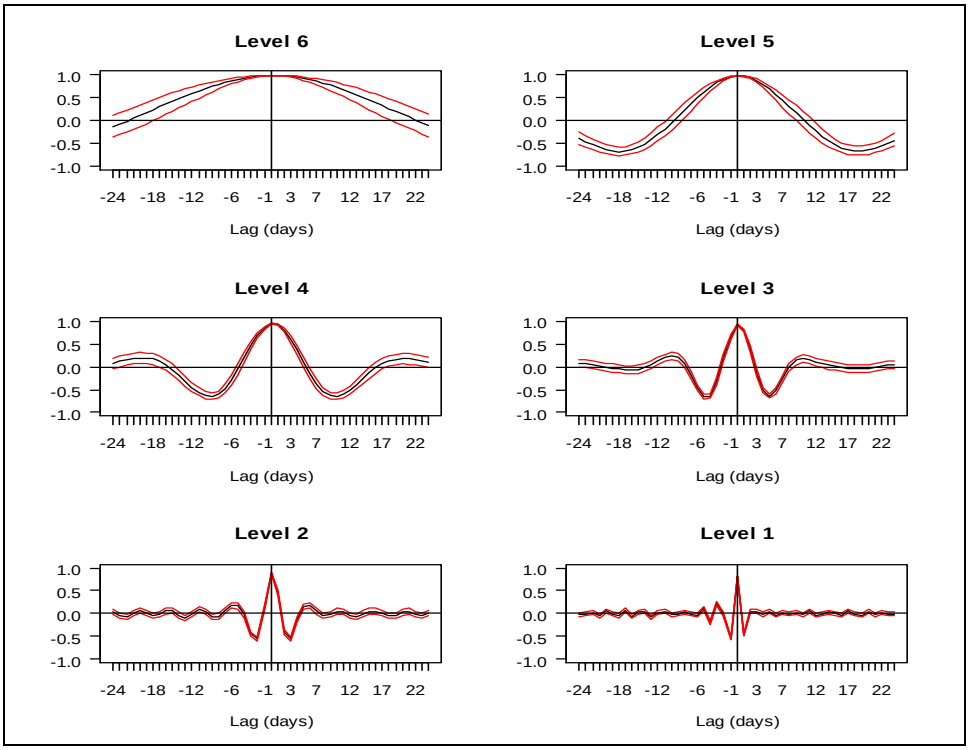

Figure 10: Wavelet Cross Correlation - Daily Close-to-Close (CTC) Return of the FBMKLCI and the FKLI

Our findings in Figure 10 reveal that the FBMKLCI and the FKLI are all in-phase at level 1 to level 6. We conclude that there is no lead-lag relationship between the FBMKLCI and the FKLI.

Results from Intraday Return Data

We analyse the Malaysian stock index and stock index futures from 15 April 2009 to 12 October 2012 using the intraday return data. The total number of data points is equal to 20640. Results from the Wavelet Correlation and the Wavelet Cross Correlation, are shown in Figure 11 and Figure 12 respectively.

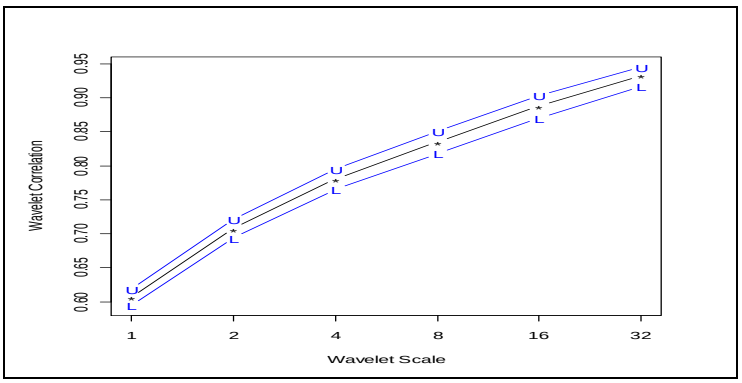

Figure 11: Wavelet Correlation - Intraday Close-to-Close (CTC) Return of the FBMKLCI and the FKLI. A line with "U" denotes the upper bound and "L" denotes the lower bound, for the approximate 95% confidence interval assuming a non-Gaussian process.

Figure 11 shows that the correlation between intraday returns of the stock index (FBMKLCI) and the stock index futures (FKLI) becomes increasingly correlated as the time scale increases. Overall, we can say that the two series are highly correlated in the short run and in the long run. Details of these time scale correlations in its numerical value are shown in Appendix 4.

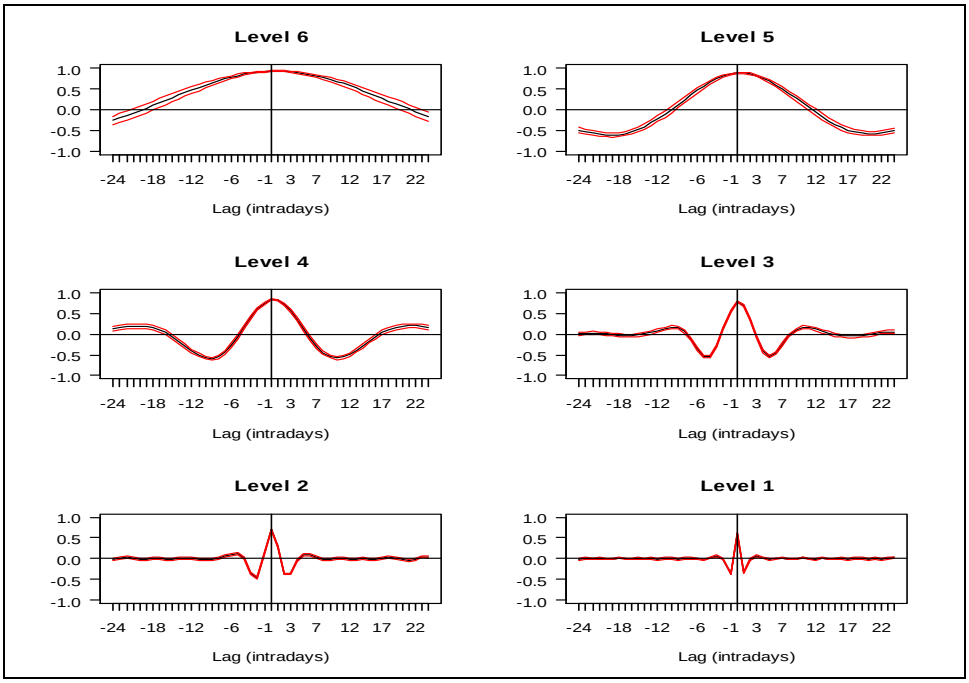

Figure 12: Wavelet Cross Correlation - Intraday Close-to-Close Return (CTC) of the FBMKLCI and the FKLI

Our findings in Figure 12 show that the FBMKLCI and the FKLI are all in-phase at level 1 to level 4. This means that there is no lead-lag relationship between the stock index and the stock index futures in Malaysia up to level 4. However, at level 5 (time scale of d5 = 16-32 intervals = 240-480 minutes or 4-8 hours) and level 6 (time scale of d6 = 32-64 intervals = 480-960 minutes or 8-16 hours) the stock index futures leads the stock index by 1 lag (see Appendix 6). Details of these lags in its numerical value (up to 5 lags only, from -5 to +5) are shown in Appendix 6. Overall, the FKLI leads the FBMKLCI between 4 hours to 16 hours. Given that there are 360 minutes or 6 hours trading session per day (24 intervals per day, therefore 24 X 15 minutes), after discarding some intervals as mentioned before; the FKLI leads the FBMKLCI by 0.67 days to 2.67 days. This result is similar to the result we obtain from the intraday data using CWT.

5. Summary and Conclusion

Overall, our preliminary observations show that:

- In general, there are similarities in daily and intraday returns and volatility behaviour of the Malaysian underlying stock index (FBMKLCI) and stock index futures (FKLI). Given that the FKLI is a derivative instrument of the FBMKLCI; both are subject to the same impact from changes in market fundamentals. This shows that there is a stable relationship between the FBMKLCI and the FKLI.
- In terms of daily return, the FKLI has a slightly larger magnitude.
- In terms of intraday return, the FBMKLCI has a slightly larger magnitude.
- The magnitude of intraday return of the FBMKLCI becomes larger compared to intraday return of the FKLI when we exclude overnight information in the intraday returns.
- There are five points of interest in relation to exact time and date where the mispricing behaviour between these two markets seems to be quite abnormal. There

were fundamental events or news that explained the abnormality during the time and date.

We use the time series of FBMKLCI and the FKLI to examine the multi-horizon nature of lead-lag relationship between the stock index and the stock index futures markets using the continuous and the discrete wavelet transforms (CWT and DWT), including the cross-wavelet correlation. Data at different time scales have been applied to analyse the correlation and the lead-lag relationship. To the best of our knowledge, this study is the first attempt to using wavelets for studying the multi-scale lead-lag relationship between the stock index and the stock index futures markets in an emerging country like Malaysia.

In summary, our results show that:

- Based on the daily data, results from CWT show a mixture of positions that in some cases the FBMKLCI leads while in other cases the FKLI leads at the scales of 16 days and below. For the period above 16 days, there is no lead-lag relationship between the FBMKLCI and the FKLI. With an exception during certain crisis periods the FKLI clearly leads by 2 to 3 hours.
- Based on the intraday data, results from CWT reflects a mixture of positions that in some cases the FBMKLCI leads while in other cases the FKLI leads. However, this lead-lag relationship happens in less than 2.67 days.
- Correlations between the two series are high and become increasingly correlated as the time scale increases. Although they are still high, the two series become less correlated when we exclude overnight information. Exclusion of certain information may influence the less informed investors with different objectives and horizons.
- Based on the daily data, results from DWT show there is no lead-lag relationship between the FBMKLCI and the FKLI.
- Based on the intraday data, results from DWT demonstrate there is no lead-lag relationship between the the FBMKLCI and the FKLI at small scales 1 to 4 but at higher scales the FKLI leads by 0.67 days to 2.67 days.

Our results show that lead-lag relationship between the two markets varies across frequencies and time scales, and this phenomenon has some policy implications for the stability of the capital market in Malaysia, specifically for the stock and the futures markets. Market participants such as speculators and investors have a different investment horizon. Therefore, examining and applying a single period time invariant causality could lead investors to inaccurate decision making. Adopting the intraday data and the wavelet analysis are very useful for examining the multi scale lead-lag relationship between the stock and futures markets as they allow us to investigate how causality can be affected from intraday to longer horizons. Subsequently, we are able to observe the difference between the 15-minute and the much longer horizon lead-lag relationship between the two highly correlated financial markets.

The main finding of this paper is that the stock index and the stock index futures market in an emerging market like Malaysia show strong dynamics in co-movement in time during various investment horizons. The results suggest that when looking at the dependence of stock and futures markets, market participants should always keep in mind its time-varying nature and look at their various investment horizons according to their different investment objectives.

The wavelet correlation between the FBMKLCI and the FKLI varies over investment horizons, but remains very high at all time scales. Similar to the results by In and Kim, (2006a), the magnitude of the correlation increases as the time scale increases, indicating that the stock and the futures markets in Malaysia are fundamentally similar. Indeed, it is apparent that investors with longer horizons in Malaysia are more likely to follow fundamentals than speculators with shorter horizons, as the relationship between the stock and futures markets become stronger at intermediate and coarsest time scales than at the smallest scales. Our result supports the argument by Lin and Stevenson (2001) that the stock and futures markets were subjected to the same impact from changes in market fundamentals since the stock index futures is a derivative instrument of the stock index.

The problem of different *Shari'ah* resolutions could obstruct the development of Islamic finance industry; when a contract is recognized by *Shari'ah* advisors in one region but rejected in another region due to conflicting *fatwas* between their advisors. Such disagreement is anticipated to arise between the Middle Eastern and Malaysian *Shari'ah* scholars (Shaharuddin et al., 2012). Even though there are divergences in opinions on certain issues among *Shari'ah* scholar and other various related *Shari'ah* issues in the capital market, they could be solved by a proper regulatory system and surveillance. In Malaysia, the capital markets are highly regulated and there is the Securities Commission who acts as a regulator to safeguard the rights of the parties involved in the capital market and contract dealings.

The issue of speculation is relevant to the composite index futures contract and Islamic asset under management. As the manager for the fund, Islamic asset management companies are committed to provide the highest possible return to their fund investors. Although these asset managers must take into account of the fundamentals for their investment decisions[15], they are allowed to allocate a small portion of their funds[16] in short term trading activities in some listed securities on the Bursa Malaysia regardless of their fundamental criteria. This is in order to take advantage of sudden securities price changes due to technical price movements or news which are speculative in nature. However, their position should be cleared out immediately in either of the following cases; once their *Shari'ah* Advisors are of the opinion that the activities of the invested company contradict *Shari'ah* principles, after getting the required return, or in the situation where the general market or the particular securities price exhibits signs of weakness. This trading activity is categorised as non-excessive speculation, therefore, a cut loss action is enforced to avoid further deterioration of investment value of their short term investment expectation. This trading activity is done in the spot rather than in the futures market in Malaysia. This is evident from the wavelet variance (see Appendix 3) where daily variance of the FBMKLCI and the FKLI, and intraday variance of the FBMKLCI decrease as the time scales increase. An exception occurs for the intraday FKLI variance where the decrease is very marginal and at all time scales the intraday FKLI variance is very stable and close to zero.

[15] Among fundamental criteria for consideration in purchasing stock for investment are stock within the growth industries, low prospective price-earnings ratio (PER), undervalue stock in relation to its net tangible asset or net value, or its comparative price-earnings multiple, stock with good earnings based on earnings per share (EPS) and with expected high dividend yield (DY), and turn around stock based on market or company's news or announcement. Other than fundamental analysis, technical analysis or market timing must also be considered in reinforcing the decision to invest.

[16] Depending on the company, the size of the fund varies but shall not exceed certain percentage (normally less than 10%) of the total cost of portfolio.

In view of the above discussion we argue that Muslim investors should avoid excessive speculative trading behaviour and invest in a longer investment horizon as this is more reflective of the market fundamentals. We note that in Islamic economics and finance, elements of *riba*, excessive *gharar* and excessive speculation are strictly forbidden. Our results suggest that the existence of futures market in Malaysia is beneficial to the spot market because for most of the time, price discovery happens in both markets with no excessive *gharar* and excessive speculation. We also find that in a longer horizon and during certain crisis periods, price discovery is greater in the futures market. Thus, supporting the view that derivatives market in Malaysia is not speculative. There is a much higher traded volume in the spot market than in the futures market and the short term traders reacted in the stock market and not at the futures market.

Based on our discussions with the regulators and domestic asset managers, the lower trading volume is due to domestic asset managers lacking knowledge and understanding of the proper use of derivatives as hedging tools. As a result, they tend to leave their portfolio position without hedging, which exposes their fund to a higher risk. Our results, consistent with discussions by Kamali, (1999a) and Kamali, (1999b) seem to support further development of Islamic equity futures within the Islamic capital market since Islamic asset managers need to protect their funds' value too. In the light of these results, it is encouraging to expand the study to other emerging countries which would provide more evidence on some particular issue of derivatives in relation to Islamic finance.

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APPENDICES

Appendix 1: FKLI Contract Specification

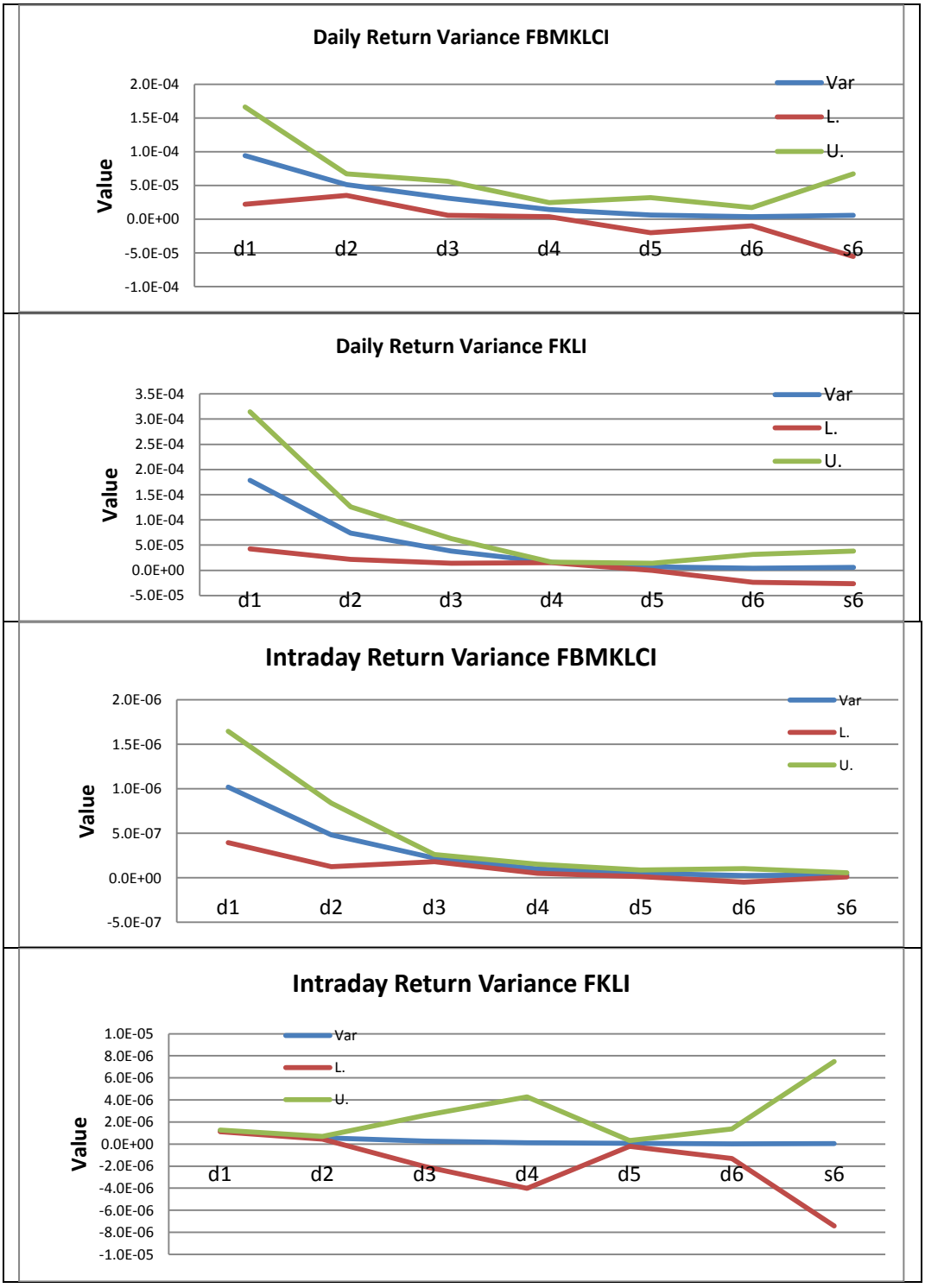
Contract Code	FKLI
Underlying Instrument	FTSE Bursa Malaysia Kuala Lumpur Composite Index (FBM KLCI)
Contract Size	FBM KLCI multiplied by RM50
Minimum Price Fluctuation	0.5 index point valued at RM25
Daily Price Limits	20% per trading session for the respective contract months except the spot month contract. There shall be no price limits for the spot month contract. There will be no price limit for the second month contract for the final five Business Days before expiration.
Contract Months	Spot month, the next month and the next two calendar quarterly months. The calendar quarterly months are March, June, September and December.
Trading Hours	First trading session: Malaysian time 8:45 a.m. to 12:45 p.m. Second trading session: Malaysian time 2:30 p.m. to 5:15 p.m.
Final Trading Day	The last Business Day of the contract month.
Final Settlement	Cash Settlement based on the Final Settlement Value.
Final Settlement Value	The Final Settlement Value shall be the average value, rounded to the nearest 0.5 of an index point (values of 0.25 or 0.75 and above being rounded upwards), taken at every 15 seconds or at such intervals as may be determined by the Exchange from time to time from 3.45:30 p.m. to 4.45:15 p.m. plus one value after 5.00pm of the FBM KLCI on the Final Trading Day excepting the 3 highest and 3 lowest values.
Speculative Position Limit	Maximum number of net long or net short positions to be held: 10,000 contracts for all months combined

Source: Bursa Malaysia

Appendix 2: Trading Hours of FBMKLCI and FKLI

Intervals	Time shown in data	Observations per day	FBMKLCI	FKLI
8.45am-9.00am	9.00am	Removed	-	Market Open
9.00am-9.15am	9.15am	1	Market Open	
9.15am-9.30am	9.30am	2		
9.30am-9.45am	9.45am	3		
9.45am-10.00am	10.00am	4		
10.00am-10.15am	10.15am	5		
10.15am-10.30am	10.30am	6		
10.30am-10.45am	10.45am	7		
10.45am-11.00am	11.00am	8		
11.00am-11.15am	11.15am	9		
11.15am-11.30am	11.30am	10		
11.30am-11.45am	11.45am	11		
11.45am-12.00am	12.00am	12		
12.00am-12.15pm	12.15am	13		
12.15pm-12.30pm	12.30am	14		
12.30pm-12.45pm	12.45am	Removed	Market Close	End of Trading
End of First Trading Session				
2.30pm-2.45pm	2.45pm	15	Market Open	Market Open
2.45pm-3.00pm	3.00pm	16		
3.00pm-3.15pm	3.15pm	17		
3.15pm-3.30pm	3.30pm	18		
3.30pm-3.45pm	3.45pm	19		
3.45pm-4.00pm	4.00pm	20		
4.00pm-4.15pm	4.15pm	21		
4.15pm-4.30pm	4.30pm	22		
4.30pm-4.45pm	4.45pm	23		
4.45pm-5.00pm	5.00pm	24	End of Trading	
5.00pm-5.15pm	5.15pm	Removed	Market Close	End of Trading
End of Second Trading Session				

Appendix 3: Wavelet Variance - Daily and Intraday Close-to-Close (CTC) Returns of the FBMKLCI and the FKLI



Appendix 4: Daily and Intraday Returns Correlation of the FBMKLCI and the FKLI

Correlation: Daily Return (FBMKLCI and FKLI)	wavecor	lower	upper
d1	0.8220546	0.8076164	0.835508
d2	0.8856405	0.8717931	0.8980736
d3	0.9332200	0.9211507	0.9434963
d4	0.9538334	0.9414195	0.9636658
d5	0.9826275	0.9754890	0.9876999
d6	0.9907120	0.9847655	0.9943440
Correlation: Intraday Return (FBMKLCI and FKLI)	**wavecor**	**lower**	**upper**
d1	0.6068538	0.5945203	0.6189017
d2	0.7080458	0.6941696	0.7213960
d3	0.7809149	0.7653872	0.7955339
d4	0.8353856	0.8181007	0.8511624
d5	0.8876180	0.8700218	0.9029556
d6	0.9329050	0.9171208	0.9457682

Appendix 5: Daily Cross-Correlation of FBMKLCI and FKLI

Lag	Level1	Level2	Level3	Level4	Level5	Level 6
-5	0.118461	0.166751	-0.6614	-0.04897	0.622097	0.90794
-4	-0.19705	-0.03117	-0.64123	0.212532	0.734611	0.93541
-3	0.2317	-0.44794	-0.31938	0.47152	0.831191	0.95776
-2	-0.00143	-0.56191	0.180641	0.700353	0.907364	0.97465
-1	-0.54582	0.168329	0.67038	0.87073	0.959043	0.98574
0	***0.822055***	***0.88564***	***0.93322***	***0.953833***	***0.982627***	***0.99071***
1	-0.46893	0.464489	0.812219	0.930741	0.975792	0.98933
2	0.042764	-0.41308	0.399529	0.80977	0.939678	0.98169
3	0.040313	-0.55551	-0.11392	0.615168	0.877265	0.968
4	-0.01903	-0.13919	-0.51933	0.3729	0.792334	0.94855
5	0.041192	0.152254	-0.64714	0.109263	0.68932	0.92366

Appendix 6: Intraday Cross-Correlation of FBMKLCI and FKLI

Lag	Level1	Level2	Level3	Level4	Level5	Level 6
-5	-0.0303	0.1282	-0.5394	-0.0567	0.5716	0.8262
-4	0.0227	0.0188	-0.5402	0.1736	0.6664	0.8592
-3	0.0696	-0.3595	-0.2887	0.4020	0.7486	0.8868
-2	-0.0094	-0.4661	0.1276	0.6044	0.8149	0.9085
-1	-0.3663	0.1686	0.5472	0.7571	0.8621	0.9240
0	**0.6069**	**0.7080**	**0.7809**	**0.8354**	0.8876	0.9329
1	-0.3399	0.2881	0.6964	0.8234	***0.8895***	***0.9347***
2	-0.0187	-0.3690	0.3605	0.7281	0.8684	0.9297
3	0.0655	-0.3663	-0.0681	0.5682	0.8263	0.9183
4	0.0159	-0.0348	-0.4128	0.3635	0.7655	0.9006
5	-0.0226	0.1011	-0.5357	0.1372	0.6890	0.8770