Suruhanjaya Sekuriti
Securities Commission
Malaysia

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AN EXPLORATORY STUDY ON THE ADOPTION OF A SHARIAH-COMPLIANT STOCK INDEX FUTURES IN THE MALAYSIAN CAPITAL MARKET

SC-OCIS VISITING FELLOWSHIP
SCHOLAR IN RESIDENCE PROGRAMME
IN ISLAMIC FINANCE 2018-2019

SC-OCIS Scholar in Residence Programme

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SC-OCIS Scholar in Residence Programme

The collaboration between the Securities Commission Malaysia (SC) and Oxford Centre for Islamic Studies (OCIS), UK was established in 2010, with the objective of promoting intellectual discourse and research on applied and contemporary issues with respect to global Islamic finance.

The SC-OCIS Scholar in Residence Programme is one of the outcomes aimed to pursue further research that complements the flagship programme, which is the annual SC-OCIS Roundtable. A thought-leadership platform, the SC-OCIS Roundtable gathers distinguished scholars, academicians, regulators and Islamic finance practitioners to discuss and exchange views on contemporary issues in Islamic finance.

Dr Hashim Jusoh from University Sultan Zainal Abidin, Malaysia was the seventh Visiting Fellow of the SC-OCIS Scholar in Residence Programme for the academic year 2018/2019. During his tenure, he completed a research titled 'An Exploratory Study on the Adoption of a Shariah-Compliant Stock Index Futures in the Malaysian Capital Market'.

The research examines the relationship between futures and spot markets in Malaysia, specifically, between the stock index futures, crude palm oil futures, conventional stock indices and Shariah stock indices, traded on Bursa Malaysia Derivatives and Bursa Malaysia Securities. Time and frequency domain approach based on the wavelet techniques are used to study multi-horizons correlations, hedging effectiveness and inter-temporal causality between the above-mentioned variables.

It is hoped that Dr Hashim's research will provide useful information and substantial evidence, towards the development of an Islamic stock index futures as a new hedging instrument. In dealing with this issue further research needs to be done, empirically and qualitatively.

Profile of Scholar

DR HASHIM JUSOH
SC-OCIS Scholar in Residence in Islamic Finance 2018/2019

Dr Hashim Jusoh is a Senior Lecturer at the Faculty of Economics and Management Sciences, University Sultan Zainal Abidin. He completed his PhD (Islamic Finance) from INCEIF; MBA from University Teknologi MARA (UiTM) and BBA (1st Class Hons.) (Finance) from Institut Teknologi MARA (ITM) where he also received the university's prestigious outstanding achievement. He is currently a joint-recipient of the SC-OCIS Scholar in Residence Programme in Islamic Finance at the Oxford Centre for Islamic Studies, for Academic Year 2018/19. His proposed study attempts to explore the possibility of introducing a Shariah-compliant stock index futures in the Malaysian capital market. Prior to joining the academic field, he has had experience in investment and fund management with a stockbroking firm, an Islamic asset management firm and also an Islamic unit trust firm in Malaysia.

An Exploratory Study on The Adoption of a Shariah-Compliant Stock Index Futures in The Malaysian Capital Market

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Acknowledgment:

"We would like to thank the SC-OCIS Visiting Fellowship in Islamic Finance 2018/2019 Programme for generous support for and hosting of this project. The fellowship is offered jointly by the Securities Commission Malaysia and the Oxford Centre for Islamic Studies. We would also like to thank Prof. Obiyathulla Bacha from INCEIF, Prof. Mansur Masih from Universiti Kuala Lumpur, Prof. Mehmet Asutay from Durham University, and Mr Wan Abdul Rahim Kamil from the Securities Commission Malaysia for their helpful advice and suggestions."

Two papers related to this study have been submitted while the third paper is ready to be submitted for publications in reputed finance journals as follows:

1. Should Investors Hedge or Diversify Their Portfolio: A Tradeoff Dilemma in Futures-Spot Markets? Perspectives of an Islamic investor (Economic Inquiry).
2. Volatility Spillover across Spot and Futures Markets: Evidence from Malaysian Dual Financial System (International Journal of Finance & Economics).
3. Multi-scale Lead-Lag Relationship between the Stock and Futures Markets: New Evidence from Malaysia based on 15- Minute Intraday Data (prepared to be submitted to Journal of Financial Research).

Abstract

There is an extensive literature focused on the issue of relationship between futures markets and its underlying capital markets in developed economies worldwide. However, there is limited empirical evidence in emerging economies. This exploratory study examines the relationship between futures and spot markets in Malaysia, specifically, between the stock index futures and crude palm oil futures, which are traded on Bursa Malaysia Derivatives, conventional stock indices and *Shariah* stock indices, traded on Bursa Malaysia Securities. Time and frequency domain approach based on the wavelet techniques are used to study multi-horizons correlations, hedging effectiveness and inter-temporal causality between the above-mentioned variables. Our work is the first attempt to study the futures-spot relationship in Malaysia as an advanced emerging country using wavelet analysis based on daily and intraday data spanning more than 10 years. Unlike the case of crude palm oil futures, our findings remarkably indicate that stock index futures, conventional stock indices and *Shariah* stock indices seem to follow the same behaviour in terms of return correlation, hedging effectiveness and inter-temporal causality. The results have strong policy implications for both investors and regulators.

Keywords: Stock index and crude palm oil futures, conventional and *Shariah* stock indices, correlation, hedging effectiveness and inter-temporal causality

1. Introduction

Malaysia has the world's most comprehensive Islamic capital market (ICM) which is supported by a robust regulatory infrastructure offering end-to-end *Shariah* compliance and it is the government's vision to sustain Malaysia as an international ICM hub. In 2007, Bursa Malaysia collaborated with FTSE to launch FTSE Bursa Malaysia EMAS *Shariah* Index (FBMEMAS SHARIAH) and FTSE Bursa Malaysia Hijrah *Shariah* Index (FBMHIJRAH SHARIAH) to benchmark performance of Islamic funds and launch index- related products. The indices are based on free-float methodology and the components of the indices are subjected to comprehensive and pragmatic *Shariah* screening by the *Shariah* Advisory Council of the Securities Commission Malaysia (SAC) and Yasaar Research (Securities Commission Malaysia, 2007).

One of the Securities Commission's (SC) main agendas is the development of the Islamic capital market in Malaysia[1][1]. The *Shariah* Advisory Council (SAC) is tasked with ensuring compliance to *Shariah* principles in its role as the advisor to the SC on all matters pertaining to the Islamic capital market development. The SAC is also the centre of reference and the highest authority for issuing related *fatwas*.

The SC adopts two approaches when introducing Islamic capital market products (Securities Commission Malaysia, 2009). Firstly it studies the validity of conventional instruments in the Malaysian capital market from the *Shariah* perspective, particularly on their composition, procedure and usage. The second stage is the formulation and development of new *Shariah* compliant financial products.

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[1][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.

According to the Securities Commission Malaysia website, as of October 2019, there are 701 *Shariah*-compliant securities out of a total of 927 Public Listed Companies (PLCs) on Bursa Malaysia. Total market capitalisation of these *Shariah*-compliant securities listed on Bursa Malaysia is RM 1.07 trillion (USD 255.02 billion) which accounts for 63.02% of total market capitalisation of securities listed in Bursa Malaysia. In addition, total size of Islamic Capital Market which includes Sukuk outstanding is RM 1.99 trillion (USD 476.96 billion). Total Asset Management is RM 822.44 billion (USD 196.76 billion), out of which RM 178.08 billion (USD 42.6 billion) is the net asset value of Islamic Asset Management, which accounts for 21.65%. Overall, Malaysian capital market size is RM 3.19 trillion (USD 763.16 billion).

Fluctuations in equity prices cause volatility of equity returns and thereby hurts wealth creation. The most basic forms of equity risk management are diversification and asset allocation (Bacha, 2004). Islamic funds and assets managers need to protect their asset values. In this sense, they should not leave their assets exposed to high risk, and leaving their assets without proper protection and unhedged could be a wrong decision based on one of the objectives of *Shariah* i.e., protection and preservation of assets (Jusoh, 2017). With a limited number of approved instruments in the capital market, Islamic investors will have limited choice to choose what type of asset classes to add into their investment portfolio based on risk analysis and performance of the assets.

Since two basic strategies of equity risk management are limited in scope, Bacha (2004) stresses that the advent of derivative instruments brought a whole new range of possibilities to risk management. Not only did it become possible to overcome the limitations of the basic strategies, but entire new strategies to alter risk profiles became possible. He also suggests that the most commonly used equity derivatives in risk management have been stock index futures contracts and index/ equity options.

Islamic capital markets, in their development stage must deal with the issue of risk management if it is to develop further. However, the acceptability and applicability of derivatives as hedging tools are relatively low in Malaysia despite the government's vision to establish Malaysia as an international Islamic capital market hub.

Inconsistencies in the arguments among *Shariah* scholars regarding permissibility of derivatives instruments have been argued by Bacha (1999). In Malaysia, the SAC basically does not reject the use of equity futures provided the underlying instrument is a *Shariah* compliant instrument for hedging purposes. However, in case of the FKLI, the underlying components of the FTSE Bursa Malaysia Kuala Lumpur Composite Index (FBMKLCI) consist of a basket of securities of halal and non- halal stocks. If the non- halal stocks are taken out, then the SAC will have no objection in approving the use of this type of instrument. One of the limited alternatives left for Islamic investors to protect their portfolio is through the use of the FCPO contract. This contract is a *Shariah* compliant derivatives instrument which can take the role of avoiding portfolio exposure to excessive risk through hedging ("*Tahawut*").

Aims to uncover the needs for more information pertaining to derivatives contract (FKLI), *Shariah* compliant derivatives contract (FCPO), conventional indices (FBMKLCI and FBMEMAS) and *Shariah* indices (FBMEMAS SHARIAH and FBMHIJRAH SHARIAH), the study is based on daily data and 15-minute intraday data. Based on daily data, the study focuses on the stock index futures (FKLI) and the Crude Palm Oil futures (FCPO), and its relationship with the conventional stock indices (FBMKLCI

and FBMEMAS), and *Shariah* stock indices (FBMEMAS SHARIAH and FBMHIJRAH SHARIAH). Based on intraday data, the study focuses only on the FKLI and its relationship with its underlying spot index (FBMKLCI) due to unavailability of data. In case of the FCPO, its spot data are only available on monthly basis. No higher frequency like intraday data are available for the spot CPO due to the fact that the spot CPO contract is not traded on an organized exchange compared to the spot equity which is traded on Bursa Malaysia. Moreover, equity is more relevant in the context of fund managers' asset allocation strategy. Equity investment has the most exposure in their portfolio compared to commodity investment.

We use 15-minute data instead of higher frequency data of 1-minute and 5-minute because of higher trading volume and higher trading volatility at 15-minute data. This is reflected by real time prices at Bursa Malaysia's official website that are delayed by 15 minutes.

In contrast with standard time series econometrics analysis, we use wavelet techniques because it can (i) overcome the problems of non-stationarity of the time series data; and (ii) address time-varying nature of financial relations, dealing with different investment time horizons or stock holding periods. This makes our contribution meaningful for investors and fund managers.

The main finding of this paper is that equity futures contracts and equity instruments in an emerging market like Malaysia show strong dynamics in co-movement and hedging opportunities in time during various investment horizons or stock-holding periods.

The rest of the paper is organized into five sections. After this introduction, Section 2 provides the literature review of the spot-futures relationship. Section 3 explains the data and methodology, while Section 4 provides analysis and discussion of the findings based on daily and 15-minute intraday data. Finally, section 5 presents the concluding remarks and policy implications.

2. Literature Review

Critics argued that derivatives are the culprits behind financial bubbles and crises, however, evidence from empirical studies are mixed as discussed in Sutcliffe (2006) and Bacha (2012). There is agreement from a majority of the studies that derivatives are rarely the origin of the crisis. However derivatives could intensify the negative effects of the crisis if there are weak regulation and supervision by regulators at macro level, and lack of proper governance and risk management controls by financial institutions at micro level.

The issues of derivatives have been well documented in academic literature and debated among economic scholars and practitioners regarding its impact in the capital market and in the whole system of the economy. *Shariah* scholars also are interested in discussing its permissibility. Askari, Iqbal and Mirakhor (2009) assert that,

"There is debate among scholars on the usage and applicability of derivatives products. Some scholars have rejected derivatives outright on the basis of the possible usage of derivatives for speculative purposes, while others have argued that such rejection of derivatives should be based on careful review of the product on case-by-case basis".

In August 2006, the Malaysia International Islamic Financial Centre (MIFC) was launched to position Malaysia as an international Islamic financial hub, including establishing Malaysia as a scholarly centre. The MIFC Community was founded as a network 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. Supported by the *Shariah* governance and legal frameworks and experts in the field, Malaysia is well positioned to facilitate and enhance greater international linkages and market integration in Islamic finance between the Asian region and the rest of the world (Ernst & Young, 2011). At present, Malaysia is the biggest hub while Saudi Arabia comes second.

The Malaysian government, via regulatory bodies such as Bank Negara Malaysia and Securities Commission, is very serious about developing its capital market. One of the growth strategies to expand the role of Malaysian capital market is stated in the Capital Market Master Plan 2 (CMP2). Among the primary objectives of the CMP2 is to facilitate efficiency of price discovery from underlying cash markets to derivatives markets due to pricing efficiencies and flexibilities for hedging (Securities Commission Malaysia, 2011). CMP2 forms another important contribution to invigorate the Malaysian economy by extending the role of capital market in supporting the country's development. As stated in the CMP2 pp 40,

"The lack of a comprehensive derivatives market poses challenges to increasing liquidity and connectivity between different market segments and asset classes leads to pricing inefficiencies which increases transaction costs and reduces trading activities due to the high costs of hedging and arbitrage".

The impacts of derivatives on the capital market and the economic system have been well documented in academic literature and debated amongst economic scholars and practitioners. While there have been many studies in developed markets, there are very few studies that have been done Malaysia, see for examples, (Mohamad, et. al., 2007; Ibrahim, Othman, and Bacha, 1999; Nor and Choo, 2002; Hassan, Mohamad, Ariff, and Nassir, 2007; Bacha, 2012; Jusoh, 2017). Pertaining to issues of derivatives in emerging markets including Malaysian market, Mohamad and Hassan (2007) and Mohamad, et. al., (2007) call for further research and also validation of the limited research results from existing literature using better models, larger samples and longer time periods.

Futures can be beneficial to Islamic capital market if modified to become *Shariah* compatible where economic efficiency is the prime goal of *Shariah* compatible futures (Al-Saati, 2002). Developing Islamic derivatives within Islamic capital market in Malaysia requires a deep understanding of the operations of the current capital market and contemporary analysis of *Shariah* principles. A thorough study regarding the permissibility of futures contracts and prospects for developing Islamic derivatives as financial instruments in Malaysia have already been undertaken by Kamali (1999a) and Kamali (1999b).

The problem of different *Shariah* resolutions could obstruct the development of Islamic finance industry; when a contract recognized by *Shariah* advisors in one region is rejected in another. Such disagreement is anticipated to arise between the Middle Eastern and Malaysian *Shariah* scholars (Shaharuddin et al., 2012). However, many issues could be overcome if there is a good regulatory system that protects the counterparty's interest in an economic system in general even though there are divergences in opinions on certain issues related to derivatives among *Shariah* scholars.

The divergences in opinions could be solved by a proper regulatory system and surveillance. In Malaysia, the capital markets are highly regulated and there is the Securities Commission Malaysia who acts as a regulator to safeguard the rights of the parties involved in the capital market and contract dealings and Bursa Malaysia that provides one of the best avenues for investment in the world through its organized exchange and automated trading platform. This is evident through the awards received by the Bursa Malaysia Derivatives as the best emerging exchange of the year 2015 following the recognition that Bursa Malaysia sustained the features of an organised exchange and maintained best practices for market integrity and safeguarding customer interest.

This empirical study contributes to filling the gap pertaining to issues of futures contracts as hedging instruments in the Malaysian market, while enriching the limited existing literature.

3. Methodology

In this study we examine the multi-horizon nature of correlations, hedging effectiveness and inter-temporal causality of the stock index futures (FKLI), the Crude Palm Oil futures (FCPO), the conventional stock indices (FBMKLCI and FBMEMAS), and *Shariah* stock indices (FBMEMAS SHARIAH and FBMHIJRAH SHARIAH). The study is based on daily data and 15-minute intraday data. Based on daily data, the study focuses on relationship between the stock index futures (FKLI) and the Crude Palm Oil futures (FCPO), and its relationship with the conventional stock indices (FBMKLCI and FBMEMAS), and *Shariah* stock indices (FBMEMAS SHARIAH and FBMHIJRAH SHARIAH). Based on intraday data, the study focuses only on the FKLI and its relationship with its underlying spot index (FBMKLCI) due to unavailability of data.

In addressing the above-mentioned issues, the study is motivated by previously undertaken research by Ibrahim, Othman, and Bacha (1999), Nor and Choo (2002), and Hassan, Mohamad, Ariff, and Nassir (2007), and more recently, Bacha (2012) and Jusoh (2017), and seeks to further their works.

The first part of this study focuses on the multi-horizon nature of correlation between the two markets, specifically, between the FKLI and FCPO traded on derivatives market, and the FBMKLCI, FBMEMAS, FBMHIJRAH SHARIAH and FBMEMAS SHARIAH traded on the stock market, in Malaysia.

Based on the underlying assumption that if a mispricing were to arise, unlimited arbitrage trading would trigger the market price back to its theoretical fair value and hedging effectiveness may go down as a result of pricing inefficiency, the second part of this study investigates hedging effectiveness of the FKLI and FCPO in relation to the FBMKLCI, FBMEMAS, FBMHIJRAH SHARIAH and FBMEMAS SHARIAH. One of the functions of futures markets is to manage risk through hedging. Therefore, it is important to empirically examine hedge ratio and hedging effectiveness of futures contracts traded on futures markets. For this purpose, among others, studies by Ederington (1979), In and Kim (2006a, 2006b, 2013), Lien and Shrestha (2007), Fernandez (2008), Chen and Sutcliffe (2012), and Hou and Li (2013) can be mentioned. Daily data are provided by Thomson Reuters EIKON for the period of 28th February 2007 through 18th November 2019 resulting in 3,088 datapoints. The prices data are then generated into the percent return series. Based on the Discrete Wavelet Transform (DWT) in Appendix 2, method of calculating hedge effectiveness in Appendix 3 is used to address the issue of hedging effectiveness of the variables.

The third part of the study examines inter-temporal causality known as the lead-lag relationship between the FKLI and FBMKLCI, a popular approach to test for price discovery function in the derivatives market. Lin and Stevenson (2001) reconstructed a dataset that differentiated the two fundamentally related time series namely spot and futures indices. Their findings showed that the lead-lag relationship existed. 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 these indices, 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. A new approach on wavelet analysis (Appendix 2) known as the Continuous Wavelet Transform (CWT) based on 15-minute intraday close-to-close (CTC) and open-to-close (OTC) data throughout the period spanning from 15 April 2009 to 19 February 2019 is used in this study. The proprietary data are gathered from TELEQUOTE and the total number of data points is 57,628 observations.

The last part of the study is a discussion on the lesson learnt from the first three parts of the study in the consideration of a *Shariah*-compliant equity futures contract. In particular, the discussion focuses on the feasibility issues and challenges regarding the need to uncover more information pertaining future research on the possible introduction of a *Shariah*-compliant stock index futures. Basically, one of the things is to understand the behaviour of these instruments for future policy making. Overall the study is intended to strike a balance between the need to avoid speculation and the genuine need for hedging portfolio risks.

4. Results and Discussion

4.1 Correlation based on Discrete Wavelet Transform (DWT)

Table 1 presents correlation results that show a strong relationship between the stock and futures markets in Malaysian markets at all-time scales. The multi-horizon correlation between the two markets varies over investment horizons but remains very high especially in the long run. As the time scales increases, correlation between the markets increases. Regardless of whether the instruments are conventional or *Shariah* compliant, the markets' behaviours are found to be similar (indifferent), suggesting that the stock and futures markets are not fundamentally different. The FKLI can be a good instrument for portfolio hedging.

Table 1: Correlation between stock index futures (FKLI) and stock indices				
Scales	FKLI-FBMKLCI	FKLI-FBMEMAS	FKLI-FBM HIJRAH SHARIAH	FKLI-FBMEMAS SHARIAH
d1	0.7507	0.7663	0.6536	0.7299
d2	0.8548	0.8527	0.7736	0.8222
d3	0.9415	0.9281	0.8762	0.8954
d4	0.9756	0.9601	0.9272	0.9374
d5	0.9857	0.9681	0.9243	0.9382
d6	0.9909	0.9766	0.9427	0.9498
s6	0.9981	0.9895	0.9548	0.9646

Table 2 presents correlation results between the crude palm oil futures and stock indices over different time scales, up to scale 8. Unlike those obtained in the previous section, the results show that the correlation between the two markets varies over different horizons but remains high. However, the magnitude of the correlation is lower compared to the correlation between stock index futures and stock markets, indicating that the crude palm oil and stock markets are found to be fundamentally different. Hence, the FCPO can be an instrument for portfolio diversification.

Table 2: Correlation between crude palm oil futures (FCPO) and stock indices				
Scales	FCPO -FBMKLCI	FCPO -FBMEMAS	FCPO -FBM HIJRAH SHARIAH	FCPO -FBMEMAS SHARIAH
d1	0.1853	0.1979	0.1688	0.1814
d2	0.2454	0.2537	0.2526	0.2571
d3	0.3027	0.3158	0.3182	0.3243
d4	0.1878	0.2052	0.2120	0.2182
d5	0.2358	0.2693	0.2949	0.3066
d6	0.2814	0.2999	0.3119	0.3270
d7	0.0956	0.0607	0.1358	0.1070
d8	0.7091	0.7026	0.7225	0.7336
s8	-0.3628	-0.2860	-0.5839	-0.3947

4.2 Hedging Effectiveness based on Discrete Wavelet Transform (DWT)

In this section we compute the hedging effectiveness of the FKLI and FCPO in relation to the FBMKLCI, FBMEMAS, FBMHIJRAH SHARIAH and FBMEMAS SHARIAH. The results are depicted in Table 3. For FCPO, we choose 6 scales for FKLI and 8 scales for FCPO to demonstrate specific behaviour of the commodity market above scale 6.

The findings (in Table 3) suggest that the decomposed hedging effectiveness increases monotonically at a decreasing rate as the series approaches scale d6 (32-64 days), converging toward the long-horizon degree of hedging effectiveness approaching one as the wavelet time scale increases. In line with, among others, In and Kim (2006a, 2006b, 2013), the index futures and stock returns are perfectly correlated, in the long run. Intuitively, as explained by In and Kim (2006a, 2006b, 2013),

over long horizons, hedging effectiveness approaches one because the shared permanent component ties the stock and futures series together and the effect of the temporary components becomes numerically insignificant.

However, the values of hedging effectiveness are slightly lower for *Shariah* indices (FBMHIJRAH SHARIAH and FBMEMAS SHARIAH) compared to their conventional counterparts (FBMKLCI and FBMEMAS). If Islamic fund managers are allowed to use stock index futures (which is non *Shariah* compliant) for hedging purposes, they would still benefit from this derivatives instrument by hedging their portfolio position. This may suggest a need to devise a new stock index future based on *Shariah* index as its underlying instrument, where Islamic investors could use it as a hedging instrument. Nevertheless, policy makers must handle this issue with care. This study can be considered as the first step towards implementation of the new Islamic stock index futures. In dealing with this issue, further research needs to be done, empirically and qualitatively.

Table 3: Hedging effectiveness between FKLI and FCPO and stock indices

Scale	FKLI	FCPO	FKLI	FCPO	FKLI	FCPO	FKLI	FCPO
	FBMKLCI		**FBMEMAS**		**FBM HIJRAH SHARIAH**		**FBMEMAS SHARIAH**	
d1	0.5635	0.0343	0.5873	0.0392	0.4272	0.0285	0.5327	0.0329
d2	0.7306	0.0602	0.7272	0.0644	0.5985	0.0638	0.6761	0.0661
d3	0.8864	0.0916	0.8613	0.0997	0.7629	0.1006	0.8010	0.1051
d4	0.9518	0.0353	0.9217	0.0421	0.8573	0.0448	0.8774	0.0476
d5	0.9716	0.0556	0.9372	0.0725	0.8521	0.0868	0.8795	0.0939
d6	0.9820	0.0792	0.9537	0.0900	0.8866	0.0971	0.9021	0.1069
s6-d7	0.9961	0.0091	0.9791	0.0037	0.9078	0.0183	0.9301	0.0114
d8		0.5029		0.4936		0.5107		0.5333
s8		0.1316		0.0818		0.3292		0.1557

In the long run, results from hedging effectiveness of FKLI show that, for FBMKLCI, it is slightly higher than FBMEMAS, FBMHIJRAH SHARIAH and FBMEMAS SHARIAH respectively. This can be explained by the fact that FBMKLCI is a weighted index and is the underlying instrument of the FKLI which means that the size and components of the constituents of two (futures and spot) indices matters. Nevertheless, in the short run, at scale 1 (1-2 days), hedging effectiveness of FKLI shows that FBMKLCI is slightly lower than FBMEMAS but is still higher than the other two *Shariah* indices, indicating that hedging strategies in less than two days are not as effective as hedging in longer days for asset managers.

Unlike the findings that we get for FKLI and stock indices, the hedging effectiveness of FCPO is low and varies at different time scales with a heterogeneous trend from scale 1 (1-2 days) to scale d7 (64-128 days). Nevertheless, the behaviour seems to be similar for conventional and *Shariah* stock indices.

Only in the long run at scale d8 (128-256 days), we find that the decomposed hedging effectiveness increases significantly. At this scale, we find that hedging effectiveness of the FCPO shows that both *Shariah* indices perform better than the conventional spot indices such as: FBMEMAS SHARIAH =

0.53, FBMHIJRAH SHARIAH = 0.51, FBM KLCI = 0.50, and FBMEMAS = 0.49 respectively. However, over long horizons, at s8 (>256 days), the decomposed hedge ratio becomes negative and hedging effectiveness decreases significantly, indicating that the crude palm oil futures (FCPO), cannot be a good hedging instrument for investors. Although classified as a *Shariah* compliant futures, our empirical results show that FCPO may not be a good hedging instrument for all funds including Islamic funds. This implies that FCPO is more suitable for portfolio diversification. The results that we get from FCPO strengthen our argument that there is a need to devise a new stock index future based on *Shariah* indices as its underlying instrument where Islamic funds could use this as a hedging tool for their portfolio.

Here we do not report results from high frequency data because of unavailability of the data of all indices and also because the results from daily data show that hedging is effective only in the long run.

4.3. Inter-Temporal Causality based on Continuous Wavelet Transform (CWT)

Case of Daily Data

This section presents inter-temporal causality results based on the Continuous Wavelet Transform (CWT) in the case of the FKLI and FCPO as futures instrument, and the FBMKLCI, FBMHIJRAH SHARIAH, FBMEMAS, and FBMEMAS SHARIAH as stock indices.

The findings based on Figure 1a, Figure 1b, Figure 2a, and Figure 2b reveal very high correlations (red zones) between the markets. In the long-run, the two markets are close to be perfectly positively correlated (in-phase), moving instantly together.
In the short-run (scales 16 days and below), small and medium blue blocks (alternate between blue

Figure 1a: FKLI and FBMKLCI

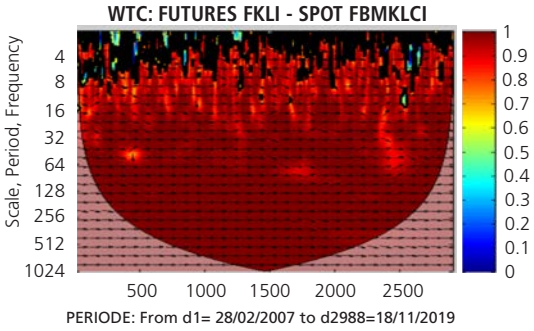
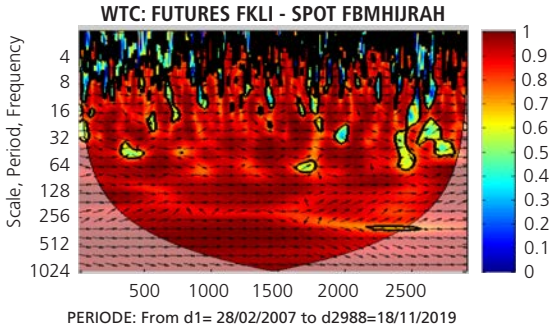


Figure 1B: FKLI and FBMHIJRAH SHARIAH



and red areas) show 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 investment objectives of short-term market participants. However, in the short-term, the arrows are heterogeneously changing, pointing in different directions indicating that the causality effect is bidirectional.

Figure 2a: FKLI and FBMEMAS

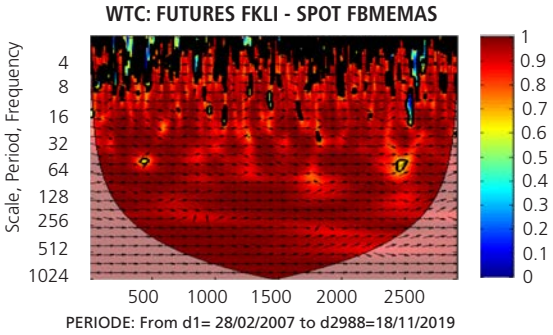
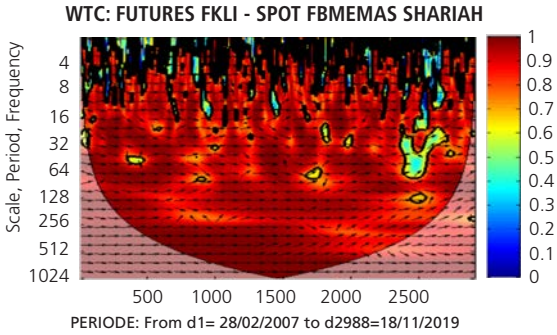


Figure 2b: FKLI and FBMEMAS



The findings based on Figure 3a, Figure 3b, Figure 4a, and Figure 4b suggest only slight linkages between commodity futures (FCPO) and all conventional and *Shariah* spot indices, indicating that FCPO could not be an efficient hedging tool compared to the equity index futures (FKLI) because of the nature of its underlying asset which is based on commodity rather than equities.

Figure 3a: FCPO and FBMKLCI

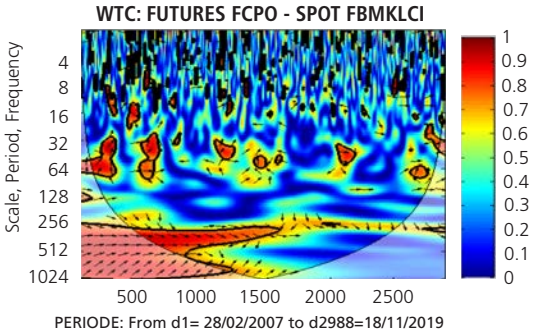
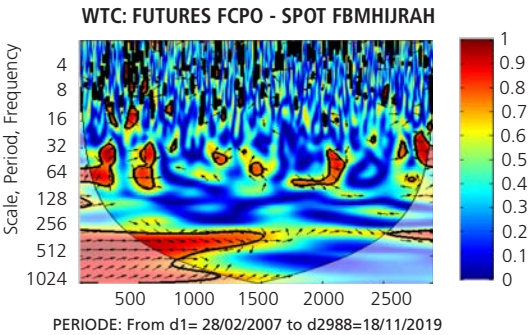


Figure 3b: FCPO and FBMKLCI SHARIAH



This indicates that FCPO cannot be an efficient hedging tool compared to the equity index futures (FKLI) because of the nature of its underlying asset which is based on commodity rather than equities.

Figure 4a: FCPO and FBMEMAS

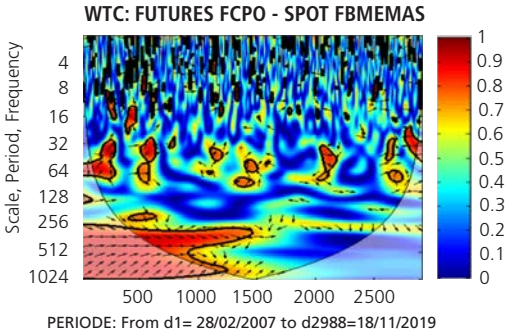
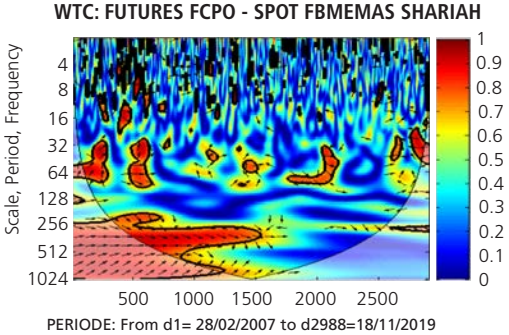


Figure 4b: FCPO and FBMEMAS SHARIAH



Case of Intraday Data (Robustness Test)

The intraday returns based on close-to-close returns demonstrate consistent correlation and in-phase trend in the long-run (Figure 5a). Interestingly, the use of 15-minute intraday data gives us more accurate information about the scale of 64 which is equivalent to 2 days plus 2/3rd day. In the scales lower than 64 (in less than 2.67 days), we observe small blue blocks (alternate between blue and red islands) showing co-movement between the FKLI and the FBMKLCI, this happens at different scales and in a non-homogeneous manner. It could relate to activities of short-term players in both markets. However, in the short-term, the arrows are heterogeneously changing, pointing in different directions. Overall, we have a mixture of positions where in some cases the FBMKLCI leads while in other cases the FKLI leads.

Figure 5a: Intraday CTC FKLI and FBMKLCI

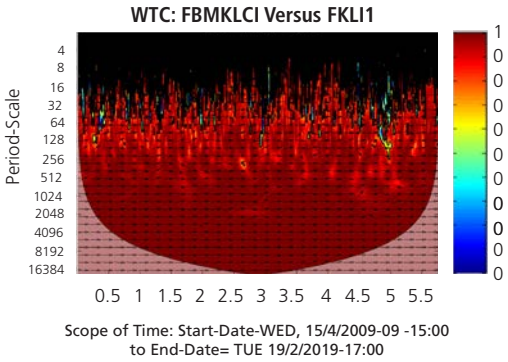


Figure 5b: Intraday OTC FKLI and FBMKLCI

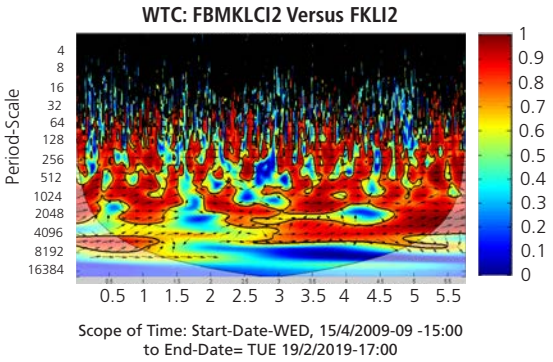


Figure 5b depicts inter-temporal causality based on intraday OTC (open-to-close) returns. It shows reduction in the very high correlation (red zones) and in-phase trend between the FKLI and the FBMKLCI from the previous intraday CTC (close-to-close) returns. In the long-run the two series at certain times 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 observe 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 observe a mixture of positions that in some cases the FBMKLCI leads while in other cases the FKLI leads.

Concluding Remarks and Policy Implications

In this study we examine the multi-horizon nature of correlations, hedging effectiveness and inter-temporal causality of the stock index futures (FKLI), the Crude Palm Oil futures (FCPO), the conventional stock indices (FBMKLCI and FBMEMAS), and *Shariah* stock indices (FBMEMAS SHARIAH and FBMHIJRAH SHARIAH) using the two datasets of data namely, daily data and high frequency 15-minute data.

In summary, our results tend to indicate that the multi-horizon correlation between the markets varies over investment horizons but remains very high especially in the long run. As the time scales increases, correlation between the markets increases. Regardless of whether the instruments are conventional or *Shariah* compliant, the markets' behaviours are found to be similar (indifferent), suggesting that the stock and equity futures markets are not fundamentally different. The FKLI can be a good instrument for portfolio hedging.

Our results suggest that the existence of the equity futures market in Malaysia is beneficial to the stock 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. There are much higher traded daily and intraday volumes in the spot market than in the futures market and the short-term traders reacted in the stock market and not in the futures market.

Evidently the lead-lag relationship between the two markets, the FKLI and FBMKLI varies across frequencies and time scales, and this phenomenon has some policy implications for maintaining the stability of Malaysia's stock and the futures markets. Market participants such as speculators and investors have different investment horizons. 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 in examining the multi scale lead-lag relationship between the two 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 equity futures market and the stock market in an emerging market like Malaysia show strong dynamics in co-movement and hedging effectiveness in time during various investment horizons or stock-holding periods. This suggests 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. Islamic Investors, like their conventional counterparts, have different investment objectives and thus need different investment time horizons. The use of wavelets techniques in this study can help Islamic asset managers get new insights in protecting their funds' value through the use of futures contracts as hedging instruments.

The high correlations at different investment horizons between the FKLI and all stock indices have implications for institutional investors' risk management activity through hedging.

On the other hand, the comparatively lower correlations at different investment horizons or stock-holding periods between the FCPO and all stock indices have implications for the investors' portfolio diversifications. In detail, our findings indicate that the crude palm oil futures (FCPO), may not be a good hedging instrument for investors. This implies that FCPO is more suitable for portfolio diversification. Although classified as a *Shariah* compliant futures contract, our empirical results show that the FCPO may not be a good hedging instrument for all funds including Islamic funds. The results that we get from FCPO strengthen our argument that there might be a need to devise a new stock index future based on *Shariah* indices as its underlying instrument where Islamic funds could use this as a hedging tool for their portfolio.

The wavelet correlation between the FKLI and the FBMKLCI varies over investment horizons, but remains very high at all-time scales. As reported in In and Kim (2006a), the magnitude of the correlation increases as the time scale increases, indicating that the stock and the equity futures markets in Malaysia are fundamentally similar. However, this is not the case with the Malaysia stock and commodity futures market, they appear to be fundamentally different. 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 becomes 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.

Our study is important in understanding the use of derivatives as hedging tools and at the same time to strike a balance between this need and the need to avoid excessive speculation. Without hedging activity, due to lack of awareness and knowledge of the benefits of derivatives contract, institutional investors may expose their funds to higher risk. Our results, consistent with discussions by Kamali (1999a) and Kamali (1999b) support furthering the development of Islamic equity futures within the Islamic capital market.

If Islamic fund managers are allowed to use stock index futures (which is *Shariah* non-compliant) for hedging purposes, they would still benefit from this derivatives instrument by hedging their portfolio position. This may suggest a need to devise a new stock index futures based on *Shariah* index as its underlying instrument, where Islamic investors could use it as a hedging instrument. However, policy makers must handle this issue with care. This study can be considered as the first step towards implementation of the new Islamic stock index futures. In dealing with this issue, further research needs to be done, empirically and qualitatively.

This study has shed some light in furthering the development of Islamic equity futures within the Islamic capital market; however, more evidence from futures studies is needed. We would encourage this study to be extended to other emerging countries to provide for more evidence on derivatives in relation to Islamic finance.

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Appendix 1

Discussion on the issue of speculation

The issue of speculation is relevant to the composite index futures contract and Islamic asset under management. 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[2[2]], they are allowed to allocate a small portion of their funds[3[3]] 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.

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.

2[2] 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.

3[3] 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.

Appendix 2

Methodology based on Wavelets

Wavelet analysis represents a powerful tool for analyzing time series on frequency range and time scales simultaneously. 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)**. There are two main classes of the wavelet transform, namely the continuous wavelet transform (CWT) and the discrete wavelet transform (DWT), which we also dealt with in our study.

1. Discrete Wavelet Transform (DWT)

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

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

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

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:

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

$$\psi_{J,k}(t) = 2^{-\frac{J}{2}}\psi\left(\frac{t-2^J k}{2^J}\right) \quad (3)$$

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:

$$\int \; \phi_{J,k}(t)f(t)dt \approx S_{J,k} \quad (4)$$

$$\int \; \psi_{J,k}(t)f(t)dt \approx d_{J,k} \quad (5)$$

$S_{J,k}$ 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:

$$\hat{r}^J = D_1 + \cdots + D_J + S_J \qquad (6)$$

$$\hat{r}^J = D_1 + \ldots\ldots\ldots\ldots\ldots\ldots + D_J + S_J$$

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 $\hat{r}^J$ $\hat{r}^J$ 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)**:

$$\tilde{\rho}_{XY}(\lambda_j) = \frac{\tilde{\gamma}_{XY}(\lambda_j)}{\tilde{\sigma}_X(\lambda_j)\tilde{\sigma}_Y(\lambda_j)} \qquad (7)$$

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:

$$\rho_X\tau(\lambda_j) = \frac{\gamma_X\tau(\lambda_j)}{\sigma_1(\lambda_j)\sigma_2(\lambda_j)} \qquad (8)$$

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. 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 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.

2. 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):

$$C(scale, position) = \int_{-\infty}^{\infty} x_t \psi(scale, position, t) dt \qquad (9)$$

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)**:

$$F(a,b) = \int \quad x_t \psi(\frac{t-a}{b}) da\ db \tag{10}$$

with an inverse transform of

$$x_t = \iint \ F(a,b)\psi(\frac{t-a}{b}) da\ db \tag{11}$$

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)**, **Gonzalez-Concepcion, et. al., (2012)**, **Madaleno and Pinho (2012)**, **Vacha and Barunik (2012)** and **Aguiar-Conraria and Soares (2014)**. **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:

$$W_{xy} = W_x W_{*y} \tag{12}$$

and the cross-wavelet power as:

$$|W_{xy}| \tag{13}$$

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)**:

$$\frac{S(W_{xy})}{[S(|W_x|^2)[S\left(|W_y|^2\right)]^{\frac{1}{2}}} \qquad (14)$$

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 (2014)** 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.

Appendix 3

Hedge Ratio and Hedging Effectiveness

Hedge Ratio

By using futures contracts, hedging model is used to offset the fluctuations in the value of spot position **(Lien and Shrestha, 2007)**. Consider a portfolio comprising of C_s units of a long spot position and C_f units of a short futures position. Let S_t and $F_t$denote the natural logarithms of spot and futures prices at the end of period *t*, respectively. The return on the hedged portfolio over a period, ΔVH, is given by:

$$\Delta V_H = C_s \Delta VS_t - C_f \Delta VF_t \qquad (15)$$

where;
ΔV_H = Return on the hedged portfolio over a period
C_s = Units of a long spot position
C_f = Units of a short futures position
ΔVS_t = $S_t - S_{t-1}$
ΔVF_t = $F_t - F_{t-1}$

The optimal hedge ratio is then derived by minimising the conditional variance of ΔVH. Following **(Lien and Shrestha, 2007)** the minimum variance (MV) hedge ratio and is:

$$MV\ hedge\ ratio = \frac{C_s}{C_f} = \frac{COV(\Delta S_t, \Delta F_t / I)}{VAR(\Delta F_t / I)} \qquad (16)$$

where:
ΔV_H = Return on the hedged portfolio over a period
C_s = Units of a long spot position
C_f = Units of a short futures position
COV = Covariance of spot and futures returns
VAR = Variance of futures return
I = Appropriate information set

Estimation of Hedging Effectiveness

After estimating the optimal hedge ratio in eq. (2), we compute hedging effectiveness (HE) of optimal hedge ratios based on variance reduction criterion suggested by **Ederington (1979)**, as given below:

$$HE = 1 - \frac{V(H)}{V(U)} \qquad (17)$$

where:
$V(H)$ = Variance of hedged portfolio
$= \sigma^2_{spot} + h *^2 \sigma^2_f - 2h * \sigma_{spot,f}$
$V(U)$ = Variance of unhedged portfolio = σ^2_{spot}
σ^2_{spot} = Variance of the spot index return
$h *$ = Optimal hedge ratio
σ^2_f = Variance of the futures return
$\sigma_{spot,f}$ = Covariance between the spot index and futures returns

Appendix 4

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				

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