PRICE DISCOVERY AND HEDGING EFFECTIVENESS IN EMERGING MARKETS ACROSS ASIA PACIFIC

By

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Futures markets play a significant role in stock markets in terms of price discovery and in hedging the price risk. While there have been an extensive number of theoretical and empirical studies conducted about the two main functions of futures markets in the developed markets, few studies exist that examine the case of the developing markets. The accuracy of price discovery and hedging is particularly important in the Asia Pacific emerging markets, considering the recent Asian and global financial crises and the substantial increases in the sizes of these markets. Additionally, it is theoretically established that when accurate price discovery is attained through a greater contribution of futures markets the hedge is more effective. The critical lack of research about this interrelationship is rather obvious.

This dissertation describes the existing methods to investigate the relationship between spot and futures prices, identify the optimal hedge ratio, and motivate, propose and implement a new method to evaluate the interrelationship between accurate price discovery and hedging effectiveness. Malaysia's FBM KLCI, Singapore's STI, Japan's NIKKEI 225, traded in the Singapore exchange, and South Korea's KOSPI 200 are examined using data from the inception of the associated futures markets to March 2013.

The empirical evidence indicates that futures markets generally contribute more to the price discovery process than spot markets. When comparing the indexes, it was determined that the spot and futures NIKKEI 225 impounds new information faster than the other indexes, while the FBM KLCI attains the highest contribution of futures markets in the process of price discovery. Moreover, the futures contracts with a moderate time to maturity play the dominant role.

Furthermore, examining the various hedging methods illustrated that the cointegration approach, with structural breaks, provides the most effective hedge ratio in which the constructed portfolio retains the lowest price risk. This is a noble finding, as it signifies that investors using this method would relish the advantages of a dynamic hedge ratio with minimal transaction costs. The greatest hedging effectiveness was found to be achieved in the NIKKEI 225 next month contract.

Ultimately, the proposed method upholds the theory, suggesting that a greater contribution of futures markets is essential in obtaining higher hedging effectiveness for longer time horizons. The result also verifies the well-recognised bi-directional causality between the aforementioned concepts. Further studies may apply alternative measures and methods to test the robustness of the findings.

Keywords: Futures Markets, Price Discovery, Common Factor Weights, Threshold Error Correction, Optimal Hedge Ratio, Hedging Effectiveness

SDG: GOAL 8: Decent Work and Economic Growth, GOAL 9: Industry, Innovation and Infrastructure, GOAL 16: Peace, Justice and Strong Institutions

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

PENEMUAN HARGA DAN KEBERKESANAN LINDUNG NILAI DALAM PASARAN MEMUNCUL ASIA PASIFIK

Oleh

HAMED MOHAMMAD SHAFIEE

Oktober 2016

Pengerusi : Profesor Madya Cheng Fan Fah, PhD
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Pasaran ke hadapan memainkan peranan penting dalam pasaran saham dari segi penemuan harga dan lindung nilai risiko harga. Walaupun terdapat bilangan kajian teori dan empirikal meluas yang telah dijalankan mengenai dua fungsi utama pasaran ke hadapan di pasaran maju, hanya beberapa kajian wujud yang mengkaji kes pasaran membangun. Ketepatan penemuan harga dan lindung nilai adalah penting dalam pasaran memuncul Asia Pasifik, memandangkan krisis kewangan Asia dan global baru-baru ini dan peningkatan ketara saiz pasaran ini. Selain itu, ianya secara teori telah disahkan bahawa apabila penemuan harga yang tepat dicapai melalui sumbangan yang lebih besar daripada pasaran ke hadapan, lindung nilai adalah lebih berkesan. Kurangnya penyelidikan mengenai hubungkait ini adalah amat jelas.

Disertasi ini menerangkan kaedah sedia ada untuk mengkaji hubungan antara harga seketika dan niaga hadapan, mengenal pasti nisbah lindung nilai yang optimum, dan mendorong, mencadangkan dan melaksanakan kaedah baru untuk menilai hubungankait antara penemuan harga tepat dan keberkesanan lindung nilai. FBM

KLCI Malaysia, STI Singapura, NIKKEI 225 Jepun, yang diniagakan dalam bursa Singapura, dan KOSPI 200 Korea Selatan dikaji menggunakan data berkaitan pasaran ke hadapan daripada permulaan hingga Mac 2013.

Bukti empirikal menunjukkan bahawa pasaran ke hadapan biasanya memberi sumbangan yang lebih kepada proses penemuan harga berbanding pasaran seketika. Apabila membandingkan indeks, ia telah ditentukan bahawa harga seketika dan niaga hadapan NIKKEI 225 impaun maklumat baru lebih cepat daripada indeks lain, manakala FBM KLCI mencapai sumbangan tertinggi pasaran ke hadapan dalam proses penemuan harga. Selain itu, kontrak niaga hadapan dengan masa sederhana sehingga matang memainkan peranan yang dominan.

Tambahan pula, mengkaji pelbagai kaedah lindung nilai menggambarkan bahawa pendekatan kointegrasi, dengan perubahan berstruktur, menyediakan nisbah lindung nilai yang paling berkesan di mana portfolio yang dibina mengekalkan risiko harga paling rendah. Ini merupakan penemuan yang mengagumkan, kerana ia menunjukkan bahawa pelabur yang menggunakan kaedah ini akan menikmati kelebihan nisbah lindung nilai yang dinamik dengan kos urus niaga minimum. Keberkesanan lindung nilai terbesar didapati dicapai dalam kontrak NIKKEI 225 bulan hadapan.

Akhirnya, kaedah yang dicadangkan mendukung teori, menunjukkan bahawa sumbangan pasaran ke hadapan yang lebih besar adalah penting dalam mendapatkan keberkesanan lindung nilai yang lebih tinggi bagi masa yang lebih panjang. Hasil kajian juga mengesahkan sebab akibat dua arah yang diiktiraf di antara konsep yang dinyatakan di atas. Kajian lanjut boleh mengaplikasikan langkah-langkah dan kaedah-kaedah alternatif untuk menguji keteguhan penemuan tersebut.

Kata Kunci: Pasaran ke Hadapan, Penemuan Harga, Pertimbangan Faktor Sepunya, Pembetulan Ralat Ambang, Nisbah Lindung Nilai Optimal, Keberkesanan Lindung Nilai

SDG: MATLAMAT 8: Pekerjaan yang Baik dan Pertumbuhan Ekonomi, MATLAMAT 9: Industri, Inovasi dan Infrastruktur, MATLAMAT 16: Keamanan, Keadilan dan Institusi yang Kuat

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree Doctor of Philosophy. The members of the Supervisory Committee were as follows:

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CHAPTER 1

INTRODUCTION

1.1 Introduction

"Hedging" is currently the most acknowledged issue in financial risk management. Hedging refers to using financial derivatives to mitigate the risk that exists in another investment (Seyller, 2008). While the objective of hedging is to reduce the exposure to this risk -that is basically derived from the adverse fluctuations of prices, called price risk- in practice, hedgers trade the price risk for the basis risk (Edwards and Ma 1992). Either considering price risk or basis risk, the key point is that hedging strategies which aim to achieve an utmost sustainable value of all the company efforts are developing as the risk management becomes the most crucial part of the financial activities.

To shed light on the expanding significance of financial risk management, the latest World Federation of Exchanges (WFE) report, marked the year of 2011 by an unusual trading pattern which was followed by a fall in the market capitalization (-13.6% at USD 47 Trillion) and extreme volatility and uncertainty that affected the global markets. This report also pointed out that high volatility and global uncertainty, created by the sovereign debt crisis, affected trading volumes throughout the year. August of 2011 was the most active month of that year in terms of trading value; this was a highly unusual annual peak for markets. The high volatility and lack of confidence that affected the financial markets globally probably drove the needs of hedging as the number of derivative contracts that were traded grew by 8.9% (WFE, 2011).

The importance of risk management in the developing countries is even more apparent. Market and non-market based strategies and instruments have been developed and pursued towards moderating the adverse effects of the previously mentioned price fluctuations. The financial markets of the developed countries have provided advanced mechanisms to reduce the volatility of prices (e.g. deliberate government interventions, reliable accounting standards, established security and derivative instruments, and information centres). Yet, in the emerging markets, these mechanisms are not developed enough to achieve the desired reduction of this volatility. In other words, the asymmetric information and lack of fine mechanisms to set the futures prices causes more violence in the developing countries' markets.

The Asia-Pacific financial markets have recently yielded a fast escalation of wealth accumulation. These markets are becoming more integrated with themselves and with the rest of the world. Subsequently, common risk factors are evident in the behaviour of their asset prices (Duan, 2007). Copious fresh investments chasing better returns will inevitably lead to volatile financial markets and make high volatility a norm. As such, volatile financial markets call for better risk management knowledge (e.g. models and techniques), more sound business practices (e.g. management systems and implementation) and improved regulations.

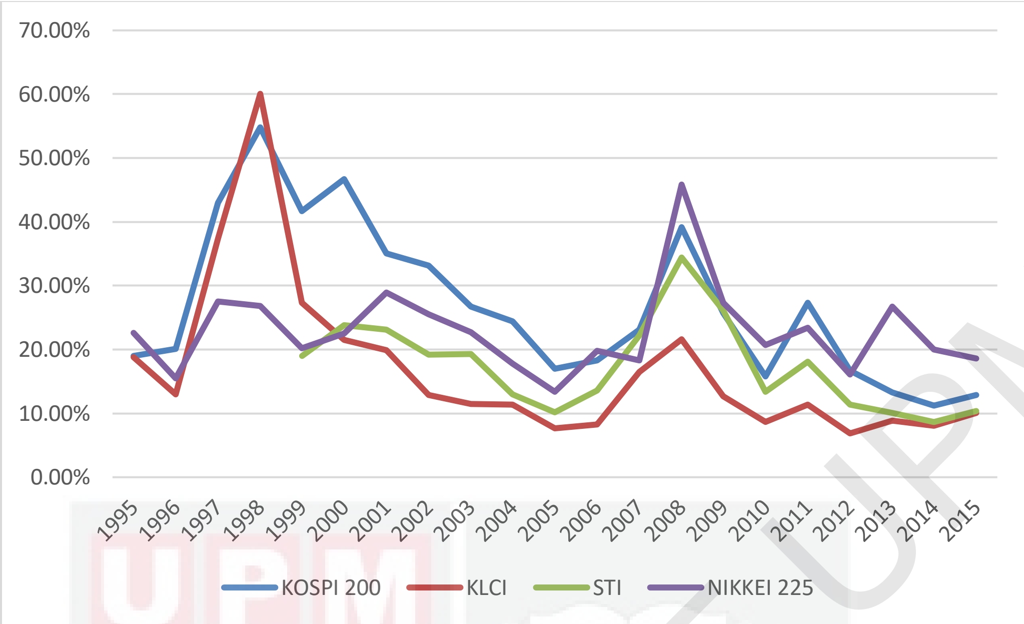

Figure 1.1 : Spot market return volatility

The economic boom in the Asia Pacific occurred in the 1990s. This led to greater participation of foreign investors, in addition to the local institutional investors and retail investors in the emerging markets of the region. The result was an extraordinary increase in volatility and the size of the markets, as illustrated in Figure 1.1, that led to a change in the market characteristics.[1] Experiencing this extraordinary financial market growth and facing the following financial crisis, the related authorities started to improve their policies to stabilize the market and its prices. The changes ranged widely, from reforming the accounting standards to launching and developing more derivative contracts and hedging instruments.

[1] Only at the KLOFEE, Malaysia, total turnover of the year of 1997 recorded at 383,059 lots, which is almost five-folds of its turnover on the previous year (77,281 lots). In 1998, the total turnover even reached to the level of 771,244 that indicates another more than 100% increase in the total market volume.

Price Discovery and Hedging

As the financial markets developed, the futures markets began performing two main functions: price discovery and hedging. The price discovery function helps market participants ascertain information about the market's expectations regarding future cash market prices from the futures market. Russell Poskitt (2007) indicates that the futures market remains the primary locus of price discovery, despite the increased use of other instruments as a pricing benchmark and hedging instrument in recent years.

On the other side of the coin, hedging and trading derivatives have become synonyms for many market participants in the financial community, due to the long common history that the two ideas share (Seyller, 2008). The hedging function facilitates the transfer of risk by allowing market participants to use the futures market as a substitute for cash transactions (Herbst 1992).

These two functions are interrelated, due to the fact that price discovery is primarily established on the existence of the basis: the difference between the spot price and the nearby futures contract. According to modern financial frameworks, such as the cointegration model, in order for a hedge to be attractive, the basis risk, defined as the variance of the basis, should be significantly less than the hedger’s cash price risk.

The fluctuations in the basis are much less than the ranges of fluctuations in the futures price itself. The futures price may oscillate and the cash price may swing widely, but the basis tends to be relatively steady. The relatively low variability of the basis is very important for hedging and for certain types of speculation (Kolb and Overdahl, 2007).

Furthermore, the basis receives a great deal of attention in futures trading, since the basis can be used as a valuable source of information to predict the future spot prices of the commodities that underlie the futures contract. Kolb and Overdahl (2006) provide evidence to indicate that the prices in the futures markets provide information that are not readily available elsewhere, and it has such a great contribution that it is cited as serving societal needs.

Lien (2010) and Chen et al. (2002) provide respectable examples of combining the informational and hedging aspects of the futures markets. By evaluating the effectiveness of hedging, they conclude that the relationship between the spot and futures market prices is one of the basic fundamentals that affects the performance of hedging.

When examining the hedging and price discovery functions of the derivative markets, it is worth mentioning that traditional futures hedging models primarily depend on historical data to calculate the hedging ratios. The effect of the spot price fluctuation on futures prices is not under consideration, so the hedging ratio usually cannot get perfectible effect of hedging. By introducing the error correction term and the dynamic GARCH models, the effect of the spot price fluctuation to the future price can be more precisely measured.

Hedging Performance

Observing the importance and interrelationship of price discovery and hedging, it is important to discuss how effective the current risk management knowledge and its practices within the framework of existing regulations assist hedgers. Note that hedging effectiveness is selected here, as opposed to efficiency, due to its scientific definition[2].

One measure of the anticipated hedging effectiveness is to compare the basis risk that the hedgers expect to assume with the price risk that they expect to eliminate. The smaller the anticipated basis risk is, as compared to the anticipated price risk, the more effective is the hedge.

The other measures attempt to capture both the variance reduction and the utility maximization. Howard and D'Antonio (1984), Lien (2012), Lien et al. (2012), Castelino (1992) and Alexander and Barbosa (2007) are the key studies that investigated appropriate methods used to measure the effectiveness of hedging. Recent studies have indicated that the minimum variance hedge ratio (MVHR) provides the most accurate results.

Development of financial markets by introducing futures contracts

The futures market was introduced as the major hedging instrument. Hence, analysts and other market participants have expected a significant decrease in the spot prices' volatility within the financial markets; however, after more than 15 years, bearing the

[2] Efficiency refers to doing things to get the maximum output with minimum resources. Effectiveness, on the other hand, refers to doing the right things. It constantly measures if the actual output meets the desired output, as it is common in the hedging practices. Efficiency of a hedge is considered as the degree of risk reduction provided by a hedge relative to the cost of the hedge; measured with the aid of the correlation between the spot price of the cash position to be hedged and the price of the hedging instrument; where a hedge is effective, if a given level of the mark-to-market derivative volatility will be offset in the profit and loss account.

high costs of maintaining the futures market, no evidence has documented the desired significant decrease.

Mayhew (1999) examining data from twenty-five countries around the globe, finds no significant volatility-dampening effect in the marketplace of the Asia pacific countries, in reference to launching the derivative markets. One interpretation of this result is that the futures market influences the underlying market through multiple offsetting channels. The significance of this effect depends on the development extent of the market. Mayhew particularly agrees that futures markets may play an important role in stabilizing the less-developed markets. A summary of his result is presented in Table 1.1.

Table 1.1 : The effect of launching derivative markets on the price volatility of the underlying asset

Exchange	***Index***	***6 Month***	***12 Month***	***24 Month***	***All data***
Bursa Malaysia	KOSPI200	Not significant	+		-
Korea Exchange	FBM KLCI	Not significant	-	+	+
Singapore Exchange *Futures/Japan Stock**	SIMEX	+	+	+	+

(Source: Mayhew, 1999)
* The first introduction of Nikkei 225 futures on the Singapore International Monetary Exchange (SIMEX) is considered as the event date

The role of financial development is not limited to this point. The literature states that financial development not only has the direct effect on prices but also it is a mediator to transfer and represent the macroeconomic conditions to the price.

Liquidity, a key element in stock market development, also affects the market in other aspects. The more illiquid a market, the more likely it is to experience higher trading costs, greater risks, and a higher cost of capital (Bai and Green, 2011).

A positive relationship has been found to exist between liquidity and price volatility (Dey, 2005 and Sang-Gyung et al., 2003). These results are consistent with those of earlier findings in that increased turnover is associated with increased volatility (Karpoff 1987). The speed of adjustment to the deviations of the price levels from their long run equilibrium has also been found to be faster in more developed markets.

However, the role of liquidity in price discovery remains understudied in the emerging markets (Hales 2012). Bai and Green (2011) specify that the liquidity, as the measure of financial development, is important, even in a relatively new emerging market. The lack of research in derivative markets is even more recognizable, considering the stated high natural volatility of these markets (Mishkin, 2000). Futures markets liquidity does affect the leadership in the price discovery process (Benz and Hengelbrock, 2008, and Mayordomo et al., 2011) and increased volatility decreases the basis and increases the open interest (Chen et al., 1995).

Hence, considering measures of financial development (e.g. liquidity) assists achieving enhanced insight about the relationship between spot and futures prices. It is also possible to provide an opportunity to evaluate its own effects on market behaviour.

Table 1.2 : Asia Pacific Domestic Market Capitalization

Exchange	*Jan 2015* (USD billions)	*% Change / Jan 14* (in USD)	*% Change / Jan 14* (in local currency)
Australian Securities Exchange	1,272	-2.00	9.19
BSE India Limited	1,682	56.23	53.41
Bursa Malaysia	452	-6.41	1.54
Colombo Stock Exchange	23	17.67	16.64
Hochiminh Stock Exchange	50	7.65	7.84
Hong Kong Exchanges and Clearing	3,325	12.38	12.19
Indonesia Stock Exchange	421	17.26	20.65
Japan Exchange Group - Tokyo	4,485	1.46	17.30
Korea Exchange	1,251	5.72	7.98
National Stock Exchange of India	1,642	56.07	53.25
NZX Limited	72	7.68	19.29
Philippine Stock Exchange	280	27.91	24.24
Shanghai Stock Exchange	3,986	65.09	67.45
Shenzhen Stock Exchange	2,285	51.29	53.45
Singapore Exchange	755	5.44	11.57
Stock Exchange of Thailand	461	33.02	31.45
Taipei Exchange	85	8.47	12.66
Taiwan Stock Exchange Corp.	861	8.02	12.19
Total region	**21,744**	**20.85**	

(Source: World Federation of Exchanges WFE Database)

Having looked at the previous debates on price discovery and hedging effectiveness, this study aims to examine the interrelationship between spot and futures prices in the emerging Asia Pacific futures markets. This study also aims to determine how this relationship, alongside other hedging tools, assists investors in increasing their hedging effectiveness.

The market capitalization of the major emerging financial markets of the area, namely South Korea, Singapore, and Malaysia, are presented in Table 1.2; as such, Table 1.2 sheds light on the importance of this issue.

Table 1.3 : Value of EOB share trading, number of EOB trades in equity shares and number of listed companies in January of 2015

Exchange	*Value of share trading* **(USD billions)**	*Number of trades in equity shares* **(in millions)**	*Number of listed companies* **(in local currency)**
Australian Securities Exchange	56	14	2,071
BSE India Limited	12	35	5,576
Bursa Malaysia	12	3	904
Colombo Stock Exchange	0	0	294
Hochiminh Stock Exchange	2	1	307
Hong Kong Exchanges and Clearing	155	20	1,763
Indonesia Stock Exchange	9	5	506
Japan Exchange Group - Tokyo	402	56	3,470
Korea Exchange	136	120	1,859
National Stock Exchange of India	62	161	1,718
NZX Limited	1	0	173
Philippine Stock Exchange	4	1	262
Shanghai Stock Exchange	1,278	279	1,007
Shenzhen Stock Exchange	800	199	1,628
Singapore Exchange	19	10	774
Stock Exchange of Thailand	32	4	615
Taipei Exchange	13	15	687
Taiwan Stock Exchange Corp.	54	922	882
Total region	**3,045**	**14**	**24,496**

(Source: World Federation of Exchanges WFE Database)

The significance of these markets is more recognizable when it is compared with the Switzerland exchange, which had a market capitalization of 1,516 USD Billion in January 2015. South Korea was among the top twenty exchanges worldwide, in terms of market capitalization at the end of 2010. It was also among the top ten exchanges, in terms of the Trade Value.

Previous studies indicate that the market characteristics of the Malaysian exchange is similar, to some extent, to the developed markets, although the market capitalization is lower than that of Singapore and South Korea (Pok et al., 2009).

1.2 Asia Pacific Emerging Futures Markets

Asia Pacific emerging futures markets are among the first and fastest growing emerging markets around the world. It is not hassle-free to point out the first futures exchange in the area, due to the fact that, in many countries, futures markets were created through the separation of the existing markets. South Korea and Singapore are among the first exchanges to introduce the derivative instruments.

In the case of the Asia Pacific developing countries, the Malaysian derivatives market opened by introducing the Futures Crude Palm Oil (FCPO) in 1980, less than a decade after the establishment of the first organized regulated futures market in financial securities at the Chicago Mercantile Exchange in October of 1975. It is worth mentioning that the first world modern agricultural commodity exchange was opened in 1848 by the Chicago Board of Trade (CBT) to foster price discovery and stabilize prices by trading futures.

Table 1.4 : Securitized derivatives, number of listed derivatives, EOB, total turnover and number of trades in January of 2015

Exchange	***Number of securitized derivatives***	***Securitized derivatives EOB turnover* (in USD millions)**	***Securitized derivatives Total turnover* (in USD millions)**	***Number of trades in securitized derivatives* (in thousands)**
Australian Securities Exchange	3,030		144	26
Bursa Malaysia	537	326	326	46
Hong Kong Exchanges and Clearing	6,918	65,066	65,067	5,423
Korea Exchange	2,664	1530	1,530	1,507
Singapore Exchange	249		258	
Stock Exchange of Thailand	941	556	561	367
Taiwan Stock Exchange Corp.	10,723	1,901	1,901	1,553
Total region	**25,062**	**69,378**	**69,786**	**8,922**

(Source: World Federation of Exchanges WFE Database)

As South Korea, Singapore and Malaysia are emerging countries in the Asia Pacific region with a high capitalization level, it is important to discuss the hedging effectiveness in these countries. The mentioned markets, during the last two decades, experienced a learning period and introduced many new instruments for their development. They also practiced instable pricing behaviours, because of the South East Asian financial crisis that lasted from July 1997 through September 1998.

In developing countries, as time passes, more corporate traders and individuals become aware of, and realize, the importance of hedging against risks associated with price movements. As such, derivative markets play a vigorous role in their economies.

In the following section, a brief introduction about the futures market in South Korea, Singapore, and Malaysia will be discussed.

South Korea

The current structure of Korea Exchange has been formed based on three divisions as the Stock Market Division, KOSDAQ Market Division, and Derivatives Market Division. These three divisions acted separately before the implementation of the Korea Stock and Futures Exchange act. The South Korea Stock Exchange is one of the oldest stock markets in Asia and recognized as the stock exchange that determines the economy of the country of South Korea.

The products offered by Derivatives Market Division are as follows:

- Index Instruments: KOSPI 200 Index Futures, KOSTAR Futures, KOSPI 200 Index Options
- Single Stock Futures

- Equity Options
- Interest Rate Instruments: 3-Years KTB (Korea Treasury Bond) Futures, 5-Years KTB Futures, 3-Years KTB Futures Options, Monetary Stabilization Bond Futures
- Foreign Exchange Instruments: USD Futures, JPY Futures, EUR Futures, USD Options
- Commodity Instruments: Gold Futures, Lean Hog Futures

The equity index futures contract in South Korea has the highest liquidity in the world (Shamsher et al., 2007). South Korea futures market offers a wide range of instruments except commodity indices. South Korea Exchange announced its program on April 2011 to lower regulatory barriers to enter the oil trading industry and to create an online exchange for oil products.

Singapore

Although the greatest range of stock indexes is found in the United States with three separate stock index futures trading in the country i.e. S&P 500, NYSE Composite and Major Market Index, in the other countries, SIMEX and NIKKEI 225 are the active stock index futures. These indexes are based on United Kingdom FTSE 100).

The financial market of Singapore is dependent on Singapore Exchange (SGX) and Singapore Mercantile Exchange (SMX). On 23rd November 2000, the former became the second exchange in Asia-Pacific to be listed via a public offer and a private placement. SGX offers a wide range of instruments including Interest Rates, Equity Indices, and Currencies. The latter is a pan-Asian multi-product commodity and currency derivatives exchange, offers a wide range of futures and options commodities instruments such as precious metals, base metals, agriculture commodities, energy, and commodity indices. In August 2010, the SMX was granted 'Approved Exchange' (AE) status, the final approval needed to operate as a regulated and licensed exchange.

The common offered futures indices are SIMEX, NIKKEI 225 and MSCI Singapore while Rubber is the most common in commodity futures.

Malaysia

Bursa Malaysia previously known as Kuala Lumpur Stock Exchange (KLSE) approved under Section 15 of the Capital Markets and Services Act 2007. It dates back to 1930 when the Singapore Stockbrokers' Association was set up as a formal organization dealing in securities in Malaya. The Stock Exchange of Malaysia was established in 1964, just before the secession of Singapore from Malaysia in 1965. Later in 1973, currency interchangeability between Malaysia and Singapore ceased, and the Stock Exchange of Malaysia and Singapore was separated.

Following the KLSE demutualization exercise on April 2004, with the purpose of enhancing competitive position and responding to global trends in the exchange sector by making themselves more customer-driven and market-oriented, it had renamed to Bursa Malaysia (BM)[3].

In case of futures exchanges, the Kuala Lumpur Commodity Exchange (KLCE) was the first in Malaysia and South East Asia, incorporated in 1980. Later on, the Malaysian Monetary Exchange, which was established to assist in the exchange's expansion to financial futures, merged with KLCE to succeed the Commodity and

[3] According to Bursa Malaysia's website, History Page; Retrieved on Feb 2012.

Monetary Exchange of Malaysia (COMEX). Finally, the COMEX merged with the Kuala Lumpur Options and Financial Futures Exchange (KLOFFE) in December 2000 to form the current Malaysia Derivatives Exchange (MDEX). MDEX is a subsidiary of the Kuala Lumpur Stock Exchange (KLSE).

MDEX is fully electronic using the KLOFFE Automated Trading System (KATS). Ten derivatives products offered includes commodity futures, equity futures, equity options and financial futures.

The Kuala Lumpur Options and Financial Futures Exchange (KLOFFE) total turnover in volume was recorded at 77,281 lots in 1996, before experiencing the significant increase of 396% and 101% during 1997 and 1998. The market volume increase in Malaysia was because of participation of institution and retail investors. The financial crisis in 1997 and 1998 caused higher volatility in the market and lead to the introduction of capital control policy. The KLSE Composite Index Futures has been utilized by investors for hedging as well as speculative purposes.

Towards praising a couple of decent studies on the Malaysian derivative market, while the others are investigated in the second chapter, Pok et al. (2009) suggest that despite the structural breaks caused by the Asian financial crises and new capital control regulations, out of sample hedging performance of dynamic GARCH models in the Malaysian market is as good as the one reported for the highly developed markets in the previous literature. Moreover, Shamsher et al. (2007) on a widespread study, summarizing a range of papers published on the Malaysian capital markets, conclude that the high volatility of market is similar to other emerging countries, the local share market of Malaysia could be placed as one of the ten most liquid and orderly emerging markets in the world.

1.3 Problem Statement

The principle economic justification for the existence of a futures market is to provide a mechanism for a price discovery and hedging facility to minimize the price risk. It is widely believed that futures markets play an informational role by providing accurate predictions of future prices. In this way, investors are capable of hedging their risk. Therefore, it is important for those involved in the trade to receive the correct signals from the futures market to help them to make more informed hedging and arbitraging decisions. Otherwise, the investors will not have the required interest to endure the costs and risks of being involved in the derivative instruments trading. If this is the case, the market will convert to a speculative environment.

The ineffectiveness of price discovery and hedging in the emerging futures markets has possibly caused the most important drawbacks of both the commodity and the Stock Index Futures contracts: there is an absence of hedgers and lack of liquidity in terms of the number of participants. This is the point that associates the price discovery characteristic as the most important level of efficiency with risk management tools. Consequently, research on the risk management efficiency of a futures market must consider both the price discovery and the hedging as the basic aspects of the study to provide a reliable outcome.

It is particularly important to assess the financial futures contracts in the Asia Pacific emerging markets, since they are the actively traded contracts used as the price indicators by producers and investors. As was mentioned previously, the futures instruments in South Korea, Singapore and Malaysia were launched at approximately the same time; hence, they walked similar paths. Despite this, there is no information available as to whether this futures market discovered prices accurately or not. Furthermore, it is crucial to determine the reason for the inequality in the liquidity growth of these markets. This inequality would be more noticeable in a detailed comparison between different instruments.

There is a great deal of research needed to discover this mechanism in developed markets. Even though these emerging markets have been operating for the last two decades, there is no in-depth information on how accurately these markets can discover the price.

Shamsher et al. (2007) propose that "the documented evidence on the local derivatives markets is scarce and there are lots of opportunities for further research on these financial derivative markets and the relatively matured commodities futures markets. There are critical issues that need to be addressed to make the derivatives markets relevant for global investors as is the case in the Hong Kong and Korean markets which started at about the same time as the Malaysian market but are already attracting global players with good liquidity."

It would be of greater importance, considering the size of the markets in these countries. In January 2015, the market capitalization of South Korea, Singapore and Malaysia are 1,251, 755 and 452 USD billion, respectively (Table 1.2). The total market capitalization of the Asia Pacific's emerging markets is over 2.1 USD trillion.

In addition, not only the expected decrease in the instability of the market prices was not achieved by introducing the futures market but also the price stability in the different markets and instruments are not consistent. In excess of the discussed lack of mechanisms to reduce the instability and the characteristics of the emerging market, the consistency is found to depend on the market, time period and asset. So it would be best to have and compare the financial indices of different markets.

On the other hand, there are some debates about the relationship of liquidity, as a key element of financial market development, and price discovery. Taking the liquidity into account in evaluating the price discovery in the market, it assists in achieving an enhanced insight about the relationship between the spot and futures prices as well as providing the opportunity to evaluate its own effects on market behaviour.

A variety of methods have been introduced over the last three decades to calculate the hedge ratio. However, there is no conclusive result to identify the optimal hedge ratio. There is no consensus in the literature regarding a single method which provides a hedge ratio that outperforms the others. Thus, an extensive study is required to apply the various methods to identify the optimal hedge ratio in the emerging markets of the region. Evaluating different methods also provides a framework to assess the interrelationship of the price discovery and the effectiveness of the hedging.

Consequently, detailed research is needed to cover the recognizable lack of comprehensive and in-depth studies on the price discovery and hedging effectiveness in these selected markets. A study such as this could improve hedging strategies and support policy makers in making the market more active and beneficial.

1.4 Objectives of the Study

This study investigates the price discovery and hedging functions of the selected futures markets to determine the best methods for increasing hedging effectiveness. The specific objectives of the study are as follows:

1. To investigate the role of spot and futures markets in price discovery and assess the market liquidity effect.
2. To identify the optimal long-term hedging strategy in emerging markets.
3. To evaluate the interrelationship between price discovery and hedging effectiveness.

1.5 Significance of the Study

Hedging primarily focuses on how financial institutions and investors manage when they are faced with the volatility of prices. Therefore, the hedging effectiveness is crucial to investors to reduce the price risk of a current or potential cash position. This is the principal reason for the existence of futures markets. The benefits of risk reduction are offered to investors, even when there is no specific futures instrument directly associated with the obtained cash instrument.

The usefulness of considering price discovery in evaluating hedging effectiveness is rather obvious. Hedging is based on the assumption of an approximate parallel movement of cash and futures prices. Taufiq (2000) indicates that if arbitrageurs fail to keep cash and futures prices in line, hedging would be similar to speculation or it loses its risk-reducing characteristics.

Numerous scholars and financial institutions have carried out studies on hedging and its effectiveness in developed countries, while few empirical studies exist on hedging in the Asia Pacific Emerging Markets. These studies as it is investigated in the next chapter examine the performance of different instruments in these markets, but none of them goes further to investigate the advanced relationship of price discovery and hedging effectiveness; however, it is briefly mentioned at times.

Despite the fact that the lack of evidence, through a comprehensive study, is the prime motivation of this study to cover the diverse aspects of the issue, this study is held as a substantial motivation to examine whether the theoretical models are of an appropriate ability to analyse these markets. Thus, providing market participants with widespread beneficial recommendations shall be the first contribution of this study.

This is substantial, given that developing risk management knowledge, in terms of hedging, including its models and techniques and the aforementioned practices, are the building blocks in enhancing financial development and positively improving the degree of obtained risk reduction. This will not only lead to stabilization in the domestic economy, it will also attract foreign investors with high liquidity.

Subsequently, the lessons learned from the development of hedging, as the principal function of derivative markets, shall provide a precious long run benefit to society. Thus, I hope to provide pleasing explanations throughout this dissertation for the reader to gain a solid grasp of the hedging effectiveness that I am advocating, as well as of the potential benefits and drawbacks.

Ultimately, derivative markets contribute to the development of the financial infrastructure of a country by linking cash markets, hedgers, and speculators. The increasing use of the derivative products offers alternatives for efficient risk management that leads to facilitating the capital flows to developing countries (Lien and Zhang 2008). Since futures markets are highly regulated financial markets, its performance depends on the accuracy and timing of the regulations. The findings from this study shall provide regulators with valuable guides to improve the existing regulations.

Another element worthy of consideration is the likelihood of extending electronic trading in these markets. As Mishkin (2000) illustrates, the developing markets are naturally more volatile than the developed market, so the intention in increasing the derivatives trading through electronic mediums shall conservatively tie up with the outcomes of this study.

1.6 The Organization of the Study

The paper is organized as follows: chapter two provides the theoretical framework and a literature review regarding the price discovery, hedging effectiveness and their relationship; chapter three illustrates offered models to analyze and to measure these two aspects and to explain methods and data employed; results and discussion is presented at chapter four; and finally chapter five concludes and recommends the policy implications.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In the world of finance, financial markets and their performance are of a great importance. A large number of researchers study the financial markets in macroeconomic aspects such as the relationship of financial market development and the economic growth of a country, while a greater number of researchers pay attention to the performance of these markets and specifically to the methods of increasing the achievements from financial markets.

Risk management is one of the key functions of financial markets that is provided in the optimum scheme by a futures market. The wide range of offered hedging strategies, to support the corporate and individuals' risk management needs, shows the earlier demand for better risk management knowledge by the introduction of futures markets. In this regard, there is much literature on selecting the best hedge ratio as it is referred to in this chapter. Further, a sort of studies in the last decades attempt to offer the appropriate methods to calculate the effectiveness of hedging.

Besides, following the introduction of stock futures, several studies have been done on the relationship between the prices in the spot and futures markets for the purpose of gathering information for price prediction and design of the accurate hedging strategy. Grossman (1977) might be the first study that states the importance of investing on information provided by futures markets. Subsequently, the following studies indicate the other advantages of investigating the behavior of futures market.

While there are decent conceptual studies on the developed markets, such as Seyller (2008), recent studies are mostly concentrated on the applied aspects of the issue employing the related relationships and information in different products and exchange circumstances to examine the hedging methods and strategies. Likewise, several empirical studies are given out on the Asia Pacific Emerging Futures Markets which examine the performance of different instruments in these emerging markets. An example of such studies is Pok et al. (2009). Although there are some occasional studies for each of these markets, the lack of a comprehensive study is clear to cover diverse aspects of the issue.

2.1.1 History of Futures Market

A futures contract is an agreement between two parties to buy or sell an asset at a certain time in the future for a certain price. The futures contracts are exchange traded instruments and exchanges specify certain features to normalize each futures instrument (Hull, 2003). For a futures contract, the delivery date is not specified; the exchange specifies certain delivery month during which the delivery must be made. In 1848, the Chicago Board of Trade was established as the first world modern agricultural commodity exchange for trading futures to foster price discovery and to stable price as the main missions.

On October 1975, the first organized futures market in financial securities was established in U.S as the Chicago Board of Trade opened a futures market in Government National Mortgage Association Pass-Through Certificates (Ederington, 1979). Followed by the introduction of a 90-day Treasury Bill futures on the Chicago Mercantile Exchange in January 1976. Since then, derivatives instruments and other financial instruments have gained attentions from both academicians and market participants.

As of the 1970s and 1980s, some major transmissions in policies placed, emphasizing on economic liberalization and the use of markets and markets-based instruments. Some international commodity agreements collapsed, others were allowed to lapse (Gilbert, 1996). As the result of the economic circumstances, futures trading came into an era of increasing and continuous growth. Although the trading of financial futures contracts account for most part of growth, the commodity futures trading as a risk management tool has expanded as well.

Organized futures markets facilitate two kinds of activities: speculation and hedging. A speculator is the one who, by virtue of his expectations and his willingness to take risk, aims to make an uncertain profit from his transactions in the market (Goss, 1972). While hedging is defined as the activity of a trader who enters the market with a spot market commitment, and hence a spot market price risk, and who, by derivative dealing, makes his position certain and transfers the risk to another party (Goss, 1972). The economic motivation for futures markets has been their natural capacity to facilitate hedging. Futures markets allow the transfer of price risk from those who deal in an instrument to speculators, whom basically have a higher risk appetite (Ederington, 1979).

There is no perfect agreement in the futures market literature not only on the hedging theories and optimum strategies but also on the initial definitions such as what hedging is or why it is undertaken. Nevertheless, one may consider the major theories of hedging as the traditional hedging strategies, Holbrook Working theory, and the latest portfolio optimisation theories. The explanation of these theories can be found on the hedging effectiveness, major theories of hedging.

2.1.2 Characteristics of Futures market

Understanding the theoretical relationship between the variables of a futures market assists researchers in specifying more accurate models as well as empirical evidences. This study brings the suggested relationships together in brief.

Time to Maturity

Samuelson (1965) suggests a theoretical relation between utility and maturity. It is argued that as the delivery date of futures contract approaches, the volatility of its price will increase. According to this hypothesis, volatility is negative function of the time to delivery (maturity). The intuition behind this argument is that, when there is a long time to the delivery date, there is still much time for new information to affect the delivery price; therefore, any single piece of information is relatively less important. However, this is a general argument which may not be accurate in all instruments.

Therefore, if volatility rises as delivery approaches, margins are also required to increase and the hedging strategies need adjustment as well. In the other words, the correlation between spot and futures prices declines.

Volume

The crucial relation of price-volume in capital market is mainly because

- It provides insight to the structure of financial market,
- The price-volume is important for event studies that use a combination of price and volume data to draw inference,
- The price relation is critical to the debate over the empirical distribution of speculative prices,
- Price-volume relations have implications for research. It indicates the importance of private versus public information in determining investors demand (Admati and Pfleideter, 1988)

Price-volume relationship can be highly complicated and it can also change overtime. Different studies suggest different models to clarify it. While crouch(1970), Rogalsky (1978) and Bhar and Malliar (1996) postulate the first model in which volume is associated with price and time, "the mixture of distributions hypothesis" and "sequential information arrival model" are the most important theories which predict a positive relationship between daily volume and price volatility. On the other hand, it implies that volume also increases as delivery approaches. This relationship can be restated as a negative relation between volume and maturity.

Open Interest

Open interest, which is equal to the sum of either the outstanding long or short positions is also one of the most informative variables. The open interest and its relation with trading volume depend on who trades the contract. For illustration, if two new parties enter into a contracts open interest will rise, while if trades involve one party closing out a position by trading with new party, open interest will remain unchanged. Otherwise, if a trade involves two opposite positions offsetting each other, open interest will decline. In another aspect, open interest is usually much smaller if there is a large volume of futures transaction. Following these examples, several insights can be generated:

- It will indicate the trading liquidity of the market if open interest remains unchanged in the long run with large trading volume and also indicate the dominance of speculators in the market.
- It will indicate the flow of entry in the market if open interest is consistently increasing in long run with the increase of volume. It also indicates the extent of hedging activity in the market.
- It will also indicate the level of arbitrage activity of the market if open interest declines over the long run.

2.2 Price Discovery

Price discovery refers to the use of futures prices for pricing cash market transactions (Working, 1948; Wies, 1978; and Lake, 1978). In general price discovery is the process of uncovering an asset's full information or permanent value. The unobservable permanent price reflects the fundamental value of the stock or commodity (Figuerola and Gonzalo, 2010). It is distinct from the observable price, which can be decomposed into its fundamental value and transitory effect. The latter consists of price movements due to factors such as bid-ask bounce, temporary order imbalances or inventory adjustments.

Whether the spot or futures market is the center of price discovery has been discussed for long time in the literature. In this section, having a review on the arbitrage pricing theory as the base of these discussions, current methods to measure price discovery are presented.

2.2.1 Theoretical Framework

The role of information in futures trading is an important ingredient in the overall smooth functioning of commodity and financial cash markets. This section discusses one of the key issues for futures market research. Hence it will help to measure the informational role of the futures market.

The general equilibrium of spot and futures market is based on two theoretical concepts. One is the Working's 'theory of the price storage" which is the groundwork of the theory of futures market. Futures markets provide intertemporal prices for a given commodity in accordance with the strength of demand across the periods. Therefore price differences between months act as a price of storage or inducement to carry stocks into distant months. Interaction between buyers and sellers ensure the amount carried forward will cover demand in distant months. Therefore, the maximum level of premium for distant over nearby months is equal to the cost of storing physical commodities (short cost of carry) for the period specified. The difference between the cash-futures premium and actual cost of storage is pure profit to traders.

Second, theory of normal backwardation was offered by Keynes (1923), which explains what he called a systematic downward bias in futures prices. Keynes argues that because hedgers typically hold the larger share of futures market as open interest at any given time and because hedgers are historically net short, speculators must be net long. Since hedgers enter the futures market to minimize flat price risk, and then they must pay, what Keynes called a risk premium to speculators as an incentive to assume the risk of being long.

Keynes discusses that backwardation is a normal alignment of prices. In his model, speculators take long positions and are assured a profit by a continuous rise in futures price throughout the life of the contract. Futures prices are therefore nearly always made partly by speculators whose action tends to raise the futures prices to a more reasonable level.

The mathematical derivation of normal backwardation and Tesler-Cootner debate as well as more details on the relationship of the commodity futures market and the CAPM can be found in Hans (1979). Examining a Keynes-Cootner insurance justification of hedging in the framework of capital market equilibrium under homogenous expectations, he shows that futures market is used to pass on some of the risks associated with holding the physical commodity.

The basis, based on his analysis, depends on:

1- The interest cost of holding the commodity;

2- The weighted average expected marginal storage cost for storers, where the weights depend on risk attitudes;

3- An aggregate basis risk which is the sum across storers of storage cost risk; and,

4- The netting out of most of the commodity price risk between hedgers and speculators.

Note that equilibrium basis may not cover expected marginal storage costs thereby reflecting new type of convenience yield is discussed. This convenience yield is caused by the existence of a natural hedge in the storage business and can arise at any scale of storage, unlike the traditional convenience yield of Kaldor. He then concludes that in the equilibrium, the spot price is the discounted value of the expected spot price, adjusted to reflect expected marginal storage costs and storer attitudes towards assessments of risk.

The general equilibrium in this case is documented in the literature in two situations:

The former is the introducing of the futures to a basic general equilibrium in which net spot demand is a simple function of the spot prices. In this case, while producers and portfolio managers make a spot sale of an exogenous quantity K in a period t, speculators are to maximize the utility of their profit. Introducing the futures market as a new instrument for expectation formation, four consequences will occur as it is concisely stated as follows:

a) It prompts the emergence of arbitrageurs operating between the spot and futures market on the basis of price spread. They can thus buy spot, invest and sell forward. It is proved that the arbitrage will not be perfect unless the transaction cost is low and liquidity is high.

b) Speculators begin to operate in the futures markets. Low initial funding requirement makes speculation easier. Therefore, it is assumed that the number of speculators will increase.

c) Participants are not very familiar with workings of the new market. Therefore, they initially resort to the same expectation formation mechanism as regards both price and volatility meaning that the formation of expectation regarding the new market is the same as old market (underlying market).

d) Now investors and producers can hedge their risk. They will have strict hedging behavior minimizing the conditional variance of their profit.

The latter is stated as situation of having the general equilibrium with the existence of futures market. Analyzing the two markets, in the spot market the net demand plus the purchases by arbitrageurs are equal to net sales by investors or producers, while in the futures market change in the speculation positions is equal to the sum of forward sales by investors or producers, arbitrageurs and hedging positions.

Defining the equilibrium in two markets, investors or producers sell forward at date t part of their wealth or production at date t+1 and deliver corresponding commodities in t+1. Therefore, if excess spot supply is positive, arbitrageurs must buy spot and sell futures. As a result if the arbitrage is imperfect (i.e. if transaction cost, liquidity is not zero) the futures price must exceed the spot price (negative basis).

In the spot market, demands may be decomposed to demands for domestic consumption, storage, speculation and export demand. Supply of the product may be decomposed into farms ability and willingness of production and environmental factors that influence production. On the other hand, futures prices are function of futures demand, current storage and speculation and futures supply.

The general equilibrium implies that if two markets are open simultaneously and general equilibrium holds, then spot market will provide current price and futures market will provide expected price. If we decompose the spot demand, storage and speculation are based on the expected prices. On the other hand, current prices are dominant in determining the demand for immediate consumption and export.

On the supply side, expected prices are related to the willingness of production whereas current prices contain environmental factors that influence the production.

Therefore, part of the spot market equilibrium is based on expected futures prices (storage and speculation) if futures market is efficient then futures prices (expected cash prices) provide the information to make the spot market in equilibrium.

Therefore, if general equilibrium between two markets holds, then futures prices will cause the spot price to adjust by providing the market related information. To find out the mathematical derivation and analysis of the interaction of prices in spot and futures markets at the terminal period, one may refer to Banerjee (1985).

2.2.2 First proved Empirical Relationships

Ever since the stock futures was introduced, numerous research investigated the relationships between the prices in the spot market and those of the futures market to gather the information required in price prediction and designation of the proper hedging strategy. Traditionally, futures markets are recognized as performing two main functions—price discovery and hedging. The price discovery function helps market participants ascertain information about the market's expectation regarding future cash market prices from the futures market. The hedging function facilitates the transfer of risk by allowing market participants to use the futures market as a substitute for cash transactions. According to Herbst and Maberly (1992), the role of information including the effects of information on the market and traders' choice is discussed in many of the studies due to the lack of information and less transparency on 1980s.

Grossman (1977) proposes "a new explanation of the role of futures markets as a place where information is exchanged, and where people who collect and analyze information about the future state of the world can earn a return on their investment in information gathering". He argues that the incentive to invest in information gathering is inversely related to the forecasting ability of the current spot price.

It is presented in previous studies that derivatives markets offered an effective and welfare-improving method to deal with price volatility. Meanwhile, the use of financial derivatives led to exacerbated volatility in several emerging markets (Mayhew, 1999). Consequently, derivatives markets have helped to support capital inflows into emerging market economies, while they may speed up capital outflow. There is a consensus that derivatives are seldom the cause of a financial crisis but they could amplify the negative effects of the crisis and accelerate contagion. Previous studies of derivatives markets have also supported the hedging role of emerging derivatives markets. Limited empirical results from emerging countries suggest a price discovery function of emerging futures markets. The findings on the price stabilization function of emerging derivatives markets are mixed. As a final point, Lien and Zhang (2008) document that constructive development of derivatives markets in emerging economies needs to be supported by sound macroeconomic fundamentals as well as updated financial policies and regulations.

Among the empirical studies, Kawaller et al. (1987) undertake a study on price relationships between the S&P 500 futures contract and the S&P 500 index and find that the futures market tends to lead the spot market by between twenty and forty-five minutes. Herbst et al. (1987) investigate the lead and lag relationship between the stock indices and the futures contracts for the Value Line index and its futures, and for the S&P 500 index and the S&P 500 index futures. Using daily data, they indicate that there is a time lead of less than one day between the futures market and the spot market.

Chan (1992) and Ghosh (1993a) further report the dominant role of S&P 500 futures in the price discovery process. However, using a cointegration approach like that of Ghosh, the study by Wahab and Lashgari (1993) find that error-correcting price adjustments occur significantly in both the S&P 500 futures and cash markets in price discovery. The cointegrating model of Hasbrouck (1995) suggests that most of the price discovery takes place at the futures market.

Further, the threshold error correction models of Dwyer et al. (1996) and Martens et al. (1998) (whereby the adjustment will only occur when deviations from equilibrium are larger than some threshold values) suggest that the S&P 500 futures market impounds information faster than the spot market.

Presenting the ARCH models, Tse (1999) examines the minute-by-minute price discovery process and volatility spillovers between the DJIA index and the index futures launched by the CBOT. However, by examining the volatility spillovers between the markets based on a bivariate EGARCH model, a significant bidirectional information flow is found. That is, innovations in one market can predict the future volatility in another market, but the futures market volatility-spillovers to the stock market more than vice versa. Both markets also exhibit asymmetric volatility effects, with bad news having a greater impact on volatility than good news. Syriopoulos et al. (2015) apply a similar methodology in a cross hedging case.

From the other point of view, Obstfeld and Rogoff (2000) have discussed “the purchasing power parity” and “the exchange rate disconnect puzzle.” Looking for a common cause for the six international puzzles, it is indicated that the latter results from a combination of trade cost, monopoly and pricing to market in local currencies. So a full model would consider this puzzle and its causes as long as traditional aspects.

Finally, Jacks (2007) exploring the divergence between popular and professional opinion on speculation in general and futures market by a deep historical investigation suggests that futures markets were associated with -and most likely caused- lower commodity price volatility. The paper further discusses the potential sources of popular antagonism against futures markets.

2.2.3 Price Discovery in the Asia Pacific Emerging Markets

There are a few studies on the lead-lag relationship between the futures market and the spot market in the selected markets; however, one may find several studies investigating the futures markets of India, China, Thailand and Australia. In this review some of the studies on the last two markets are also mentioned due to similarity of those markets and their noble models and analysis.

Tse (1995) performs a study on the Nikkei Stock Average futures traded on SIMEX and the underlying stock index. The author finds that the spot price is influenced by the spot and futures price from up to two days previously, while the futures price is not affected by the past spot or futures prices.

Min and Najand (1999), studying Korean futures and spot markets, conclude that the futures market leads the spot market by as long as thirty minutes. In general, most of the studies cited above point out that the stock index futures tends to lead the underlying stock index. However, there are studies presenting bi-directional causality between the futures and the spot markets.

In the case of Malaysia, the study of Mahdhir et al. (2002) find that in the five-year period, futures market tends to lead the spot market by one day during the periods of stable market, and there is a mixed lead-lag relationship between the two markets during the period of highly volatile market. It is established that the lead-lag pattern between the two markets changes under different volatility levels. The leading effect from the futures market to the spot market is reckoned to be due to three reasons, namely, the infrequent trading of KLSE CI's component stocks, low transaction costs and capital requirement to trade futures, and the absence of short-selling restrictions in the futures market.

The other issue discussed is the Malaysian futures-cash market relationship with the introduction of automated system in the Crude Palm Oil Futures (FCPO) in December 2001, employing EGARCH-t model specification. Specifically, it examines whether the introduction of the automated trading system has increased or decreased the volatility level of its underlying cash market and whether the asymmetric response of volatility differs between these two markets. In addition, it compares whether the volatility level and volatility persistence before and after the introduction of the automated trading system differs in FCPO market. Ahmad-n (2010) covers the period of January 2000 to December 2006 to study this issue. Findings reveal that the volatility persistence is marginally higher under the automated trading system relative to the open outcry system for the FCPO market; asymmetric volatility parameters for the spot market are insignificant for both pre-and post-auto periods. It appears that converting the futures market has, in part, led to higher degree of information asymmetry.

Shamsher et al. (2007) reviewing the studies in the Malaysian derivative market, point out the rush to introduce more derivative securities in emerging markets, despite the documented losses suffered by established enterprises dabbling in futures contracts (in China, Malaysia, United States, Germany, United Kingdom and Indonesia) and the failures of many futures contracts in Hong Kong and Singapore exchanges. The push for the introduction of derivatives is to attract institutional investors and increase the liquidity in the market, as these investors usually resort to derivative contracts to manage their investment risk. Should the spot market's price risk increase, they could hedge their position using contracts in the futures markets. It makes good economic sense, from their point of view, to justify futures markets.

The three key issues in the feasibility of futures instruments are: demand, underlying market resilience for price discovery and the overall contribution to risk management. It is a foregone conclusion in financial economics that viable demand for derivatives requires speculative demand to reveal prices and hedge demand to create opposite positions. In the local market, commodity futures contracts on palm oil and rubber have been traded for almost three decades with speculators providing liquidity for producers to cover price risk, resulting in very efficient pricing of commodities, despite the failure of Tin market in the 1970s.

It is also worth to consider studies on the pricing efficiency of derivatives markets towards achieving a better insight about the Malaysian market; although there is scarcity of evidence in this regard. Abdul et al. (1999) examine several issues related to the introduction and trading of stock index futures contracts. They document no evidence of increasing volatility, expiration date effect, mispricing and no lead-lag relationship between the stock market and futures market. Taufiq et al. (2007a) document evidence on the pricing of stock index futures contract traded on the MDEX. The latter study takes the transaction costs and different regulatory regimes into consideration before and after the 1998 financial crisis and the capital control regimes. They report that the difference between the actual price and theoretical price of contracts is small and that the deviations became very large immediately after the financial crisis, for the most cases, in one direction. It is also indicated that similar to the case of developed markets mispricing tends to decrease when the contract approached expiration date, due to the limiting of arbitrage opportunities.

Taufiq et al. (2006) document the pricing behavior of interest rate futures contracts i.e. the 3-month KLIBOR futures contract. Evidence indicates that the level of mispricing for shorter maturities is minimal compared to long maturity contracts. It is also observed that the financial crisis had minimal impact on the pricing of KLIBOR futures contracts.

These contracts, however, lack liquidity probably due to managed interest rate policies implemented since the onset of the financial crisis, and perhaps also due to the absence of institutional interest in this market compounded by lack of awareness and confidence to use these contracts for hedging interest rate risks.

Exploring the issue, Junaina et al. (2013) finds that increased liquidity through a rise in the number of foreign investors may surge volatility by creating excessive herding opportunity. They argue that this is significant as foreign participants' manipulation is followed by ordinary local investors. Thus, stock index futures Granger causes the cash index with no feedback in the reverse direction during periods of financial crisis and recovery. They also, interestingly, reveal signs of increasing integration between cash and futures markets over time.

In commodity markets, the informational efficiency of Crude Palm Oil (CPO) futures contracts is analyzed by Taufiq et al. (2007b). Separating the futures prices according to their maturity life cycles they find that if futures price formation follows rational expectations, then information flows from futures to spot. The results are generally consistent with the expectations. All distant month error terms in spot equations are statistically significant for three sub-period samples (1987- 89, 1990-92 and 1996-98). The findings are consistent with the notion that all expectations will converge in the terminal month prices and the spot market plays a dominant role, along with futures, in adjusting prices.

The applicability of the Arbitrage Pricing Theory on stocks listed on the KLSE is another issue that is tested by Lim (2005), identifying both macroeconomic and firm-specific factors which are correlated with price changes. The findings support a conclusion that there is a weak applicability of APT in this market for the data over a 21-years period. This finding is also consistent with Hossari (1994) who finds only one factor for the Malaysian market using a one-year test window.

Shamsher et al. (2007) suggest that further research is therefore warranted in this area, with lengthier test windows, using refined measures and robust methodology. For instance, although a wide range of commonly reported economic and financial variables were used, the relevant variables was not identified. Wasserfallen (1989) also supports this premise in another aspect, suggesting that the factors identified by factor analysis do not exactly correspond to economic variables.

2.3 Hedging Effectiveness

2.3.1 Why Hedge

Futures markets are equally important for hedging operations hence a great number of participants in futures markets are hedgers. They aim to practice futures to remove or reduce a specific risk that may rise from oil price, foreign exchange rate or the stock market price fluctuations. A perfect hedging is the one that can remove risks completely. However, in reality, a perfect hedging is rare. In the most cases, hedging risk using futures can be constructed in a way that they can perform as close to perfect as possible.

Working (1953) points out 3 advantages of hedging. First, hedging can reduce the risk related to the excess holding of commodity stocks or forward commitments; it can minimize the risk of unwise holding of the commodity that will be undertaken, or unwise forward commitments made. Second, its widespread practice tends to eliminate the uncertainty of spot prices. Third, when surplus happens, hedging tends to promote traders to store commodities in private hands and release them at a proper time.

Hedging is for risk reduction. As Goss (1972) indicates that "risk avoidance in an ex ante sense is not possible, because hedging in a futures market, where the futures contracts are closed out by reversal, substitutes a basis risk for a price risk; risk avoidance in an ex post sense may occur if spot and futures prices move in an exactly parallel fashion". An essential feature of commodity hedging is that the trader synchronizes his activities in two markets: one is generally the 'cash' or 'spot' market (the market for immediate delivery); the other is generally the futures market (Johnson, 1960).

In addition, there may be other reasons why firms hedge, such as tax advantages. Low-income firms, for example, those that are below the highest corporate tax rate can particularly benefit from the interaction between hedging and progressive corporate income tax structure (Wong, 2005).

2.3.2 Hedging with Futures

Depending on the risk being hedged and the construction of the hedge, futures hedges can be characterized in several ways. A short futures position refers to a situation where a firm or trader sells an asset in the future to hedge its price movement while a long futures position is known as a firm or trader buys an asset in the futures to hedge its price fluctuation risk.

Working (1953) concludes that there are at least four different reasons to hedge by futures. (1) It facilitates buying and selling decisions. When hedging is practiced systematically, there is no need to consider the adverse price movement, the only thing that needs to be considered is whether a favorable purchase or sale price can be made when considering the current price. (2) It gives a reliable basis for conducting storage of commodity surpluses. The warehousing of surplus commodity stocks is uncertain when the company tries to judge whether the price is good for storage or not. While through hedging with futures, it is easy for company to judge by simply analysis whether the spot price is low or above the related futures price. (3) It gives greater freedom for business action. Finally, hedging reduces company's risks when hedging is done for any of the above reasons.

Optimal hedge ratio is the foundation of standard futures hedging policies. From several decades to now, optimal hedge ratio is an active research area in financial economics. Indeed, after Ederington (1979), the concept of optimal hedge ratio has been widely extended by researchers. Schmidt and Statman (1980) and Losq (1982) focus on problems with uncertain prices and input. Rolfo (1980) and Kerkvliet and Moffett (1991) solve models where there is uncertain relationship between prices and quantities. There is also considerable work on cross hedging through futures contracts such as Anderson and Danthine (1980). Experimental work on the effectiveness of the optimal hedge ratio may be seen in the work of Smith and Stulz (1985) who provide a detailed survey of possible determinants of firms' hedging policies.

Most commodity trading theorists have visualized the hedger as a dealer in the 'actual' commodity who desires 'insurance' against the price risks he faces (Johnson, 1960). For example, a trader sells a unit of commodity at certain spot price x. The price further fluctuates and he is subject to a capital loss or gain depends on whether the price rises or falls and the amount of that price change during the period of his repurchasing. Then according to these theorists, the trader would take a futures position to protect his profit. He would take a long futures position of x units from the risk of such price movement by purchasing an enough number of futures contracts to cover delivery of x units at the same time. After his repurchasing, he would liquidate his futures position by selling the same amount of contracts as before. If the price movement are at the same direction, he would incur no gain no loss as the gains in one market offsets the losses from another market, which would leave him in the normal position. In other cases, he would gain or loss depends on how price moves.

On the other hand, the major role of the speculator in futures, according to the bulk of the literature, is to assume the risk that hedgers expect to remove from their side; the futures market is therefore viewed as a risk transfer mechanism through which price risks can be transferred from one group who are not willing to take risks to another who are willing to take risks. The hedger is often described as an apparently unsophisticated participant in futures dealings (Johnson, 1960). In general, hedgers are prepared to accept the payment of a risk premium for reducing price risks they face. On the other hand, speculators are willing to participate in futures market if a considerable risk premium is expected.

Stein (1961) outlines a theory explaining the allocation between hedged and unhedged holding of stocks. The optimal combination of hedged and unhedged stocks can be found if a utility map relating expected returns and risk is given. The optimal hedging proportion provides the maximum attainable level of utility for the inventory holder. Johnson (1960) reformulates this theory of hedging and suggests that hedging and speculative activities are often combined in the actions of a decision maker.

Figlewski et al. (1988) describes a technique for estimating an optimal futures hedge. This technique considers several important facts which are rarely given sufficient attention: First, a true optimal hedge is one in which the investor's subjective marginal rate of substitution between risk and return is equal to their marginal rate of transformation within the hedged position. Second, in computing this optimum, one should estimate the statistical relation between the cash position and the futures contract in a manner that allows for the fact that it varies substantially over time.

According to Anderson and Danthine (1980), "although conventional descriptions seem to propose a view of hedging as taking a position in a futures market that is equal in size and opposite to a predetermined position in the cash market, such a simple view goes well with the observed diversity and sophistication of futures markets participants".

However, previous literature brought out some of the deficiencies of the routine hedge prescription. The existence of basis risk is emphasized by Working (1962). He indicates that basis risk affects the elimination of all risks. Telser and Higinbotham (1977), Johnson (1960), Stein (1961), and Peck (1975) have analytical models of optimal hedging. Johnson and Stein derive optimal hedges for mean-variance utility maximizers, recognizing the simultaneity of cash and futures decisions.

2.3.3 Major Theories of Hedging

The classic economic rationale for futures markets is, of course, that they facilitate hedging – that they allow those who deal in a commodity to transfer the risk of price changes in that commodity to speculators more willing to bear such risks (Ederington, 1979). Telser and Higinbotham (1977) points out that by providing a standardized contract and by substituting the trust of the exchange for that of the individual traders, organized futures markets facilitates transactions, so risks from price fluctuation can be eliminated by taking delivery on futures purchased or sold.

Nevertheless there is no perfect agreement in the futures market literature such as what hedging is or why it is undertaken, there are three major theories of hedging: the traditional theory, the theories of Holbrook Working, and the portfolio theory.

a. Traditional Hedging Theory

Traditional hedging theory is still important although it predates the theories of Holbrook Working and the application of portfolio theory to hedging. Indeed, it is the traditional theory which underlies almost all the early "How To" articles on hedging which accompanied the establishment of the GNMA and T-Bill futures markets (Ederington, 1979).

Traditional hedging theory emphasizes the risk avoidance potential of futures markets. Hedgers are assumed as the one who are taking the futures positions opposite to his position in the cash market and in the equal amount. For example, a trader who is going to sell X units of commodities would protect himself from price fluctuation risks by taking a long futures position of the same amount of commodities. When the commodities are sold, the futures contracts are purchased, which cancels both positions.

If the spot price at t_1 is P_1 and at t_2 is P_2, the gain or loss from an unhedged position U of x units is $X(P_2-P_1)$. On the other hand, if the futures price at t_1 is F_1 and at t_2 is F_2, the gain or loss from a hedged position H is $X[(P_2-P_1) - (F_2-F_1)]$. Traditional theory argues that in general spot and futures prices are moving together so that the absolute value of H is less than the absolute value of U. However, this is often questioned in terms of the change in the cash price versus the change in the "basis", where the basis is defined as the difference between the futures and spot prices (Hull, 2003). The change in the basis is $[(F_2 - P_2) — (F_1 — P_1)]$ or $– [(P_2-P_1) - (F_2-F_1)]$.

If the change in the basis is zero, the hedging is considered as perfect. However, it is often argued that the change in the basis is small if the possibility of delivery is high, which is true as the higher possibility eventual delivery reduces the change in the basis though a range of variations still remains. It is obvious that the change in basis leads to the imperfection of traditional hedging theory.

Working (1953) indicates that most writers ignore this fact: "A major source of mistaken notions of hedging is the conventional practice of illustrating hedging with a hypothetical example in which the price of the future bought or sold as a hedge is supposed to rise or fall by the same amount that the spot price rises or falls".

b. Holbrook working's Theory

Working (1953, 1962) challenges the view that the aim of hedgers is risk reduction and emphasizes on the aim for profit maximization. According to Working (1962), hedgers function much like speculators, but since they held positions in the cash market as well, they were concerned with relative not absolute price changes. Instead of arguing futures and spot price move together, he discusses that most hedging is done in expectation of a change in spot-futures price relations. Consequently, a long position holder in the cash market would hedge if basis was expected to fall but would not hedge if basis was expected to rise.

As emphasized by Working (1953), although in general, hedging activities appear to be motivated by the desire to reduce risk, as described in traditional theory, the levels of inventory held appear to be not independent of expected hedging profits. Furthermore, the practice of individuals that may hold a mix of hedged and speculative positions in response to expectations concerning absolute price changes is a practice not well explained in either traditional theory or in Holbrook Working's theory (Johnson, 1960).

c. Portfolio and Hedging Theory

Based on the view that hedging is a simple application of basic portfolio theory, Johnson (1960) and Stein (1961) integrate the risk avoidance of traditional theory with Holbrook Working's expected profits maximization. Johnson and Stein explain that the risk-return reasons for those who buy or sell futures are the same as those buy any other security. While traditional theory specifies that hedgers should always be completely hedged, Holbrook Working's hypothesis indicates that hedgers would be completely hedged or unhedged. The application of portfolio theory allowed them to explain why hedgers would hold both hedged and unhedged commodity stocks.

2.3.4 Hedging Effectiveness and Hedge Ratio in the literature

Numerous studies focus on the potential strategies of hedging in the futures market. Cicchetti et al. (1981) is one of the first studies in the era which simply assumes that hedgers are solely interested in minimizing the risks due to interest rate fluctuations, whereas there are some disagreements as to the exact motivation of those who use the futures market for the hedging.

Common sense may lead one to assert that having the opposite but same magnitude positions in spot and futures markets is the simplest and the best way to hedge oneself against volatility in asset prices. Indeed, this is the traditional hedging approach. However, in reality the spot and futures prices are not perfectly correlated. Hence, in order to follow an optimal hedging strategy, the magnitudes of the positions in spot and futures markets are different.

The optimal hedge ratio, defined as the ratio of the size of portfolio taken in futures contracts to the size of the exposure in spot market under minimum risk constraint, is used to determine the amount of futures position that optimally covers the spot exposure (Hull, 2003). Nevertheless, the computation of the optimal hedge ratio is not straightforward as there is lack of consensus about the best empirical model for the estimation process. Different studies document contradictory results in this regard.

A significant amount of empirical research in the hedging literature focuses on estimating the optimal hedge ratio for a variety of futures contracts through various econometric techniques. It was firstly revealed by Johnson (1960) and Stein (1961) that a hedger can only maximize utility via minimizing the unconditional variance of the covered portfolio returns. Hence, the hedge ratio that provides the minimum portfolio variance ought to be the optimal hedge ratio. Extending these pioneering studies, Ederington (1979) adopts OLS regression method to derive risk-minimizing hedge ratio. He concludes that the OLS-based hedge ratio outperforms the naïve one-to-one hedging strategy in terms of hedging effectiveness. The OLS regression method is commonly employed by numerous authors because of its simplicity in hedge ratio estimation. Amongst others, Hill and Schneweis (1981), Figlewski (1984), Myers and Thompson (1989), Benet (1992) and Lien (2005) all verify the robustness of hedge ratios calculated by the OLS regression method for different futures markets.

Even though the OLS approach has been widely applied in literature, it was subject to a number of theoretical criticisms (see Myers, 1991) stemming from the rigid assumptions of the process particularly and parallel to advances in financial econometrics. One of these challenges is highlighted with the serial correlation detected in residuals, which caused bias in hedge ratio estimates. To eliminate the serial correlation in residuals, Herbst et al. (1993) model the spot and future returns through a bivariate vector autoregressive (VAR) framework and gather more realistic hedge ratios. Further, the instantaneous feedback relation (mostly bidirectional) between spot and future markets is clearly documented under the lead-lag pattern, which has been taken into account by the bivariate VAR model in the estimation of the hedge ratio (e.g. Chan (1992), Abhyankar (1998), Brooks and Persand (2002), and Kavussanos and Visvikis (2008)).

Another structural viewpoint on hedge ratio estimation hinges upon the probable cointegration relationship between spot and futures prices. The existence of such a correlation would not allow prices to diverge extensively from the long-run equilibrium. Engle and Granger (1987) state that the cointegration among variables might invalidate the findings of conventional methods. They suggest applying error correction mechanisms in the case of cointegration. The error correction model (ECM) in the estimation of optimal hedge ratio is initially used by Ghosh (1993a and 1993b). He reports that the hedging effectiveness is remarkably improved through the hedge ratio estimates of ECM, which incorporates the long-run equilibrium to the system and overcomes the misspecification problem.

Similar findings referring to superiority of ECM are reported by Lien and Luo (1993), Chou et al. (1996) and Kenourgios et al. (2008), Fan et al. (2014), Huang (2014) and Kocks (2015). However, Moosa (2003) shows that consideration of cointegration has a negligible effect in terms of hedging effectiveness.

Furthermore, since the most of the financial time series have the feature of heteroskedasticity, the GARCH based models are also usually conducted with the aim of estimating hedge ratios (Bollerslev, 1986). Myers and Thompson (1989) allege that the hedge ratio should be adjusted continuously based on conditional information set. As a consequence, the conditional variance and covariance have to be taken into account jointly. Most researchers choose multivariate derivation of the GARCH model (called as M-GARCH) empirically in order to capture simultaneous interactions between spot and future prices.

For instance, Yang (2001) employs a standard D-VEC M-GARCH (1, 1) model under the constant correlation hypothesis. He stress that the hedging effectiveness is improved via the M-GARCH hedge ratios for the Australian stock index futures. Choudhry (2004) implies that the time-varying (dynamic) hedge ratios of various M-GARCH derivations outperform the constant hedge ratios obtained from different estimation procedures for many stock markets and their corresponding future contracts.

Despite the presence of a large amount of research for developed markets on the time varying hedge ratio concept, emerging markets are insufficiently researched. A small number of studies, such as Choudhry (2003) for Hong-Kong and South Africa, Floros and Voguas (2005) for Greece, and Bhaduri and Durai (2008) for India emphasize the ability of M-GARCH framework to compute risk-minimizing hedge ratios for these markets.

Hedge Effectiveness is another concern of the researchers. Among the papers considering this issue Chouldhry (2003) also investigates the effects of the long-run relationship between stock spot index and futures index on the hedging effectiveness of six stock futures markets of Australia, Germany, Hong Kong, Japan, South Africa and the United Kingdom. Effectiveness of five different hedging ratios depending on different estimation procedures is investigated. Results show that the time-varying hedge ratio outperforms the constant hedge ratio.

Saumitra (2008) further investigates the effectiveness of various optimal hedge ratios through the mean returns and the average variance reduction between the hedged and the unhedged positions. It is showed that the time-varying hedge ratio derived from the MGARCH model has higher mean return and higher average variance reduction across hedged and unhedged positions. However, from a cost of computation point of view, it is accepted to consider the simple OLS strategy equally that performs well at the shorter time horizons.

A small number of studies such as Howard and D'Antonio (1984) assert that the return after hedging is also important and should be taken into account when measuring the effectiveness of hedging. For this reason, the average daily returns of the constructed portfolios are also calculated and analyzed as a supportive tool in assessment process. When the return of the portfolios is taken into account, there is a slight difference between in sample and out-of-sample datasets. One possible explanation for this anomaly might be the reduced correlation between spot and future prices for the out-of-sample period.

Moreover, there are several studies on the interaction of exchange rates and stock prices before and after the Asian financial crisis in Asian or the ASEAN countries. The results are different utilizing different methods; however, I do not concentrate on this issue. For instance, Rodolfo (2005) using a two-factor arbitrage pricing theory model suggests that stock returns did not react significantly to foreign exchange rate fluctuations before the period of the crisis. In the other side, Hatemi and Roca (2005) find that during the period before the Asian crisis, with the exception of the Philippines, exchange rates and stock prices were significantly related, with the direction of causality running from the former to the latter in the case of Indonesia and Thailand, and from the latter to the former in the case of Malaysia. During the crisis period, this relationship ceased to exist in any of the countries. This could mean that the foreign exchange and stock markets became segmented or the transmission of information between the two markets became efficient during the crisis. This would have important implications in terms of policy and in terms of hedging of portfolios. For investors in the stock markets, it would imply that during crisis periods they cannot use the foreign exchange markets to effectively hedge their investment and vice versa.

In excess of common issues in futures hedging, Lee (2014) examines the effect of time to maturity in hedging effectiveness and Holmes (1996) considers expiration effects and hedge ratio stability. Further, Pennings and Garcia (2010) investigate the hedging behavior of managers. They conclude that risk attitudes and risk perceptions do not influence behavior uniformly and that heterogeneity is influenced by managers' focus on shareholders' value and the firm's capital structure (private investors vs. portfolio managers). Similar studies explain the difference between segments like as Penning (2000) and the moderation of hedging behavior influences by the environment in which the policy makers operate as Aldrich (1979) and Rajagopulantel (1993).

2.3.5 Hedging Effectiveness in Asia Pacific Emerging Markets

While there are various studies on the developed futures markets in different aspects utilizing numerous statistical methods, there are quite a few studies concentrating on the emerging markets of Asia. Evaluating these studies briefly in this section, it is worth mentioning that the interests on the issue are of a great increase nowadays by the increase in the speed of spreading information with the extension of the electronic trading apparatuses.

Sim and Ralf (2001) focus on the impact of the 1997 Asian financial market crisis upon hedging effectiveness within the KOSPI 200 stock index and index futures markets in South Korea. Practically, they examine the effectiveness and performance of various hedging strategies for active traders in an emerging and dynamic securities exchange before and after the 1997 Asian crisis. The paper utilizes the inter-temporal relationship between the two markets to examine the characteristics of several minimum variance hedge ratios. It also examines the performance of alternative hedging strategies for dynamic portfolio management in the presence of cointegrated time-varying risks. The results show a decline in the persistence of conditional volatility within market prices after the crisis. This decline leads to the relatively superior performance of constant hedge ratios over more sophisticated time-varying hedge ratio strategies.

Fazillah (2008) focuses on the simultaneity relationship between hedging through forwards, futures, swaps and capital structure for non-financial Malaysian firms. In excess of the topic, it mentions some interesting points like the motivations behind the use of derivatives by the Malaysian firms starting by "Some say that the Asian Financial Crisis could be averted if Malaysian firms had used foreign exchange derivatives." Specifically, it points out the determinants of hedging and its effects on the financing decisions in the Malaysian context.

Furthermore, Pok et al. (2009) show that rankings of the constant and dynamic hedging models change for the in-sample period depending on evaluation criteria used. Performance of models is compared in terms of variance reduction and expected utility levels for the full sample period as well as the three subperiods which encompass the Asian financial crisis and introduction of new capital control measures in Malaysia using daily data from Dec 1995 to Apr 2001 and bivariate GARCH and TGARCH models.

TGARCH based models provide better hedging performance but only in the period of higher information asymmetry following the imposition of capital controls in Malaysia. Overall, despite the structural breaks caused by the Asian financial crisis and new capital control regulations, out of sample hedging performance of dynamic GARCH models in the Malaysian emerging market is as good as the one reported for the highly developed markets in the previous literature. The findings suggest that changes in the composition of market agents caused by large scale retreat of foreign investors following the imposition of capital control regulations may not have any material impact on the volatility characteristics of the Malaysian market.

Investigating the spot and futures CPO returns using daily data from January 1996 to August 2008, Ruzaimah and Roslee (2010) did not find any evidence to show a structural break presence in the dynamics of returns that produces a regime shift in the long run equilibrium relationship between spot and futures prices. The finding indicates two structural break at December 1998 and July 1999 (roughly) in CPO as well as FCPO return mean and huge number of regime changes in the variance series. They utilize the k_2 test result which indicates the breaks on late 1996, late 2001 and early 2008 due to the global recession, only applicable to FCPO.

2.4 Interrelationship of Price Discovery and Hedging Effectiveness

Since 1984, several studies given out that evaluate hedging strategies and their performance considering price discovery; however, it is not the main focus of almost all of these studies. One of the most related empirical studies in the Asian markets is Chen et al. (2002), a comparison of Hedging Effectiveness and Price Discovery between TAIFEX TAIEX Index Futures and SGX MSCI Taiwan Index Futures. The other papers usually investigate the issue in special commodity markets such as shrimp, barley, soya bean and corn. In some cases price discovery has not discussed directly but there are some other points on mispricing or price limits.

Chen et al. (2002) examines the hedging effectiveness, price behavior, and lead-lag relationship of two futures indices using Gibbs sampler, to find out whether TAIFEX index futures has a better hedging performance. A variance ratio test reveals that mean reversion and negative correlation of returns exist in SGX index futures. Only TAIEX futures is cointegrated with TAIEX spot. The Granger causality test shows a uni-directional causality from SGX to TAIEX and from TAIEX to TAIFEX. In terms of price discovery, SGX MSCI Taiwan index futures plays a more important role than TAIFEX TAIEX futures.

In order to understand the interaction and relationship between these stock index futures and TAIEX spot, several issues are investigated in this study: (1) hedging effectiveness and Gibbs sampler, (2) market efficiency and variance ratio, and (3) lead-lag relationship and Granger causality. In comparing the hedging effectiveness of these two index futures, the OLS regression is first utilized to estimate the hedge ratios, then the estimator in Bayesian Approach is constructed using Gibbs sampler. In investigating the futures price behavior, the variance ratio test proposed by Lo and MacKinlay (1988) is utilized to determine whether the futures prices correspond to random walk. An issue of concern in the current literature is the lead-lag relationship and price transmission between spot and futures markets. In this study, both the augmented Dickey-Fuller test and the Granger causality test using error correction model (ECM) and vector autoregression (VAR) are applied to examine whether futures or spot markets play the leader role in the process of price discovery and information dissemination.

The minimum-variance model has been extensively applied to estimate the hedge ratio and hedging effectiveness for various futures contracts in earlier articles, for example Hill and Schneeweis (1984) for T-bond futures, Overdahl & Starleaf (1986) for CD futures, Howard & D'Antonio (1984) for T-bill futures, Figlewski (1984 and 1985) and Junkus and Lee (1985) for stock market index futures, Hill and Schneeweis (1982a and 1982b), Grammatikos (1986) and Hwang et al. (1996) for foreign currency futures.

All these articles show that, compared with the unhedged spot position, a hedge strategy with minimum-variance model in futures market can substantially reduce the price risk. Although the new-fangled models in estimating hedging effectiveness or risk reduction is introduced, the simpler minimum-variance model is commonly utilized as it is proven by some studies (including McNew and Fackler, 1994) that using such sophisticated procedures may be unwarranted, and eventually, not cost effective.

Most of the hedging papers in 1980s explains the basic methods and compares the performance of available models. Carter (1984), in a more advanced study, conducts several tests to investigate the stability of basis, the pricing efficiency and hedging effectiveness of the Winnipeg barley futures market. Analyzing both the intertemporal and spatial behavior of futures and cash prices, he concludes that a market is deemed price efficient if it rapidly and accurately adjusts to a particular information set.

Hedging effectiveness is measured by the stability of the basis. Several weak-form efficiency tests, including serial correlation analyses, price variability analyses and price-trend analyses, are performed on the barley and corn market prices. The results indicate the market does a good job of reflecting Canadian domestic information on supply and demand. Lastly, the barley market was found to have a relatively stable basis and the rural markets displayed a less variable basis than the terminal Thunder Bay market. Overall, hedging rural cash barley on the barley futures market reduces price risk more effectively than does hedging rural corn on the corn futures market.

A hedging analysis that specifically incorporates the effects of futures contract mispricings on hedging decisions is further developed by Merrick (1988). As evidenced by empirical results, short-term hedging performance in the S&P 500 stock index futures market depends importantly on the distribution of the mispricing return. Predictable reversals of initial mispricings generated substantial differences between the expected return on hedges begun with overpriced versus underpriced futures.

Furthermore, results showed that risk-minimization requires both underhedging and upward revisions of the hedge ratio as the contract expiration date approaches. Such stock index futures hedges eliminated about 85 percent of one-day stock market return variance over the 1982-1984 period and about 90 percent of that variance over the 1985-1986 period. While empirical results apply only to stock portfolio hedges, the arbitrage/ carrying charge perspective on hedging is relevant for all futures and option markets. In the spirit of Working (1962), short-term hedging is more akin to arbitrage than to the traditional views representing either risk-avoiding or selective risk-taking behavior.

On the contrary, futures markets are not always found as a perfect hedging tool and price discovery mechanism. For instance, Maynard et al. (2001), using Granger causality tests, reveals leading indicators of US shrimp futures prices, implying that futures prices do not reflect all available market information and potentially fail to be an exemplary price discovery mechanism. The trading simulations confirm that the use of some leading indicators allows profitable arbitrage in shrimp futures trading. Shrimp futures is also an incomplete hedging tool since correlations between futures and wholesale cash prices were often low, and basis risk rivaled price risk. Lack of liquidity is a likely explanation for the shrimp futures' shortcomings.

In addition, the forecasting ability of futures market is the key concern of Wilson (1989) in analyzing the performance of hedging the sunflower price risk. Optimal hedge ratios and measures of hedging effectiveness are calculated for selected hedging instruments. The employed Thiel's inequality test shows that the paper market establishes price forecasts which are comparable to those from the soybean oil futures, although the hedge ratios and effectiveness varies from year to year. Additional tests present a significant monthly variability in the intercept. This is a reflection of the basis behavior which increases in the new crop harvest seasons. Prices, interestingly, are not biased in favor of long hedges and speculators.

In the latest efforts, theoretical aspects of the interrelationship of price discovery and hedging effectiveness is studied in Alexander (1999), Lien (2004, 2009 and 2010), and Lien et al. (2012). Recapping the analytical importance and intuition behind considering the spot-futures prices relationship in calculating the optimal hedge ratio, they present the required mathematical proof to explore the superiority of the methods take this term into account.

Furthermore, following the methods scrutinized by Sim and Zurbruegg (2001), Moosa (2003) and Lien (2005), some recent studies investigate the innovative advanced methods to check whether there is a potential to consider all the discussed issues in one econometric model. Ederington and Salas (2008) and Hatemi and Roca (2010) are the outstanding studies exploring these methods. The econometric models are presented in details in the next chapter.

2.5 Summary

This chapter reviews and discusses the existing theoretical and empirical research in three issues related to futures markets. The first section of the chapter reviews the literature on the role of futures and spot market in price discovery. To date, assessing the contribution of each market through CFW measure and the influence of market development and liquidity on accurate price discovery FDI has yet to be analyzed. Therefore, this study intends to fill the gap by examining the role of liquidity in obtaining the desired outcome in addition to calculating the CFW in each market. The second section focuses on various methods of calculating hedge ratio. Although this issue appears to be important in many studies, only a few studies has been carried out to examine different hedging strategies and find out the optimal hedge ratio in emerging markets. Finally, the third section reviews the literature on the interrelationship of price discovery and hedging effectiveness. This study explores the hypothesis of positive relationship between price discovery and hedging effectiveness in emerging financial markets.

CHAPTER 3

METHODOLOGY AND DATA

3.1 Introduction

The methods and econometric models in this chapter are presented in several sections, according to the objectives of this study. Each section starts with delineating the theoretical underpinning of methods that is employed for that specific objective before clarifying the exact model to be used.

The methodology is started with a fleeting review on the methods related to price discovery in the following section. The econometric implementation of the basic method is further modified to support the declared supplementary hypothesis. The third section discusses the alternative methods available for calculating the hedge ratio. Several methods among the wide range of available methods are selected and examined to estimate the optimal hedge ratio. Discussion about measures of evaluating the hedging effectiveness is the next step.

Finally the offered methodology to evaluate the third objective, examining the interrelationship of price discovery and hedging effectiveness in the Asia Pacific emerging markets, is reviewed, before presenting the description of data in the last Section.

3.2 Price discovery

Trading in futures experiences a smaller transaction cost than does trading in the spot market. So by introducing derivatives into the market it is expected to increase information flows that lead to a robust price discovery function in the derivatives market. The futures price involves information about anticipated demand and supply that may assist decision making in the whole economy. Price discovery methods are evaluated in brief and some advancements are provided to examine the effect of financial market development which is not provided by any research earlier, to the best knowledge of the author.

A popular approach to investigate the relationship of spot and futures prices is reviewing the lead–lag relations in returns (price changes) of cash and derivatives markets. Empirical evidence on stock index futures markets in the United States and other developed economies, as fully described in chapter two, overwhelmingly indicates that index futures is playing the lead role. The estimates of the lead time are ranging from five to thirty minutes. However, there are studies that find out evidence of a shorter lead in cash market that occasionally leading futures by 1-2 minutes, as occurs in France (Shyy et al., 1996).

Reviewing the methods employed for evaluating the price discovery, it is important to note that not many methods are developed for assessing the price discovery compared to the wide range of methods introduced for finding optimal hedge ratio. It is also worth to mention that as the spot and futures price of every index or instrument are tied together, it is strongly expected to have the cointegration between two series. What makes the issue interesting is the additional information that can be achieved by assessing this relation.

3.2.1 The bivariate cointegration approach:

Examining the price relation shall be started with a look at its theoretical background. The main points that deserve attention in the basic model is related to the cost of carry model:

$$F_t = S_t e^{r_{T-t}}, \qquad (1)$$

where F_t is contemporaneous price of a futures contract for that index, S_t is spot price of that underlying index, and *r* is the interest rate. The first point is this relation implies that the cointegrating relation is not constant over time. So models such as ECM that takes the speed of adjustment into account would better describe the relationship.

The second point is about the implementation of the model. The standard approach is considering the logs of the prices:

$$\ln(F_t) = \ln(S_t) + r_{T-t}, \qquad (2)$$

Therefore, we would have a constant slope, equals to one, and a time varying intercept. Furthermore, using the typical log return in estimating the coefficient, the weight of interest rate modifications in the intercept would be immaterial. So there is no necessity to ponder the interest rate.

The remaining specifics are dividends and transaction costs. While it is not necessary to consider the first one, as dividend is taken into account in the calculation of indices; it is assumed that the transaction cost in the selected countries is trivial[4].

As a prerequisite for our cointegration model, it is required to examine whether the series are stationary. To test the stationary, the Augmented Dickey–Fuller (ADF) and Phillips-Perron unit root test are employed. The ADF test for unit roots is widely applied to the natural logarithms of the cash and futures prices. The expected result is the time series of prices are I(1) and the returns are stationary, as it is the case for most of the prices in financial markets.

Moreover, based on the cointegration concept, if both time series F_t and S_t are I(1), and there exists a linear combination of F_t and S_t, which is stationary or I(0), then Ft and St are cointegrated. In other words, once the residual of this combination found stationary, the variables are co-integrated, the model is a long run model and the coefficient of S_t is a long run coefficient. To test the cointegration between the spot and the futures prices the Johansen method is applied.

3.2.2 The ECM framework

Assuming the variables are I(1) and co-integrated, the ECM model is applied accordingly. Traditionally, the VAR framework specifies the variables in level (Sims, 1980). Since the time series variables have been widely noted to be non-stationary, the main statistical problem that may arise from the level VAR is that the results are

[4] The most important determinant of the transaction cost is defined as the difference between bid and ask quotes, called spread. Offering the online trading platforms, the spread in the modern systems can be as less as 0.0001, which is ignorable.

spurious and misleading. Moreover, utilizing properly differenced variables in the VAR may lead to model mis-specification if the level variables share the long-run relationship or are cointegrated.[5] In this case, the VAR should be written in a vector error correction form as:

$$r_t^X = \alpha^X + \sum_{\tau=1}^{k} \beta_\tau^X r_{t-\tau}^X + \sum_{\tau=1}^{k} \gamma_\tau^X r_{t-\tau}^F + \delta^X (p_{t-1}^X - p_{t-1}^F) + \varepsilon_t^X$$

(3)

$$r_t^F = \alpha^F + \sum_{\tau=1}^{k} \beta_\tau^F r_{t-\tau}^F + \sum_{\tau=1}^{k} \gamma_\tau^F r_{t-\tau}^X + \delta^F (p_{t-1}^X - p_{t-1}^F) + \varepsilon_t^X$$

Where *p* denotes log price series and *r* denotes log return. The indices X and F identify observations and coefficients relating to the spot and futures market accordingly. This study uses the pre-specified cointegrating vector (1, -1).[6] The optimal number of lags are determined using the Schwartz Information Criterion. The t-statistics shall be based on Newey-West standard errors as heteroscedasticity and serial correlation of the residuals is probable issues.

The formulation of the VECM treats all variables as potentially endogenous. Each variable, expressed in its first difference, is specified to respond to changes in other variables as well as to the deviation of the variable under consideration from the long-run equilibrium path. The framework enables us to evaluate their causality in Granger-sense, which is based on the statistical significance of the error correction term and of the lagged first-differenced terms for each explanatory variable. Interestingly, Masih and Masih (1996) term the former as the "long-run" causality and the latter the "short-

[5] The VAR model is similar to VECM model concerning the lagged items, but it does not have error correction term. ECM outperforms VAR in many empirical studies as well. [See Ghosh (1993), Wahab and Lashgari (1993), Koutmos and Tucker (1996), Shyy et al. (1996), Tse (1999).]

[6] It is according to the standard vector employed in almost all of the previous studies. (see Dwyer et al., 1996, Fleming et al.,1996, Martens et al., 1998, Booth et al., 1999, Tse, 2001, and Schlusche, 2009)

run" causality. These tests assist uncovering the patterns of causal interactions among the pairs of variables, whether it is (1) a unidirectional causality from a variable, say x, to another variable, say y, (2) a bi-directional causality, or (4) x and y are independent.

Note that the sign of the ECT coefficient should be negative[7], less than one and significant in order to consider the estimated long run relationship valid. The diagnosis test is further applied.

The last problem with the VAR technique is that structural interpretation of the VAR coefficients may not be made. According to Genberg et al. (1987), this will not pose a serious problem if the focus is not on structural interpretation.

3.2.3 Measuring Contribution of markets to Price Discovery

The standard measure to evaluate the contributions of spot and futures markets to price discovery is the Common Factor Weight (CFW) proposed by Schwarz and Szakmary (1994). The CFW is calculated using the coefficients of the error correction terms as follows:

$$CFW^X = \frac{\delta^F}{\delta^F - \delta^x}, \; CFW^F = \frac{-\delta^x}{\delta^F - \delta^x} \tag{4}$$

The measure would indicate the share of each market in shaping the price. The coefficient of the error term should be significant in order to consider the role of spot

[7] In a single equation model the coefficient of the error correction term ought to have a negative sign. In our model, the error correction term in the second equation, with the futures returns as the dependent variable, follows the same pattern of the first equation, so it should be positive.

or futures market on the price discovery valid. Otherwise, there is no choice but to set the 100% of weights in this regard to the other market.

There are other alternatives such as information share of Hasbrouck (1995). It is indicated by Grammig and Peter (2008) and Yan and Zivot (2010) that the information share faces limitations when there is high frequencies. Further, it is not applicable to the modified model that is utilized in the next step of this study.

3.2.4 Modifying the ECM model

This study augments additional variables to the conventional price discovery model in order to recognize the effects of financial market development, and to specify a more efficient model fit the whole time period.

In order to pursue this issue, earlier studies investigating the effects of financial market development on the volatility of prices and returns are examined. It is stated in the literature that it not only has a direct effect on the prices, but also it is a mediator to transfer the macroeconomic conditions to the price.

Furthermore, considering measures of financial market development assists achieving an enhanced insight about the relationship between spot and futures prices and provides an opportunity to evaluate its own effects on the market behavior. This study uses liquidity as the proxy of futures market development measured by futures daily volume and open interest. It is believed that it captures the both size and importance of stock market as well as the activity of the market. This modification is inspired by Theissen (2012).

The correlation of basis and liquidity measures, in excess of the typical relationship of liquidity and prices, is an essential concept that shall be investigated in this study.

The long run equilibrium with liquidity measure is:

$$\ln(F_t) = \ln(S_t) + \ln(FD_t) + \varepsilon_t, \tag{5}$$

The alternative specification to consider the effect of liquidity is to perform this modified model with an interaction term as follows:

$$r_t^X = \alpha^X + \lambda r_t^F + \sum_{\tau=1}^{k} \beta_\tau^X r_{t-\tau}^X + \sum_{\tau=1}^{k} \gamma_\tau^X r_{t-\tau}^F + \delta_1^X (p_{t-1}^X - p_{t-1}^F)$$
$$+ \delta_2^X FD_t (p_{t-1}^X - p_{t-1}^F) + \delta_3^X FD_t + \varepsilon_t^X$$

(6)

$$r_t^F = \alpha^F + \lambda r_t^X + \sum_{\tau=1}^{k} \beta_\tau^F r_{t-\tau}^F + \sum_{\tau=1}^{k} \gamma_\tau^F r_{t-\tau}^X + \delta_1^F (p_{t-1}^X - p_{t-1}^F)$$
$$+ \delta_2^F FD_t (p_{t-1}^X - p_{t-1}^F) + \delta_3^F FD_t + \varepsilon_t^X$$

The interaction term is the combination of the other two variables used to construct it, so adding the interaction term may lead to multicollinearity problem. In order to alleviate this problem, the interaction is orthodogonalised using the following two step procedure suggested by Burill (2007). First, the interaction term is regressed on the original variables. Second, the residuals from the first step regression are used to represent the interaction term.

The coefficients δ_2^X and δ_2^F measure whether the adjustment to price deviations is different in more developed financial markets.

3.3 Optimal Hedge Ratio

Having examined the price discovery in the selected markets as a prerequisite for providing a successful hedging, the methods of calculating the hedge ratio would be evaluated in this section to identify the optimal hedge ratio as the second objective of this study. It is widely believed that if futures market plays its informational role by providing accurate prediction of future prices, investors would be capable to hedge the risk that is the main objective of introducing the futures market. Otherwise, when the prices are not discovered precisely, the futures market may lose its efficiency as a hedging instrument and convert merely to a speculative environment.

The hedging role of futures particularly on the formulation and the implementation of an optimal hedge strategy has been recently the focal aim of many researchers. Various developments have been offered in the theoretical and empirical aspects to improve the effectiveness of hedging with futures contracts during the last years.

In this section, the alternative methods available for calculating the hedge ratio are discussed in order to find out the finest strategies suitable for our context. The discussion about measurements of the hedging effectiveness is left for the next section.

An optimal hedge strategy is theoretically based on the expected utility maximization and the minimum variance paradigms. While the latter might be considered as a simplification of the former paradigm, it has been used in a much wider extent traditionally. To the best knowledge of the author, as more statistical properties of financial time series explored, the more developments in econometrics literature introduced, and more practitioners started employing sophisticated hedging strategies.

The next session which is allocated to discuss about hedging effectiveness shall further explore this advancements.

At the empirical level, futures hedging benefits from the developments in the estimation techniques. Many studies investigate different ideas to improve the estimation of the optimal hedge ratio.

To classify these methods, the timing of their introduction and succeeding alterations are followed. Therefore, the minor modifications and adoptions are ignored to provide a humble path indicating the preceding generations of hedge ratio optimization.

Introducing the hedging concept, the very first method was to consider the hedge ratio of one, to be called Naïve. To initiate the classical regression method, a modest time-invariant hedge ratio is employed. The principal estimation technique, OLS, still obtains support in many empirical and theoretical studies as the estimation method that outperforms advanced estimations. As the next step, the literature on cointegration suggested that futures and spot prices are cointegrated and so we can achieve enhanced estimates by exploring this relationship. The conditional volatility literature then introduced numerous univariate and multivariate models that capture the time-varying variance and covariance of the time series.

This study examines a particular technique from each generation. The performance of the technique based on the former theoretical and empirical studies would be the criteria for selecting the technique. In the following sections, the theoretical background and model specification of the estimation techniques including Naïve, conventional OLS, cointegration approach and GARCH hedge ratios as well as VECM hedge ratio with structural breaks are studied.

3.3.1 Conventional Hedging Framework

Traditional wisdom suggests that for hedging a unit of a spot position a unit of the opposite position in the futures market should be adopted. Accordingly, the optimal hedge ratio, which is the amount of the futures position divided by the amount of the spot position, is one for both long (long in futures and short in spot) and short (short in futures and long in spot) hedgers. This hedging strategy, called Naïve, is incorporated into the Commodity Futures Trading Commissions (CFTC) guidelines that define a bona fide hedger as a hedger who has equal but opposite spot and futures positions.

Subsequent to this preliminary method, the regression methods to estimate the hedge ratio are widely offered claiming that the optimal hedge ratio aiming to reduce the risk or maximize the utility is not necessary equal to one. While there are lots of debates about the precise method of calculating the optimal hedge ratio, the conventional approach mainly use a simple bivariate regression to find out how spot and futures prices interact. With a fleeting review on the analytical framework, this section focuses on the practical aspects of this conventional approach.

The Analytical Framework

Hedging decisions are illustrated with a one-period model. At the beginning of the period, that is $t = 0$, an individual is committed to a given spot position, Q, on a specific asset.[8] A futures market with different maturities is available for the security. The individual may choose to go short in the futures market to reduce the risk exposure. Regarding the liquidity, it is assumed that he trades only in the "nearby" futures contract (it is the contract that the maturity of which is closest to the current date). The individual becomes a short hedger with the futures trading. Let X denotes the futures position. At the end of the period, say, $t = 1$, the hedger's return, r, is calculated as follows:

$$r = (r_p Q - r_f X)/Q, \tag{7}$$

where r_p is the return of the spot position and r_f is the return of the futures position.[9] As both spot and futures returns are unknown at $t = 0$, r is a random variable. To minimize the risk or uncertainty associated with the random return, the hedger will choose X.

In the finance literature, to measure the risk of a random variable usually the variance (or standard deviation) conditional on the available information is used. Let Φ denotes the information set at $t = 0$. Then the hedger's risk is summarized by the conditional variance of r, $Var(r|\Phi)$. From equation (7),

$$Var(r|\Phi) = [Var(r_p|\Phi)Q^2 - 2Cov(r_p, r_f|\Phi)XQ + Var(r_f|\Phi)X^2]/Q^2. \tag{8}$$

[8] The assumption that the spot position is fixed will be maintained throughout this study. For the case where the spot position is uncertain see Rolfo (1980), Honda (1983), Paroush and Wolf (1986) and Lapan et al. (1991).

[9] Except for the initial margin and subsequent margin calls, no investment is required for a futures position. Thus, the term return of the futures position should not be interpreted in the conventional sense. Notwithstanding this difficulty; however, we shall continue to use this term for convenience.

The optimal futures position X^* is chosen to minimize $Var(r|\Phi)$. Thus,

$$X^* = [Cov(r_p, r_f|\Phi)/Var(r_f|\Phi)]Q = hQ, \tag{9}$$

where $h = Cov(r_p, r_f\ |\Phi)/Var(r_f\ |\Phi)$ is the minimum-variance hedge ratio.

A more general approach to the hedging problem relies upon the expected-utility framework. Suppose that the hedger is endowed with a von-Neumann Morgenstern utility function $U(.)$ such that $U`(.) > 0$ and $U``(.) < 0$. Let $E\{.\}$ denotes the expectation operator with respect to the joint distribution of r_p and r_f. The optimal futures position, X^e, is selected to maximize the (conditional) expected utility $E\{U(r|\Phi)\}$. That is, X_e must satisfy the following condition:

$$E\left\{U'\left(\frac{r_pQ - r_fX^e}{Q}\right)\frac{r_f}{Q}\middle|\Phi\right\} = 0, \tag{10}$$

or alternatively,

$$Cov\left\{U'\left(\frac{r_pQ - r_fX^e}{Q}\right), \frac{r_f}{Q}\middle|\Phi\right\} + E\left\{U'\left(\frac{r_pQ - r_fX^e}{Q}\right)\middle|\Phi\right\}E\left\{\frac{r_f}{Q}\middle|\Phi\right\} = 0. \tag{11}$$

Assume that $r_p = \alpha(\Phi) + \beta(\Phi)r_f + \epsilon$, where r_f and ϵ are stochastically independent.[10]

Now suppose that $E\{r_f\ |\Phi\} = 0$ (which means the futures price is unbiased), the above equation leads to $X^e = \beta(\Phi)Q$, which is in turn equal to $Cov(r_p, r_f\ |\Phi)Q/Var(r_f\ |\Phi)$. Therefore, the optimal hedge ratio, defined by X^e/Q and derived from a

[10] This assumption is satisfied when r_p and r_f are jointly normally distributed conditional on the information set Φ.

general utility function, is equal to the minimum-variance hedge ratio. This result was first discussed in Benninga, Eldor and Zilcha (1983) and later extended by Lence (1995) and Rao (2000). Furthermore, Lien (2000a) validated the result under Knightian uncertainty.

If the futures price is biased as $E\{r_f|\Phi\} \neq 0$ (due to transaction cost, for example), the optimal hedge ratio diverges from the minimum-variance hedge ratio. In this case, however, there is a speculative motivation to trade for the purpose of taking advantage of the bias in the futures market. Consequently, X^e contains both hedging and speculative components. The hedging component is characterized by the condition $E\{r_f|\Phi\} = 0$. So, the hedging component of the optimal futures position is equal to the minimum variance futures position. Assuming a mean-variance utility function given by $E\{r|\Phi\} - (A/2)Var(r|\Phi)$ for the hedger where $(A/2)$ is the Arrow-Pratt risk aversion coefficient, the optimal futures position X^* is $E\{-r_f|\Phi\}/A + [Cov(r_p, r_f|\Phi)/Var(r_f|\Phi)]Q$. The first component, in the above formula, represents the speculative trading whereas the second is the usual optimal hedge position.

It is important to note that in the above derivation the information set Φ includes both minimum-variance and optimal hedge ratios. In this sense, as Φ changes consequently both hedge ratios change. The historical spot and futures returns, the contract maturity, and the hedge horizon are functions of typical information sets. It can be seen from this derivation that as the spot and futures return distributions depend on the information variables, both optimal hedge and minimum-variance hedge strategies depend on the time-varying hedge ratios.

In the next section, estimating the minimum-variance hedge ratio in the conventional framework is discussed.

Estimating Hedge Ratio by Regression

To estimate the minimum-variance hedge ratio, a conventional method involves estimating the following linear regression model:

$$r_{pt} = \alpha + \beta r_{ft} + \varepsilon_t, \tag{12}$$

where r_{pt} and r_{ft} are the spot and futures returns for period t. The ordinary least squares (OLS) estimator of β provides an estimate for the minimum-variance hedge ratio.

However, it is proved in a large number of theoretical and empirical papers that OLS outperforms the advanced time varying hedge ratios (among all see Lien, 2009), there is still a major concern about it. The OLS hedge ratio is dependent on the unconditional second moments, whereas the (true) minimum-variance hedge ratio is based on conditional one. Based on Bell and Krasker (1986), the correct regression model should allow the regression coefficients to be functions of the information available, that is,

$$r_{pt} = \alpha(\Phi) + \beta(\Phi) r_{ft} + \varepsilon_t. \tag{13}$$

Suppose the similarity between the above equation and the pre-condition for the minimum variance hedge ratio to be optimal.[11] Unfortunately, the functional forms of

[11] The information set Φ here includes information up to but not including t.

$\alpha(\Phi)$ and $\beta(\Phi)$ are unknown in empirical works and researchers have to decide on the model specification. This method has been used by Cita and Lien (1992) to the wheat futures market allowing both the intercept and the slope to be linear functions of the historical spot and futures returns. They suggest that the conventional method is outperformed by the modified regression model in describing the spot price behavior. Their specification suggests the minimum-variance hedge ratio as a function of the conditioning information, and therefore is time-varying. Upon allowing the intercept to be a linear function of the conditioning information variables while retaining a constant slope (adopting above statement to consider intercept as a liner function of conditioning information variables while retaining a constant slope), Myers and Thompson (1989) present a generalized hedge ratio through a regression model with a large number of lagged price changes as information variables.

Specifically, they describe the spot and futures returns by the following equations:

$$r_{pt} = Z_t'\theta_p + \varepsilon_{pt}, \tag{14}$$

$$r_{ft} = Z_t'\theta_f + \varepsilon_{ft}, \tag{15}$$

where Z_t is a (column) vector of (exogenous) information variables. Then the minimum variance hedge ratio can be calculated as an estimate of β from the following regression:

$$r_{pt} = \beta r_{ft} + Z_t'\theta_p + \varepsilon_{pt}, \tag{16}$$

Based on Myers and Thompson (1989) Z_t should consist of a large number of lagged spot and futures returns.

The equation (12) is still preferred in this study as its model specification has been extensively applied in the literature, and it is a common technique among ordinary practitioners. Among the empirical studies, Kroner and Sultan (1993) and Lien (2005a, b) are two of many studies that indicate the simple OLS hedge ratio outperforms all other constant hedge strategies in both within sample and out of sample. It is also proven by Lien (2009) that the OLS provides the best performance –even compare to the advanced GARCH methods-, specifically for large sample cases, by means of a precise mathematical derivation.

3.3.2 The Cointegration Approach

Fama and French (1987), Castelino (1992) and Viswanath (1993) argue that the basis reflects the cash-futures price convergence and also an important information variable, so it should be included in the hedge ratio estimation. Their approach is entirely justified by the recent statistical findings in the cointegration literature. Specifically, it is now well known that spot and futures price series typically contain a unit root. Thus, random-walk type of price behavior is prevalent. The unit-root property leads to the possible existence of a cointegration relationship (Engle and Granger, 1987). In spite of some skepticism (such as Quan, 1992 and Brenner and Kroner, 1995), the cointegration relationship plays an important role in the statistical modeling of many spot and futures prices (Lien and Luo, 1993, Ghosh, 1993, Wahab and Lashgari, 1993 and Tse, 1995).

Let Δ denote the difference operator such that $\Delta p_t = p_t - p_{t-1}$ and $\Delta f_t = f_t - f_{t-1}$. Thus, Δp_t and Δf_t are, respectively, the continuously compounded return (or log return) of the spot and futures.[12] Suppose that both (logarithmic) price series contain a unit root and are, furthermore, cointegrated. Then the Engle-Granger specification for an error-correction (EC) model is:

$$\Delta p_t = \alpha_p + \sum_{i=1}^{m} \beta_{pi} \Delta p_{t-i} + \sum_{j=0}^{n} \gamma_{pj} \Delta f_{t-j} + \theta_p z_{t-1} + \varepsilon_{pt}, \quad (17)$$

$$\Delta f_t = \alpha_f + \sum_{i=0}^{m'} \beta_{fi} \Delta p_{t-i} + \sum_{j=1}^{n'} \gamma_{fj} \Delta f_{t-j} + \theta_f z_{t-1} + \varepsilon_{ft}, \quad (18)$$

where z_t is a stationary linear combination of p_t and f_t. The Engle-Granger representation specifies that at least one of θ_p or θ_f is nonzero. In many empirical studies, it is found that z_t can be well approximated by the basis, $f_t - p_t$.

On the other hand, based on no-arbitrage principle there is a cost-of-carry relationship between the spot and futures prices depending on the time to maturity. Thus, z_t should assume the following form: $z_t = f_t - p_t - k\tau_t$, where k is the per-period cost of carry, according to Garbade and Silber (1983). The cost-of-carry is problematic since not only each futures contract is usually active for only three months but also the price series during the delivery month tend to be noisy and unreliable. A futures price series corresponding to "nearby" contract is often constructed to make a long time series for a meaningful time-series study. The differences in the time to maturity across data points in the "nearby" futures price series are rather small (usually ranging from two or three weeks to less than four months). Thus, the data set cannot usually identify the time-varying nature of the cointegration relationship. Hence the cost of carry can be omitted (Tse, 1995).

[12] See Campbell, Lo, and MacKinlay (1997) for the full terminology.

Rewriting the equation (17), this study applies cointegration approach by applying the following specification:

$$\Delta p_t = \alpha_p + \lambda \Delta f_t + \sum_{i=1}^{m} \beta_{pi} \Delta p_{t-i} + \sum_{j=1}^{n} \gamma_{pj} \Delta f_{t-j} + \theta_p z_{t-1} + \varepsilon_{pt}, \qquad (19)$$

The OLS estimate of λ is the estimated minimum-variance hedge ratio. Lien and Luo (1993), Ghosh (1993) and Wahab and Lashgari (1993) all demonstrate the superior hedging performance when the hedge ratio was estimated taking the cointegration relationship into account. Lien (1996) provides a theoretical analysis to characterize the effects of the cointegration relationship on the minimum-variance hedge ratio and the hedging effectiveness.

3.3.3 Time Varying Hedge Ratio

The above sections assume that the hedge ratio is constant over time. With the recent developments in econometrics literature, considering a time varying hedge ratio is quiet common. There are numerous studies that concentrate on hedging performance of dynamic hedging strategies as it obtains a theoretical support.

The minimum variance hedge ratio depends on the conditional second moments of the spot and futures returns. Thus, when the conditional moments vary over time so does the hedge ratio. Recent empirical works strongly support that time-varying volatility prevails in many economic and financial time series; however, many studies challenge this inference indicating that the time varying strategies would result in a same hedging performance except in specific conditions such as structural breaks (see Imad Moosa, 2003, for empirical evidence, and lien et al., 2012, for theoretical approach).

Most researchers adopt and apply the bivariate Generalized Autoregressive Conditional Heteroscedasticity (GARCH) framework as a widely recognized model in examining the behavior of the spot and futures prices as well as scheming the dynamic hedge strategy (Baillie and Myers, 1991, Myers, 1991, Lien and Luo, 1994, Bera, Garcia and Roh, 1997, and Pirrong, 1997).

Consider the error-correction model described by equations (17) and (18). Let σ_{pt}^2 denotes $Var(\varepsilon_{pt})$, σ_{ft}^2 denotes $Var(\varepsilon_{ft})$, and σ_{pft}^2 denotes $Cov(\varepsilon_{pt}, \varepsilon_{ft})$. The general VECH-GARCH model suggested by Bollerslev, Engle and Wooldridge (1988) consists of the following conditional second moment equation:[13]

$$\begin{bmatrix} \sigma_{pt}^2 \\ \sigma_{pft} \\ \sigma_{ft}^2 \end{bmatrix} = A + \sum_{j=1}^{m} B_j \begin{bmatrix} \sigma_{p,t-j}^2 \\ \sigma_{pf,t-j} \\ \sigma_{f,t-j}^2 \end{bmatrix} + \sum_{k=1}^{n} C_k \begin{bmatrix} \varepsilon_{p,t-k}^2 \\ \varepsilon_{p,t-k}\varepsilon_{f,t-k} \\ \varepsilon_{f,t-k}^2 \end{bmatrix}, \qquad (20)$$

where A is a 3×1 column vector, and B_j and C_k are 3×3 matrices. The model contains $3 + 9m + 9n$ parameters that renders some estimation problems. To achieve parsimony, a diagonal version is considered. This model assumes that all B_j and C_k matrices are diagonal. In other words, the conditional variance of the spot returns is affected by its own history and the history of the squared innovations in the spot returns. Similar structures apply to the conditional variance of the futures returns and the conditional covariance between the spot and futures returns. In general, the VECH-GARCH model (or the diagonal version) fails to ensure the conditional variance covariance matrix of the spot and futures returns to be positive semi-definite. Indeed,

[13] Note the GARCH models assume that the conditional variance and covariance depend only on the past conditional second moments and residuals. Extraneous information is ignored. The conditional moments can be specified more generally using transfer function models as described in Chiang and Chiang (1996).

Lien and Luo (1994) apply the model to the foreign currency markets and find in their empirical estimation that the positive semi-definiteness condition failed frequently. To overcome this difficulty, Engle and Kroner (1995) suggest using the so-called BEKK specification (named after Baba, Engle, Kraft and Kroner). Bera, Garcia and Roh (1997); however, show that this specification does not produce hedging performance better than the OLS hedge ratios.

The constant-correlation GARCH (CC-GARCH) model suggested by Bollerslev (1990) is an alternative specification to resolve the problem of a possible non-positive semi-definite conditional variance-covariance matrix. In this model the conditional second moment equations are specified as follows:

$$\sigma_{pt}^2 = \gamma_p + \sum_{j=1}^{m} \alpha_{pj}\, \sigma_{p,t-j}^2 + \sum_{k=1}^{n} \beta_{pk}\, \varepsilon_{p,t-k}^2 \,, \tag{21}$$

$$\sigma_{ft}^2 = \gamma_f + \sum_{j=1}^{m'} \alpha_{fj}\, \sigma_{f,t-j}^2 + \sum_{k=1}^{n'} \beta_{fk}\, \varepsilon_{f,t-k}^2 \,, \tag{22}$$

$$\sigma_{pft} = \rho \sigma_{pt} \sigma_{ft} \,. \tag{23}$$

Note that equations (21) and (22) maintain the assumptions of a diagonal GARCH model, while equation (23) states that the conditional correlation coefficient between the spot and futures returns, ρ, is time invariant. Thus, a CC-GARCH model imposes restrictions on the general vector GARCH (VGARCH) model to achieve parameter parsimony while maintaining the positive semi-definiteness property. Kroner and Sultan (1993), Park and Switzer (1995), and Lien, Tse, and Tsui (2002) apply CC-GARCH model to obtain the minimum-variance hedge ratios of a variety of commodity, financial, and currency markets. The results still indicate that conventional hedge strategies perform as well as or better than these modified strategies.

Combining the advantages of error correction method and autoregressive conditional heteroskedasticity (ARCH) effects into the model, Kroner and Sultan (1993) is the most well-known study that utilizes a bivariate VECM with a GARCH error structure in calculating the hedge ratio in relation to the hedging of different currencies with futures contracts. In more recent studies, Yang and Allen (2004), Kenourgios et al. (2008) and Maekawa and Setiawan (2014) employ the VECM-GARCH model in estimating hedge ratios with regards to the hedging of the Australia all ordinary stock index in, the S&P 500 stock index, and the S&P 500 and Nikkei 225, respectively.

Having examined typical MGARCH methods, a VECM-GARCH model using BEKK specification is adopted and utilized in this study. Two goals are considered in the selection of this method. First, it is important to select a method which would be able to represent the advancements in GARCH models to make us able to compare these purported improvements with conventional hedging framework. Second, it is aimed to consider the interrelationship of price discovery and hedging effectiveness. Besides, the stated equality in performance of time-varying hedging strategies shall be a support for this decision.

The model that captures time varying second moment effects in the joint distribution of spot and futures returns, in order to estimate the optimal hedge ratio, is the GARCH(1,1) specification as follows:

$$y_t = \mu + \alpha EC + V\beta + \varepsilon_t;\ \varepsilon_t|\Omega_{t-1} \sim N(0, H_t) \tag{24}$$

where $y_t = (r_s, r_f)'$ is a vector of observations of the spot and futures rates of returns, μ, α and β are column vectors of parameters, *EC* is the error correction term from any cointegrating relationship that may exist between the two rates of returns, *V* is a row vector of lagged values of y_t, and $\varepsilon_t = (\varepsilon_s, \varepsilon_f)$ is a vector of residuals.

The bivariate GARCH(1,1) model is represented as:

$$H_t = CC' + A\varepsilon_{t-1}\varepsilon'_{t-1}A' + BH_{t-1}B' \tag{24a}$$

where *C*, *A* and *B* are 2×2 symmetric parameter metrics. The conditional variance covariance matrix H_t is estimated recursively from equation (24) and must be positive definite matrix for all possible evaluations of $\varepsilon_{i,t-1}$. In addition, the GARCH process must be stationary.

The optimal time varying hedge ratio can be expressed as:

$$h_t = \frac{\widehat{H}_{12,t}}{\widehat{H}_{22,t}} \tag{25}$$

where $\widehat{H}_{12,t}$ is the estimated conditional variance between the cash and futures returns and $\widehat{H}_{22,t}$ the estimated conditional variance of the futures returns from the utilized GARCH model. Given that the conditional second moment is time varying, the optimal hedge ratio is time-dependent.

Various parameterizations of the multivariate GARCH process have been proposed.

The popular BEKK representation would be adopted and followed to ensure that the variance covariance matrix is positive definite, by defining C to be lower triangular, so that it is of full rank.

3.3.4 Hedge Ratio with Structural Breaks

Asia Pacific emerging markets experienced some crisis periods that changed the behavior of the markets ranging from private investment strategies to government policies and regulations such as exchange rate regime changes, prohibiting the short selling, and changing the accounting standards. Hence it is stated in literature that the Asian financial crisis and the following capital control regulations might cause structural breaks (Pok et al., 2009); however, there is no theoretical explanation verifying that the these markets experienced such structural breaks either during the Asian financial crisis of 1998 or the global financial crisis of 2008.

In fact, no significant trading limit on either mutual funds or other institutions, change on trading systems, trading style, or restrictions on foreign investment is recorded that convince scholars on occurrence of substantial changes in the microstructure of these stock markets. Thus far, it is beneficial to empirically examine if there is any structural breaks in the prices. With this inference, the modified model that allows for unknown structural breaks is established to capture the effects of such changes.

Moreover, the earlier empirical and theoretical studies that indicate that the only methods that may outperforms the traditional OLS are those which allow for the structural breaks (Lien, 2003 and 2010c), in excess of studies that stated the probable structural breaks following the Asian financial crisis and the new capital control regulations, greatly incentivize considering this hypothesis.

This study employs two different methods to investigate one and two unknown structural breaks. Examining the single break, Zeileis et al. (2003) introduce a method using the generalized fluctuation test and the F test (Chow test) frameworks to find out one unknown structural break. It includes methods to fit and test fluctuation processes (e.g. recursive/moving estimates) and F statistics. While testing one structural break is common in the finance literature, the extended approach of Hatemi-J and Roca (2010) considers up to two unknown structural breaks based on the cointegration concept.

The standard model specification with a linear regression is employed in the case of one break. Illustrating the novel model of two unknown structural breaks, the following regression model is used to calculate the optimal hedge ratio:

$$S_t = \alpha_0 + \alpha_1 D_{1t} + \alpha_2 D_{2t} + \beta_0 F_t + \beta_1 D_{1t} F_t + \beta_2 D_{2t} F_t + u_t \qquad (26)$$

where S_t is the spot returns and F_t is the futures returns. The indicator variables to take the effect of potential breaks into account are denoted by D_{1t} and D_{2t} which are defined in the following form:

$$D_{1t} = \begin{cases} 0 \; if \; t \leq [n\tau_1] \\ 1 \; if \; t > [n\tau_1] \end{cases} \text{ and } D_{2t} = \begin{cases} 0 \; if \; t \leq [n\tau_2] \\ 1 \; if \; t > [n\tau_2] \end{cases} \qquad (27)$$

The timing of structural change is indicated by the unknown parameters $\tau_1 \in (0,1)$ and $\tau_2 \in (0,1)$ and *n* which is the number of observations.

The parameter β_0 is representing the initial optimal hedge ratio, while β_1 signifies the change in the optimal hedge ratio during the first break and β_2 shows its change through the second break.

Three cointegration tests are used. One of these is the ADF test which is a t-test for the slope of $\hat{u}_{t-1}$ in a regression of $\Delta\hat{u}_t$ on $\hat{u}_{t-1}$, $\Delta\hat{u}_{t-1}$, …, $\Delta\hat{u}_{t-k}$, where $\hat{u}_t$ is the residual term from the standard regression specified in Equation (27). The other two tests are based on the Z_α and Z_t test statistics, originally developed by Phillips (1997). The detail of the method and the model is also well documented in Hatemi (2008) and Hatemi and Roca (2010).

The estimations in this study is conducted using R software application, applying the existing strucchange package for the case of one break, and following procedure similar to the one produced by Hatemi-J (2009) for the case of two breaks.

The beauty of this approach is while the significant changes in the optimal hedge ratio will be reflected, investors would be able to ignore the costly frequent rebalancing of the hedging strategy.

3.4 Hedging Performance

Evaluating the performance of hedging is one the most critical points in the hedging activities since it is the base of developing optimized hedge ratio strategies. It also affects the practitioners who are in need of modifying their strategies. So it is essential to select a proper measurement.

In theory, the recent debate is more on the basic concept of hedging performance. While the traditional approach is to minimize risk –as hedging is a risk management tool, many researchers argue that it is required to capture the returns as well. Therefore, one typical measure of hedging performance is through the mean-variance framework or the investor's utility maximisation function. The investor's utility maximisation function is calculated by comparing the hedged portfolio mean return with the variance attained for each investment strategy, taking into consideration the level of risk aversion of the investors.

Gagnon, Lypny and McCurdy (1998) lay out the utility maximisation of each investor as follows:

$$\max_{h} = \{E(RH_t|\Omega_{t-1}) - 1/2\emptyset VAR(RH_t|\Omega_{t-1})\} \qquad (29)$$

where RH_t is equal to the return of the hedging portfolio, Ω_{t-1} defines the surrounding information at period *t–1*; $\emptyset$ is the risk tolerance considered by investors, and $VAR(RH_t)$ represents the variance of hedging portfolio. A similar measurement is reported by Yang and Allen (2004) applied in the Australian stock index futures. The main drawback of this measure is comparing the risk and return which is subjective and it is hard to draw a conclusion that covers all the market participants.

While the risk reduction approach is extensively acknowledged and applied, with the advancement of available techniques, some studies discuss about the significance of manipulating the downside risk. It is due to the fact that a return lower than a certain amount offers risk, while an unexpected higher return is undoubtedly welcome in practice. SemiVariance, LPM, VaR, and CVaR are tail specific measures introduced to fulfill this conception.

This study applies the traditional risk reduction measure which compares the basis risk that the hedgers expect to assume with the price risk they expect to eliminate. The smaller the anticipated basis risk is compared to the anticipated price risk, the more effective is the hedge. This measure of effectiveness can be stated formally as:

$$HE = 1 - \frac{Var(B)}{Var(P_S)} = 1 - \frac{\sigma_B^2}{\sigma_{P_S}^2} \qquad (28)$$

where B is basis and PS is the spot price. In the second expression, σ_B^2 represents the variance of hedged portfolio and $\sigma_{P_s}^2$ represents the variance of unhedged portfolio. Therefore, the closer *HE* is to 1, the more effective is the hedge[14].

Johnson (1960) and Ederington (1979) are the first researchers who develop this Minimum Variance framework as the measure of hedging effectiveness, called Ederington Hedging Effectiveness (EHE). It is argued that since variance of prices is considered as the measure of risk in finance, the less variance indicates the less risk and so the more effective hedge.[15]

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[14] Note that hedging effectiveness, HE, is selected as opposed to efficiency due to its scientific definition. Efficiency refers to doing things to get the maximum output with minimum resources. Effectiveness, on the other hand, refers to doing the right things. It constantly measures if the actual output meets the desired output, as we mean in the hedging practices. Efficiency of a hedge is considered as the degree of risk reduction provided by a hedge relative to the cost of the hedge, measured with the aid of the correlation between the spot price of the cash position to be hedged and the price of the hedging instrument, where a hedge is effective if a given level of the mark-to-market derivative volatility will be offset in the profit and loss account.

[15] Some studies use the regression R^2 to compare the performance of hedging. It is proven by Lien (2005) that this is not an adequate and proper measurement.

A main attraction of the minimum-variance hedge strategy is that, under certain conditions, it is consistent with the expected-utility paradigm regardless of the utility function chosen. Such as the case if (i) the hedger is not allowed to borrow or lend, (ii) there are no transaction costs i.e. trading fees and margin accounts, and (iii) current futures prices are unbiased for future futures prices.

Beside the theoretical and empirical background, the common use of this measure in the emerging markets is a support for this selection.

3.5 Price Discovery and Hedging Effectiveness

It is traditionally accepted that the cointegration of spot and futures markets leads to a more accurate price discovery, and it affects the hedging performance. In the developed markets, the dominant condition is spot and futures prices are cointegrated. However, it might not be the case for the emerging markets due to the lack of structures and mechanisms to reduce the volatility such as established instruments and information centers.

For a hedge to be attractive, the basis risk –defined as the variance of the differences between the spot and futures prices- should be significantly less than the hedger's cash price risk. In other words, it is not only the unique information provided by the futures market but also the basis that affects the hedging effectiveness. Fama and French (1987) argue that the basis has predictive power for the spot returns. Their approach is adopted by Viswanath (1993) using a different rationale. Specifically, it is stated that the spot returns would adjust to the basis because of the convergence between the spot and futures prices at the maturity date.

While some studies state the effect of considering the cointegration terms in the hedging model specification (Moosa, 2003, and Ederington and Salas, 2008 for empirical evidence and Alexander, 1999 and lien, 2004 and 2009 for theoretical approach)[16], no study evaluates this effect exclusively and for the whole market instead of considering an investor or a hedging strategy.

This study offers a novel approach to investigate the effects of providing a more accurate price through the higher contribution of futures markets on the effectiveness of hedging. The following steps are designed to achieve this objective.

3.5.1 Estimations to Calculate Quarterly CFW and HE

The available daily spot and futures returns over the whole sample of each index is categorized into several series based on the quarters every year in order to construct the quarterly CFW and HE. Thus, for each year we made 4 series i.e. 60 series for a 15 years period. The quarterly CFW, as the contribution of futures market in each quarter, is then calculated. The VECM method is applied to each quarter series and the coefficient of basis is employed to obtain the CFW.

On the other hand, the superior method of calculating the hedge ratio is employed to calculate the optimal hedge ratio in each quarter, using the same VECM regression, based on the result of investigating various techniques in the second objective. Considering the limited observations of each quarter, there is no significant advantage to use hedge ratios with structural breaks. Therefore, the cointegration approach shall

[16] to see more empirical studies, refer to Park and Switzer (1995), Koutmos and Pericli (1998), Lien and TSE (1999) and Sim and Zurbruegg (2001).

be the choice. Furthermore, Ederington measure is utilized to calculate the hedging effectiveness in each quarter.

The optimal lag lengths selected for the estimations in all the quarters of each index is set to be the same as the optimal lag length for the whole sample. It is basically to maintain the consistency as well as the simplicity. The obtained CFW and HE of each index are sorted in two series so the interrelationship between the two can be investigated.

3.5.2 Investigating the relationship of price discovery and HE

To achieve the ultimate goal of this study that is examining how the interrelationship between spot and futures prices affects the effectiveness of hedging in designated markets, the quarterly CFW and HE in different markets and instruments shall be compared.

First of all, the stationarity characteristics of the two series of CFW and HE are examined using augmented Dickey-Fuller test, the Phillips-Perron test, and the KPSS test. Moreover, the series associated with each index are tested for cointegration. The Johansen cointegration test is applied. Regressing HE on CFW by fitting the data in a simple OLS estimator shall provide us with more information to investigate their relationship. The optimal lag lengths is determined utilizing SIC and stepwise approach. To conclude, a causality test is required to pattern the bidirectional effects of price discovery and hedging effectiveness.

3.6 Description of Data

The historical data covers the spot and futures daily closing prices of Malaysia's Kuala Lumpur Composite Index, Singapore's Straits Times Index, Japan's NIKKEI 225 Index traded in Singapore exchange, and South Korea's KOSPI 200 Index.[17] All available contract months of each index from the inception of the futures index to 19 March 2013 are used to construct the futures continuous contract for the next month, next quarter month, next two quarter month, and next three quarter month maturity. Using the whole sample provide the capability to analyse the historical price movement over various crisis and recession periods such as Asian financial crisis in 1997-98, the early 2000s crisis and the global financial crisis of 2007-08. This improves the accuracy and precision of the estimations.

The spot and futures are converted to logarithmic form so their first order differences can be observed as stock market return of the respective index, except for the basis which is the difference between original futures and spot price at each period.

Daily closing prices for all contracts are obtained from Commodity Research Bureau (CRB) database which maintains the daily data published by the related exchange. The required liquidity data, measured by daily volume and open interest, is attained from datastream database.

[17] The daily closing price for index futures is determined by the clearing house and indicates the value of the futures with which all open positions are marked to market daily. Daily closing price and the last trading price are almost similar and a small variation is assumed not to affect the results.

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 Introduction

Exploring the theoretical and practical aspects of price discovery and hedging in the futures markets in the preceding chapters, an approach is planned to investigate the relationship between spot and futures prices, identify the optimal hedge ratio, and evaluate the interrelationship between accurate price discovery and hedging effectiveness. The empirical result of the study is presented and discussed accordingly.

This chapter is divided into five sections following the introduction. To ease the understanding of the results, the sections are structured according to the objectives of this study. Therefore, section 4.2, starting with a review on the data set and the data preparation procedure, presents the results of unit root and cointegration tests required to run a non-spurious error correction model. The model is estimated to investigate the relationship between spot and futures prices. The CFW for each model is then calculated. The last sub-section tries to search for possible effect of higher liquidity in different markets. The impact of considering volume and open interest in the regressions is evaluated, in line with the literature.

Section 4.3 lists the results related to the calculation of the 5 designated alternative static and dynamic methods for calculating the optimal hedge ratio. The hedging effectiveness of each ratio is then calculated in Section 4.4. Comparisons are provided in order to select the finest method. Section 4.5 exhibits the results of the last hypothesis i.e. whether an accurate price discovery through greater contribution of futures market increases the hedging effectiveness. To this end, the first sub-section explains how the whole sample is divided into several series according to different quarters. Subsequently, the CFW and HE are calculated for each quarter, and the empirical results of investigating the last hypothesis are offered.

All the tests are conducted for 15 series of spot and futures prices, covering the next month, next quarter month, next two quarter month, and next three quarter month of each index. Each section ends with a discussion on the findings. At the final section, the conclusions from the statistical analysis's findings are represented.

4.2 Price discovery

4.2.1 The Data

The section begins with a revision of the data, following by its preparation details. This study focuses on price discovery and hedging in the three Asia Pacific Emerging Markets starting from the inception of each futures market to March 2013. The historical data covers the spot and futures daily closing prices for all available contract months. Malaysia's Kuala Lumpur Composite Index, KL, Singapore's Straits Times Index, TI, Japan's NIKKEI 225 Index traded in Singapore exchange, NX, and South Korea's KOSPI 200 Index, KS, are utilised. The above mentioned data is then combined with the associated volume and open interest data.

The spot price, volume and open interest can be obtained as continuous time series, but the futures prices are shorter time series that last only during the life-span of the associated contract. In fact, futures markets are comprised of individual contracts, each with a pre-determined life-span. At any stage, the market consists of a number of contracts, or "delivery months", that have expiry dates stretching out into the future. As one contract expires, another is listed for trading, and so the cycle continues. A contract month is the month in which a futures contract expires. Each month is represented by a single letter. The major existing contract months are March, H, June, M, September, U, and December, Z. This means that trading, and therefore price making processes, starts with the inception of each contract and ends when its maturity dates arrived. Therefore, to analyse the historical price movement over multiple contracts we need to build a continuous contract which is a combination of the various delivery months of a contract.

In this regard, we produce the continuous series of each futures index for the next month contract, NMC, next quarter month contract, NQM, next two quarter month contract, N2QM, and next three quarter month contract, N3QM for all the chosen indexes. There are different methods to string the contracts together. The simplest one is carrying on with the next contract once the current contract expires. A second method is to stick to the calendar months. The latter is employed; although, the method should not make any difference in this study. It is due to the fact that the series take account of the data for more than a decade in this research; thus, light differences in a few days every quarter shall not impact the whole estimation. KL index does not have an effective price for the next three quarter month contract, so we ignored N3QM for KL index. All the spot and futures continuous prices are then changed to the log return form.

Regarding the NIKKEI 225 index traded in Singapore exchange, we know that the index launched on 1986. The trading of NIKKEI 225 contracts in Singapore then moved from floor trading to Electronic Trading in the year 2005, thus, there are two indexes in datastream. The Splice function can be used on 1 November 2004: SPLC#(SNACS00,SNECS00,11/1/04) to combine the series; however, the function only combines the two time series with no amendment on the probable variations during the rollover. Hence, the R software application is used to combine the data.

In the last step of data preparation, the missing values and outliers are eliminated. Removing the outliers was not necessary to obtain more accurate result but also because the coefficients of error correction terms were found insignificant before outliers' elimination in many cases. For example, in case of FBM KLCI indexes, the coefficients were estimated at -1.25E-05, -3.08E-05, and -1.93E-05 for NMC, NQM and N2QM, respectively. While the coefficients are similar in values to those after removing outliers, the t-statistics were calculated at -0.53, -1.33, -1.9 which indicate that none of the speed of adjustments were statistically significant. Therefore, the popular criterion (Q1−3IQR, Q3+3IQR), where Q1 is the first quartile, Q3 is the third quartile, and IQR is the inter-quartile range (Q3−Q1) is the base to detect and remove the extreme outliers.

Table 4.1 provides informative descriptive statistics on all produced continuous contracts of the 4 indexes. Statistics are reported for the whole sample. Two features of the data are worth mentioning. First, the number of observations normally decreases in the series with longer time to maturity. It is mainly because of the later introduction of futures contracts with longer horizons. Second, the correlation of all of the futures indexes with the underlying index is over 0.99.

Table 4.1 : Summary statistics – futures continuous series

Index	Series	Obs.	Mean	Std. Dev.	First Day	Last day
STI	NMC	3091	2394.05	651.69	28/06/2000	19/03/2013
STI	NQM	3082	2398.63	650.31	28/06/2000	19/03/2013
STI	N2QM	3046	2408.72	638.22	28/06/2000	19/03/2013
STI	N3QM	3015	2415.20	630.41	28/06/2000	19/03/2013
NIKKEI 225	NMC	3553	13324.84	4708.86	12/02/1987	19/03/2013
NIKKEI 225	NQM	5637	15566.64	5538.77	05/01/1987	19/03/2013
NIKKEI 225	N2QM	5511	15188.81	5191.74	05/01/1987	19/03/2013
NIKKEI 225	N3QM	5174	14530.13	4515.67	17/03/1987	19/03/2013
KOSPI 200	NMC	1081	160.86	69.45	03/02/1998	19/03/2013
KOSPI 200	NQM	3543	157.25	70.88	20/01/1998	19/03/2013
KOSPI 200	N2QM	2701	181.82	63.16	11/03/2002	19/03/2013
KOSPI 200	N3QM	2588	183.96	63.52	11/03/2002	19/03/2013
FKLI	NMC	4017	1033.26	330.12	17/12/1995	19/03/2013
FKLI	NQM	3503	1046.76	331.14	22/01/1996	19/03/2013
FKLI	N2QM	3322	1038.66	340.18	03/08/1998	19/03/2013

Notes: Obs. stands for the number of observations (trading days), and Std. Dev. is the standard deviation of series for the whole sample in each constructed continuous series as stated in the last two columns. The name of series follows this pattern: NMC: next month contract, NQM: next quarter month contract, N2QM: next two quarter month contract, and N3QM: next three quarter month contract.

The descriptive statistics of the spot indexes are presented in Table 4.2. We only report the statistics of the period in which we have used the spot index as one of our futures indexes' underlying asset.

Table 4.2 : Summary statistics –spot indexes

Index	Obs.	Mean	Std. Dev.	Min	Max	First Day Used	Index Inception
STI	3082	2407.34	655.45	1213.82	3875.77	28/06/2000	21/06/2000
NIKKEI 225	5174	14519.76	4428.94	7054.98	29284.00	05/01/1987	31/05/1945
KOSPI 200	3543	156.72	70.50	32.26	295.35	20/01/1998	02/05/1990
FBM KLCI	4017	1033.93	332.63	315.66	1788.43	17/12/1995	03/12/1993

Notes: Obs. stands for number of observations (trading days) in which we have used the spot index as one of our futures indexes' underlying asset, and Std. Dev. is the standard deviation of the same period. All the series are normally distributed.

Table 4.3 : Optimal lag lengths

Underlying Instrument	Series	VAR	OLS
STI	NMC	3	4
STI	NQM	4	4
STI	N2QM	4	4
STI	N3QM	4	4
NIKKEI 225	NMC	2	2
NIKKEI 225	NQM	2	2
NIKKEI 225	N2QM	3	4
NIKKEI 225	N3QM	3	4
KOSPI 200	NMC	3	3
KOSPI 200	NQM	2	4
KOSPI 200	N2QM	3	5
KOSPI 200	N3QM	2	2
FBM KLCI	NMC	1	2
FBM KLCI	NQM	2	5
FBM KLCI	N2QM	3	5

Optimal lag length in VAR is selected using the SIC -12 lags included, while in OLS a stepwise approach is employed.

It should be pointed out that the number of lags determined in simple OLS and VAR models and used in all the related models in order to maintain the consistency. Optimal lag length in VAR is found using the Schwartz Information Criterion (SIC) while in OLS a stepwise approach is employed. The optimal lags in each model are presented in Table 4.3.

4.2.2 Unit Root Test

As required by any cointegration tests, the stochastic structure of the individual variables has to be checked. The financial market's data –either stocks or exchange indexes- are expected to have unit root; nevertheless, most of the empirical studies found that the first differenced series are stationary. The Augmented Dickey Fuller (ADF), Phillips-Perron and the KPSS unit root tests are performed to make sure that robust results will be achieved in the following models.

Table 4.4 : Unit root test

Underlying Instrument	Series	Level		1st Difference	
		ADF τ-stat.	P-Value	ADF τ-stat.	P-Value
STI	SPOT	-0.921795	0.7818	-54.20209	0.0001
STI	NMC	-0.961261	0.7688	-54.74508	0.0001
STI	NQM	-0.980698	0.7621	-54.24493	0.0001
STI	N2QM	-1.048885	0.7376	-31.09571	0.0000
STI	N3QM	-1.116349	0.7115	-54.90153	0.0001
NIKKEI 225	SPOT	-1.934333	0.3166	-74.98652	0.0001
NIKKEI 225	NMC	-2.182480	0.2129	-61.27823	0.0001
NIKKEI 225	NQM	-1.752004	0.4049	-33.27380	0.0000
NIKKEI 225	N2QM	-1.942866	0.3127	-74.75417	0.0001
NIKKEI 225	N3QM	-2.392211	0.1440	-75.12201	0.0001
KOSPI 200	SPOT	-1.131712	0.7053	-53.47899	0.0001
KOSPI 200	NMC	-1.033955	0.7429	-33.98221	0.0000
KOSPI 200	NQM	-1.145450	0.6998	-62.28806	0.0001
KOSPI 200	N2QM	-1.173817	0.6879	-54.07671	0.0001
KOSPI 200	N3QM	-1.111692	0.7134	-54.13733	0.0001
FBM KLCI	SPOT	-0.730725	0.8371	-52.61451	0.0001
FBM KLCI	NMC	-0.264064	0.9277	-64.56201	0.0001
FBM KLCI	NQM	-0.324135	0.9190	-58.06415	0.0001
FBM KLCI	N2QM	-0.857692	0.8018	-59.08773	0.0001

Notes: The ADF τ-statistics is reported when intercept in the test equation is included. The original spot and futures values are utilized for the unit root test. The results indicate the same rejection or acceptance either by using the logarithmic forms or including the trend in the test equation. The 1%, 5% and 10% critical values for the ADF τ-statistics (with intercept) are -3.431433, -2.861903 and -2.567006, respectively.

The daily data of all indexes are converted to logarithmic form, so their first order differences can be regarded as stock market returns of the respective markets. Unit root tests indicate that all the time series are non-stationary at level, in both original and logarithmic forms, but they are stationary at their first difference. The ADF statistic (τ-stat.), as presented in Table 4.4, for data in level indicates the null hypothesis that the series has unit root cannot be rejected at 10 percent significance level or less. Meanwhile, the τ-statistic for the respective series in the first order difference significantly rejects the null hypothesis of unit root at one percent significance level, except in case of TI N3QM which is only marginally significant. Overall, the findings are consistent since the log returns are used in the following regressions.

4.2.3 Bivariate Cointegration Analysis

Cointegration implies that in a long-run relationship between two or more non-stationary variables, it is required that these variables should not move too far apart from each other. Such non-stationary variables might drift apart in the short-run, but in the long-run they are constrained. Thus, cointegration means that one or more linear combinations of these variables is stationary even though they are not individually.

In order to establish that our fitted regression models are not spurious, we carry out cointegration analysis between the log of spot and futures indexes on the assumption that logarithm of both series are I(1) in all cases; however, as remarked in previous section, the TI N3QM is only marginally I(1). We thus investigate the existence of a long-run relationship between each two series using Johansen cointegration test. The result of the tests are reported in Table 4.5. The tests indicate that only SRT N3QM futures series is not cointegrated with its underlying spot indexes using models with intercept only while all test statistics using models with both intercept and trend in the cointegration equation indicate that the spot and futures series are cointegrated at 10% significance level. So the hypothesis of no long-run relationship is clearly rejected. This is a strong support for our expectation that the spot and futures series of one specific index with correlation of 0.99 are cointegrated.

Table 4.5 : Johansen cointegration test

Underlying Instrument	Series	Intercept in CE and VAR		Intercept and trend in CE intercept in VAR	
		Trace stats	No of CE	Trace stats	No of CE
STI	NMC	0.997 (0.317)	r=1	5.195 (0.023) [b]	r=2
STI	NQM	0.938 (0.333	r=1	5.004 (0.025) [b]	r=2
STI	N2QM	0.862 (0.353)	r=1	5.128 (0.024) [b]	r=2
STI	N3QM	0.937 (0.333)	r=0	5.181 (0.023) [b]	r=2
NIKKEI 225	NMC	3.814 (0.051) [c]	r=1	3.655 (0.056) [c]	r=1
NIKKEI 225	NQM	2.617 (0,106)	r=1	7.961 (0.005) [a]	r=2
NIKKEI 225	N2QM	3.129 (0.077) [c]	r=1	7.209 (0.007) [a]	r=2
NIKKEI 225	N3QM	4.556 (0.033) [b]	r=2	7.185 (0.007) [a]	r=2
KOSPI 200	NMC	2.332 (0.127)	r=1	8.887 (0.003) [a]	r=2
KOSPI 200	NQM	2.461 (0.117)	r=1	8.016 (0.005) [a]	r=2
KOSPI 200	N2QM	1.123 (0.289)	r=1	5.647 (0.018) [b]	r=2
KOSPI 200	N3QM	1.143 (0.285)	r=1	5.299 (0.021) [b]	r=2
FBM KLCI	NMC	0.925 (0.336)	r=1	5.210 (0.022) [b]	r=2
FBM KLCI	NQM	1.237 (0.266)	r=1	17.820 (0.000) [a]	r=2
FBM KLCI	N2QM	6.238 (0.013) [b]	r=2	14.455 (0.000) [a]	r=2

Trace and Max-Eigen statistics found equal in at most 1 CE null hypothesis and the associated critical values. CE stands for Cointegrating equation. Figures in parentheses are p-values for at most one cointegration equation and [a, b, c] indicate statistical significance at the 1%, 5% and 10% levels. Critical values are based on MacKinnon-Haug-Michelis (1999). Logarithm of prices are used in the cointegration tests.

4.2.4 The ECM framework

Having established that the time series are I(1) and cointegrated, we can proceed by estimating the base error correction model. The following model is utilised:

$$r_t^X = \alpha^X + \sum_{\tau=1}^{k} \beta_\tau^X r_{t-\tau}^X + \sum_{\tau=0}^{k} \gamma_\tau^X r_{t-\tau}^F + \delta^X (p_{t-1}^X - p_{t-1}^F) + \varepsilon_t^X$$

(1)

$$r_t^F = \alpha^F + \sum_{\tau=1}^{k} \beta_\tau^F r_{t-\tau}^F + \sum_{\tau=0}^{k} \gamma_\tau^F r_{t-\tau}^X + \delta^F (p_{t-1}^X - p_{t-1}^F) + \varepsilon_t^X$$

where *p* denotes price series, *r* denotes log return, and the indices X and F identify observations and coefficients relating to the spot and futures market accordingly. The difference in the previous periods' spot and futures prices are used as the pre-specified cointegrating vector, according to the literature. The model is estimated using OLS approach, while the t-statistics are based on Newey-West standard errors as heteroscedasticity and serial correlation of the residuals are probable issues. The optimal lags are selected trough a stepwise approach, as remarked in Section 4.2.1.

Examining the result of all the regressions, in general, it is found that the independent variables have considerable explanatory power for the spot market returns, as is evidenced by very high adjusted R^2 as well as significant and close to one coefficients. They have slightly less explanatory power for the returns in the futures markets, according to the adjusted R^2 for the futures market equation. The amount and significancy of coefficients does not seem to be a support for this proposition.

Returns in both markets, in a general assessment, depend negatively on the associated past information of the index i.e. their own lagged values. This may be due to bid-ask bounce. We further find that returns in both markets depend positively on lagged returns in the other market. Moreover, in most of the series, one or two lags can explain the majority of the present stock market returns. The importance of past information may be used for setting arbitrage strategies in the markets to exploit the market inefficiency. Lastly, the values of the F-statistics and at the coefficient values and their t-statistics reveal, however, that the impact of lagged futures returns on the spot market is far stronger than the impact of spot market returns on the futures market.

Table 4.6 : Speed of adjustments

		Spot		Futures	
Underlying Instrument	**Series**	**Coefficient**	**S. e.**	**Coefficient**	**S. e.**
STI	NMC	3.51E-05	5.59E-06	-3.26E-05	5.51E-06
STI	NQM	1.42E-05	2.70E-06	-1.36E-05	2.66E-06
STI	N2QM	5.42E-06	1.90E-06	-4.98E-06	1.80E-06
STI	N3QM	3.01E-06*	1.70E-06	-3.01E-06*	1.60E-06
NIKKEI 225	NMC	2.71E-03	5.93E-04	-2.47E-03	5.57E-04
NIKKEI 225	NQM	7.10E-04	1.30E-04	-5.92E-04	1.17E-04
NIKKEI 225	N2QM	4.56E-04	8.70E-05	-3.82E-04	7.92E-05
NIKKEI 225	N3QM	2.40E-06	4.46E-07	-2.24E-06	4.19E-07
KOSPI 200	NMC	2.84E-05	2.42E-06	-2.79E-05	2.38E-06
KOSPI 200	NQM	1.20E-05	9.63E-07	-1.15E-05	9.32E-07
KOSPI 200	N2QM	4.40E-06	6.58E-07	-4.12E-06	6.27E-07
KOSPI 200	N3QM	5.37E-04	6.62E-05	-4.04E-04	6.89E-05
FBM KLCI	NMC	1.28E-04	1.21E-05	-9.77E-05	9.42E-06
FBM KLCI	NQM	5.45E-05	8.41E-06	-3.63E-05	6.67E-06
FBM KLCI	N2QM	2.71E-05	6.03E-06	-1.89E-05	4.34E-06

Notes: Spot and futures titles denote the regressions in which the spot or futures index is the dependent variable. Coefficient refers to the coefficient of the error correction term.

Investigating the pair of equations for all VECM models, the coefficient of the error correction term, which is called the speed of adjustment, has the expected sign and is significant at 5% level, except in the case of TI N3QM which is significant at 10% level. Thus, both markets contribute to price discovery. Apparently, however, the futures market dominates the process of price discovery. No dummy or control variable is used in this base model, in line with the common practice; however, the liquidity measures utilised in the subsequent modified models could captivate some of the effects of the crises occurred. The residual of VECM can be regarded as a market shock or the unexpected return, which is used in the following sections to analyse the volatility.

4.2.5 Contribution of markets to Price Discovery

This section elaborates the empirical results on the evaluation of the contribution of each spot and futures market in the indexes' price discovery using the Common Factor Weight (CFW). The coefficients of the error correction terms are extracted and used in the calculation of the CFW as follows:

$$CFW^{X} = \frac{\delta^{F}}{\delta^{F}-\delta^{x}},\ CFW^{F} = \frac{-\delta^{x}}{\delta^{F}-\delta^{x}} \qquad (2)$$

The measure would sensibly indicate the share of each market in shaping the price.

The results, as depicted in Table 4.7, indicate that both markets contribute to price discovery; however, the futures market dominates the process of price discovery. It is evident from the CFW calculation results that the futures market has maintained a greater contribution in the price discovery process rather than the spot market although the difference is not substantial in some cases. The lowest contribution of futures market is found in case of TI N3QM in which the contribution of the markets are equal.

This supports the theoretical expectations as well as most of the previous empirical studies who find that the futures market is a clear leader including Kawaller et al. (1987), Herbst et al. (1987), Chan (1992), Ghosh (1993a), Hasbrouck (1995), Dwyer et al. (1996), Martens et al. (1998), Tse (1995 and 1999) and Min and Najand (1999). It is, nevertheless, in contrast with Wahab and Lashgari (1993) concluding price adjustments occur significantly in both S&P 500 futures and cash markets and Shyy et al. (1996) who find, using lead-lag relationship between the cash market and stock index futures in France exchange, that the spot market leads in the process of price discovery when the estimation is based on quote midpoints.

Table 4.7 : Market contributions

Underlying Instrument	Series	Market Contribution	
		Spot	**Futures**
STI	NMC	0.4815	0.5185
STI	NQM	0.4892	0.5108
STI	N2QM	0.4788	0.5212
STI	N3QM	0.5000	0.5000
NIKKEI 225	NMC	0.4767	0.5233
NIKKEI 225	NQM	0.4547	0.5453
NIKKEI 225	N2QM	0.4558	0.5442
NIKKEI 225	N3QM	0.4828	0.5172
KOSPI 200	NMC	0.4956	0.5044
KOSPI 200	NQM	0.4894	0.5106
KOSPI 200	N2QM	0.4836	0.5164
KOSPI 200	N3QM	0.4293	0.5707
FBM KLCI	NMC	0.4329	0.5671
FBM KLCI	NQM	0.3998	0.6002
FBM KLCI	N2QM	0.4109	0.5891

Comparing the outcome for different indexes shows that both spot and futures NIKKEI 225 impound new information faster than the other indexes. The second index with quick adjustment to new information is KOSPI 200, though it is far below the NIKKEI 225. The FBM KLCI and STI are the slowest-moving indexes in this regard. Furthermore, FBM KLCI is found with the highest contribution of futures market in the process of price discovery. The reason behind this is the Kuala Lumpur futures prices respond to shocks much faster than the underlying spot price. Hence, it is necessary for researchers investigating into the market response to macroeconomic news, or into informational linkages between markets in different countries, and the market practitioners to pay a greater attention to the futures market data in their analysis of Malaysian Exchange.

The CFWs further assign the next quarter month and next two quarter month contracts a slightly higher contribution to price discovery than next month or next three quarter month contracts. In other words, the futures contracts with moderate time to maturity lead in the process of price discovery.

Examining the coefficient of error terms indicates that all the estimated coefficients are significant at 1% level and so the CFWs are valid, with the exception of the TI N3QM which is significant at 10% level. The latter is also the mere series with the identical contribution of markets.

4.2.6 The effect of higher Liquidity

The second step of our analysis is to evaluate the impact of futures market development on the accuracy of price discovery practice by modifying the base VECM model. As explored in chapter 3, this study employs liquidity as the key element and proxy of the futures market development measured by daily volume and open interest. It is believed that they represent both size and importance of the market as well as its activity level.

The nature of volume and open interest is very similar, so significant coefficients cannot be obtained when both of them are considered as explanatory variable, due to collinearity problem. Whether volume or open interest should be applied as the proxy of financial market development is examined with checking the estimated coefficients t-statistics as well as inspecting the redundant and omitted variable tests.

The findings suggest that considering either volume or open interest has only minor effect on the goodness of fit. While the coefficient of volume and open interest are both valid in most of the series, open interest has usually a slightly more significant role. The exceptions are both open interest and volume in series associated with FTSE Bursa Malaysia Kuala Lumpur Composite Index (FBM KLCI) and the latter in series associated with Strait Times Index (STI).

In contrast, the results, in comparison with the earlier results, indicate that making allowance for the liquidity measures does not upsurge the speed of adjustment. In actual fact, the result varies from index to index. For instance, including either volume or open interest has imprecisely rise the speed of adjustment in FBM KLCI, open interest has also a similar effect on STI, while both of the measures impose an opposite noteworthy impact on the NIKKEI 225 Index.

Table 4.8 : The effect of higher liquidity on speed of adjustment

Underlying Instrument	Series	Coefficient			
		Open Interest * Basis	Basis	Volume * Basis	Basis
STI	NMC	-4.35E-07 (0.000)	-4.97E-05 (0.000)	-4.45E-07 (0.000)	-4.09E-05 (0.000)
STI	NQM	-3.63E-07 (0.000)	-2.96E-05 (0.000)	-4.69E-07 (0.000)	-2.34E-05 (0.000)
STI	N2QM	-2.09E-07 (0.000)	-1.36E-05 (0.000)	-3.84E-07 (0.000)	-1.35E-05 (0.000)
STI	N3QM	-1.53E-07 (0.000)	-9.03E-06 (0.000)	-3.17E-07 (0.000)	-9.83E-06 (0.000)
NIKKEI 225	NMC	4.03E-11 (0.002)	-2.77E-05 (0.000)	5.69E-11 (0.005)	-2.92E-05 (0.000)
NIKKEI 225	NQM	-4.32E-11 (0.000)	-1.78E-05 (0.000)	-9.83E-11 (0.000)	-1.54E-05 (0.000)
NIKKEI 225	N2QM	-1.18E-11 (0.038)	-6.07E-06 (0.000)	-2.94E-11 (0.083)	-5.41E-06 (0.000)
NIKKEI 225	N3QM	-5.48E-12 (0.391)	-3.20E-06 (0.000)	1.41E-11 (0.291)	-2.26E-06 (0.000)
KOSPI 200	NMC	3.73E-08 (0.000)	-2.254E-03 (0.000)	6.65E-09 (0.000)	-2.355E-03 (0.000)
KOSPI 200	NQM	1.58E-08 (0.000)	-6.19E-04 (0.000)	1.78E-09 (0.025)	-5.64E-04 (0.000)
KOSPI 200	N2QM	1.82E-09 (0.623)	-3.86E-04 (0.000)	-2.15E-09 (0.002)	-3.96E-04 (0.000)
KOSPI 200	N3QM	-7.67E-10 (0.901)	-4.17E-04 (0.000)	-2.38E-09 (0.014)	-4.08E-04 (0.000)
FBM KLCI	NMC	-4.29E-10 (0.430)	-1.26E-04 (0.000)	-3.06E-09 (0.021)	-1.11E-04 (0.000)
FBM KLCI	NQM	-1.02E-09 (0.004)	-5.61E-05 (0.000)	-2.95E-09 (0.001)	-4.78E-05 (0.000)
FBM KLCI	N2QM	-4.50E-10 (0.104)	-3.18E-05 (0.000)	-1.91E-09 (0.003)	-2.59E-05 (0.000)

Demeaned Open Interest and Volume are used as measure of Liquidity in interaction with demeaned lagged basis. Figures in parenthesis are p-values.

Ultimately, applying the interaction term shows that higher liquidity increase the speed of adjustment in most of the examined indexes. The negative coefficient of the interaction term (consisted of the demeaned open interest or volume as the measure of liquidity multiplied by the demeaned lagged basis) indicates that when the liquidity is higher the basis has greater impact on adjusting the prices. The results are presented in Table 4.8.

To sum up, the outcome support the effect of higher liquidity on speed of adjustment but it is not robust enough to verify that markets with greater liquidity are offering a more accurate price discovery; however, it is align with Benz and Hengelbrock (2008) and Mayordomo et al. (2011) findings that imply liquidity (measured by bid-ask spreads and the relative number of market participants in the CO_2 allowances and credit derivatives respectively) is a factor affecting the leadership in the price discovery process.

4.3 Optimal Hedge Ratio

The proposed models in the methodology of optimal hedge ratio calculation is aimed to examine the relationship between returns of spot and futures indexes in order to identify the finest risk management approach. In this section, the findings of different models are presented, winding up with a comparison of the effectiveness of models in the last subsection.

4.3.1 Traditional vs. Minimum Variance Hedging

The constant hedge strategies begins with the introduction of traditional hedge strategy in which a futures position equal in magnitude but opposite in sign is adopted to the established cash position. As described in chapter three, the traditional hedge will not minimize risk because the cash and the futures market may not move together perfectly. The minimum variance hedge ratio takes account of this lack of perfect correlation and identifies the hedge ratio which minimizes risk, using the slope coefficient of the regression of spot returns on futures returns series. This conventional approach is also called β hedge. The following equation is utilised in this study:

$$r_{pt} = \alpha + \beta r_{ft} + \varepsilon_t, \tag{3}$$

where r_{pt} and r_{ft} are the spot and futures returns for period t. The ordinary least squares (OLS) estimator of β provides an estimate for the minimum-variance hedge ratio. A stepwise approach is employed to determine the optimal lag length in this model. The number of lags is presented in Table 4.3.

The optimal hedge ratios using this approach is reported in Table 4.8. Examining the calculated hedge ratios, it is clear that the ratios in KL series are significantly less than the ratios in the other series. The ratios are 0.57 to 0.60 in KL series, 0.79 to 0.87 in KS series, 0.91 to 0.94 in TI series, and 0.94 to 0.96 in NX series. This might be caused by the higher contribution of futures market in price discovery, which is explored in section 4.5.

4.3.2 The Cointegration Approach

The following regression model is applied to take the cointegration relationship into consideration:

$$\Delta p_t = \alpha_p + \lambda \Delta f_t + \sum_{i=1}^{m} \beta_{pi} \Delta p_{t-i} + \sum_{j=1}^{n} \gamma_{pj} \Delta f_{t-j} + \theta_p z_{t-1} + \varepsilon_{pt}, \tag{4}$$

where Δp_t and Δf_t are the spot and futures returns for period t and z_t is the basis. The OLS estimate of λ is the estimated minimum-variance hedge ratio. We discussed in chapter three that the basis is not only a stationary linear combination of p_t and f_t – comparable to the standard error correction term, but also a reflection of the cash-futures price convergence and the variable that carries important information. It is worth to mention that the standard error correction model is also applied; however, using the basis provides more consistent and significant outcome. Therefore, we merely report the result of this approach to maintain the cohesion and integrity of the study.

Finally, the lag lengths, offered in Table 4.3, are the same as the conventional OLS method. In line with the common practice, no dummy variable is used although this study covers the evaluation of structural breaks in which dummy variables are built-in. The optimal hedge ratios using this approach is represented in Table 4.9.

The obtained hedge ratios from the VECM model are following the same patterns compared to the hedge ratios previously calculated using the OLS model, specifically in NIKKEI 225 contracts. On average, the hedge ratios in STI contracts are 1.2 percent higher while they are 3 to 3.7 percent higher in the other two contracts. The increase in hedge ratios is more apparent in contracts with longer time to maturity.

Table 4.9 : Optimal hedge ratio

		Optimal Hedge Ratio	
Underlying Instrument	**Series**	**OLS**	**ECM**
STI	NMC	0.931613	0.942158
STI	NQM	0.937894	0.947412
STI	N2QM	0.913368	0.926992
STI	N3QM	0.925241	0.937491
NIKKEI 225	NMC	0.939704	0.944148
NIKKEI 225	NQM	0.964874	0.966392
NIKKEI 225	N2QM	0.945387	0.948268
NIKKEI 225	N3QM	0.942435	0.946161
KOSPI 200	NMC	0.840990	0.866112
KOSPI 200	NQM	0.862522	0.879728
KOSPI 200	N2QM	0.794870	0.838278
KOSPI 200	N3QM	0.868132	0.905023
FBM KLCI	NMC	0.575493	0.594021
FBM KLCI	NQM	0.598856	0.617496
FBM KLCI	N2QM	0.574284	0.589707

Notes: Technically, the β hedge ratio is positive as long as there is a positive correlation between the spot and futures prices. It is due to the fact that the standard deviation of spot and futures, as the remaining variables in the calculation of hedge ratio, are always positive. So to hedge the price risk of the existing cash portfolio the investor needs to go short by selling futures contracts.

4.3.3 Time Varying GARCH Hedge Ratio

The dynamic hedge ratio is calculated using the standard BEKK approach. The error correction model specification is as follows:

$$y_t = \mu + \alpha EC + V\beta + \varepsilon_t;\ \varepsilon_t|\Omega_{t-1} \sim N(0, H_t) \qquad (5)$$

where $y_t = (r_s, r_f)'$ is a vector of observations of the spot and futures rates of returns, μ, α and β are column vectors of parameters, EC is the basis, V is a row vector of lagged values of y_t and $\varepsilon_t = (\varepsilon_s, \varepsilon_f)$ is a vector of residuals. Consistently, The bivariate GARCH(1,1) model is represented as:

$$H_t = CC' + A\varepsilon_{t-1}\varepsilon'_{t-1}A' + BH_{t-1}B' \qquad (6)$$

where C, A and B are 2×2 symmetric parameter metrics and H_t is the conditional variance covariance matrix of equation (5) residuals, estimated recursively. The Ljung–Box test for serial correlation is applied.

The optimal time varying hedge ratio can be expressed as:

$$h_t = \frac{\widehat{H}_{12,t}}{\widehat{H}_{22,t}} \quad (7)$$

where $\widehat{H}_{12,t}$ is the estimated conditional variance between the cash and futures stock returns and $\widehat{H}_{22,t}$ the estimated conditional variance of the futures returns from the bivariate GARCH model. Given that conditional covariance is time-dependent, the optimal hedge ratio is time-dependent.

4.3.4 Unknown Structural Breaks

Two methods are employed to detect and test one and two unknown structural breaks, using R statistical software. The one unknown structural break point is estimated through the existing "strucchange" package developed by Zeileis et. al (2003), which reviews tests for structural change in linear regression models. The modified package further implements the tests from the fluctuation test and F test (Chow test) frameworks to find out one unknown break point.

The two unknown structural breaks; however, is inspired from the work of Hatemi (2008) and Hatemi and Roca (2010). We employed the developed algorithm to detect the break point and test for cointegration with two unknown regime shifts by transforming Hatemi (2009) Gauss codes to R with a minor modification. The original code is a sound novel approach, yet it is not designed for running extended time series including the daily data of over a decade. Such process takes over 400 hours to run the model for a series containing the returns of three thousands days. Therefore, we modified the model to get the result in a two-step process. In first step, we take the average price of every 20 days and utilise this created figures in order to detect the break point in the whole sample. Then, in the second step, we test the original daily data from 15 days before to 15 days after each break point found, to find out the exact break point.

Table 4.10 : Break point estimation

Underlying Instrument	Series	One Structural Break	Two Structural Breaks	
		The Point	1st Point	2nd Point
STI	NMC	13/03/2008	02/05/2002	01/06/2011
STI	NQM	23/01/2008	11/10/2007	06/01/2011
STI	N2QM	23/01/2008	04/06/2007	08/04/2011
STI	N3QM	18/02/2008	30/04/2002	01/06/2011
NIKKEI 225	NMC	17/06/2009	19/11/1997	19/01/2011
NIKKEI 225	NQM	22/08/2000	23/05/1996	27/09/2007
NIKKEI 225	N2QM	26/03/2001	24/07/1996	05/10/2009
NIKKEI 225	N3QM	11/03/2002	03/06/1996	06/08/1999
KOSPI 200	NMC	NA	17/11/2000	01/08/2011
KOSPI 200	NQM	11/08/2005	28/09/2000	08/02/2011
KOSPI 200	N2QM	NA	17/10/2003	01/09/2011
KOSPI 200	N3QM	30/08/2012	15/12/2003	27/07/2011
FBM KLCI	NMC	21/11/2008	24/08/1998	11/01/2011
FBM KLCI	NQM	NA	25/10/2000	20/05/2011
FBM KLCI	N2QM	NA	25/10/2000	20/06/2011

Notes: the break point in the one unknown structural break model is not between the two points estimated through the two unknown structural break model. It might be owing to the structure of data; not necessary because the models follow different algorithms.

The code is designed in a way that both of the numbers employed in standard averaging (k=20) and the precision test (n.search=15) can be simply changed to any other number. Several combinations starting from k=3 is tested to make sure the result is robust. We found that different k and n.search lead to detection of alike break points; likewise, the calculated critical values are matching in all combinations.

Table 4.10 shows the break points in each model. The results reveal that the one structural break in different series occurred in dissimilar dates, while when we test for two breaks closer dates will be detected. The results are reported only when a valid break point is found at 5% level, based on the critical values of each method.

The estimated hedge ratios are represented in Table 4.11. In general, the optimal hedge ratios are increased during time. In case of one structural break, the optimal hedge ratio varies before the break from 0.59 in KL NMC, to around 0.8 in KS series, to about 0.9 in TI and NX series. The only exception before the break is NX NMC with a high optimal hedge ratio of 0.96; the series which also accounts for the least increase in hedge ratio by an escalation value of less than 0.05. Most of the hedge ratios are increased by 7 to 10 percent after the break. To this end, the hedge ratio reached 0.65 in KL NMC, 0.9 in KS series, and 0.97-0.99 in TI and NX series. In the last two series, the exception after the only break is TI N3QM which is increased to 0.94. Computing the percentage increase in the hedge ratios, the hedge ratio in NX NMC is the least expansion of 3 percent. This is expected as the break point is estimated on mid-2009, which is after the 2008 global crisis and therefore a trivial change in hedge ratio is sensible. Surprisingly, the hedge ration in KS N3QM has experienced a sharp upsurge of 14 percent, while the break point is on late-2012, where no crisis is seen in South Korea.

Table 4.11 : Optimal hedge ratios

Underlying Instrument	Series	One Structural Break		Two Structural Breaks		
		Before Break	After Break	Before Breaks	Between Breaks	After Breaks
STI	NMC	0.9014274	0.9920461	0.8821908	0.9439548	0.9965633
STI	NQM	0.8917236	0.9815761	0.8832251	0.9807396	0.9905804
STI	N2QM	0.8947079	0.9617512	0.8775972	0.9618991	0.9795348
STI	N3QM	0.8919232	0.9397966	0.8693565	0.9160610	0.9727130
NIKKEI 225	NMC	0.9585347	0.9884874	0.9031260	0.9739495	0.9867721
NIKKEI 225	NQM	0.9027347	0.9703512	0.8857416	0.9491772	0.9755630
NIKKEI 225	N2QM	0.9049159	0.9753082	0.8837936	0.9591011	0.9664754
NIKKEI 225	N3QM	0.9199203	0.9705871	0.8922554	0.9213882	0.9669577
KOSPI 200	NMC	NA	NA	0.7186119	0.9064260	0.9659542
KOSPI 200	NQM	0.8081047	0.9056708	0.7319347	0.8901553	0.9244452
KOSPI 200	N2QM	NA	NA	0.8065778	0.8824168	0.9175441
KOSPI 200	N3QM	0.7923432	0.9024619	0.6091752	0.8042693	0.9098735
FBM KLCI	NMC	0.5914641	0.6454658	0.6051335	0.5868802	0.7070531
FBM KLCI	NQM	NA	NA	0.5670239	0.5675448	0.7062021
FBM KLCI	N2QM	NA	NA	0.5736250	0.5623877	0.7069473

Notes: The results are reported only when a valid break point is found at 5% level, based on the critical values of each method.

Estimating the two unknown structural break points, we found that the first breaks occurred between mid-1996 to late-2007, in which NX series have experienced the earliest breaks in 1996 and 1997, then KL series in 1998 and 2000, KS series in 2000 and 2003, and TI series in 2002 and 2007. It is not the same for the second breaks. However, the second breaks are seen during more than a decade from mid-1999 to late-2011, all of the second breaks are estimated within year 2011 except for NX series, namely N3QM, NQM and N2QM with second breaks in 1999, 2007 and 2009 respectively.

The two structural breaks estimation is similar to the one break in terms of the increase in the optimal hedge ratio over time. While the minimum hedge ratio before the first break is 0.57 in KL NQM and N2QM and 0.61 in KL NMC and KS N3QM, no ratio is calculated less than 0.7 in KL series after the second break. The only exception to the general increase of the ratios are KL NMC and N2QM in which the ratios are declined by 0.01 after the first break; however, a vast expansion of 0.11 and 0.14 after the second break covered the mentioned shrink. The ratio is also increased in the rest of KS series from 0.72-0.80 to 0.88-0.90 after the first break and then to 0.92-0.96 after the second break. Likewise, the optimal hedge ratio in TI and NX series are calculated between 0.87 to 0.90 before the first break, 0.92 to 0.98 in the middle of the breaks, and 0.97 to 1 after the second break.

The documented rise in optimal hedge ratios is relatively greater during the first break. This can be explained by the volatile financial markets within the first and second break mainly due to the fact that crises occurred often and more severe in magnitude. Nevertheless, the second rise of the optimal hedge ratio indicates that not only the markets are not in steady conditions after the recognised financial crisis but also there is even a higher level of volatility and risk involved in the markets, calling for better risk management knowledge, models, techniques and sound business practices, management system and implementation.

4.4 Hedging effectiveness Comparisons

Having examined the result of various hedging strategies, we now look at the effectiveness of each strategy. Since the main theme of this section is to find out the most effective hedge ratio, comparison between the effectiveness of different hedge ratios is made by constructing portfolios implied by the computed ratios and then comparing the variance of these constructed portfolios. The portfolios are constructed as $(r_t^X - \beta_t^* r_t^F)$; where r_t^X is the spot returns, r_t^F the futures returns and β^* the estimated optimal hedge ratio. In the case of the constant ratio, the time subscript does not exist. The variance of these constructed portfolios is then estimated and comparisons made using the minimum variance measure of hedging effectiveness by means of $HE = 1 - \sigma_B^2 / \sigma_{P_S}^2$, as observed in chapter 3, where, σ_B^2 represents the variance of hedged portfolio and $\sigma_{p_s}^2$ represents the variance of unhedged portfolio. Therefore, the closer HE is to 1, the more effective is the hedge.

The results, as presented in Table 4.12, highlight the quite substantial reduction in the portfolio variance compared with the unhedged portfolio. The greatest hedging effectiveness is achieved in NIKKEI 225 next month contract, using a VECM with two unknown structural breaks while the weakest hedging strategy is traditional hedge in the FBM KLCI's associated next quarter month contract.

More interestingly, the results support the literature on the accuracy of OLS models. As remarked earlier, the OLS, even though suffers from misspecification, offers more effective results compared with the time-varying hedge ratios (Hill and Schneweeis, 1981, Figlewski, 1984, Myers and Thompson, 1989, Benet, 1992, Lien, 2005 and Saumitra, 2008). It is almost the same when the error correction term is considered in a cointegration approach i.e. in almost all of the series, the OLS and VECM hedge ratio portfolios outperform both the traditional and the VECM-GARCH time-varying ratio portfolios. This is consistent with Moosa (2003) that the impact of considering cointegration in hedging effectiveness is negligible.

Table 4.12 : Hedging effectiveness (%)

Underlying Instrument	Series	Traditional HR=1	OLS MVHR	Cointegration Approach	Dynamic VECM-GARCH	One structural break	Two structural breaks	Average of all strategies
STI	NMC	92.72	93.13	93.12	93.00	93.34*	93.23	93.04
STI	NQM	92.43	92.93	92.92	92.81	93.14	93.20*	92.85
STI	N2QM	91.83	92.43	92.42	92.18	92.55	92.64*	92.28
STI	N3QM	91.05	91.88	91.86	92.11*	91.94	91.96	91.74
NIKKEI 225	NMC	93.66	93.78	93.78	93.65	93.80	93.85*	93.73
NIKKEI 225	NQM	90.62	90.99	90.99	90.57	91.11	91.11*	90.86
NIKKEI 225	N2QM	91.33	91.67	91.67	91.41	91.80	91.80*	91.58
NIKKEI 225	N3QM	92.04	92.35	92.35	92.25	92.42	92.44*	92.28
KOSPI 200	NMC	84.37	86.57	86.54	86.38	NA	87.50*	85.97
KOSPI 200	NQM	81.32	84.33	84.26	83.09	84.59	85.04*	83.52
KOSPI 200	N2QM	79.36	81.23	81.09	79.92	NA	81.38*	80.40
KOSPI 200	N3QM	53.17	56.96	56.79	55.72	56.98	57.59*	55.92
FBM KLCI	NMC	33.60	60.95	60.89	57.20	61.01	61.07*	54.73
FBM KLCI	NQM	26.99	59.20	59.14	58.07	NA	59.40*	50.85
FBM KLCI	N2QM	27.00	59.94	59.90	57.17	NA	60.14*	51.00

* indicates the strategy with the greatest hedging effectiveness.

The effectiveness of hedging FBM KLCI price risk using the futures contracts is remarkably small. The principal reasons for futures hedging shortcomings are the lack of liquidity (Maynard et al., 2001) and the slow process of impounding new information. The former is probably due to the strict regulations implemented since the onset of the Asian financial crisis as well as the absence of institutional interest compounded by the lack of awareness and confidence to use these contracts, as illustrated by Taufiq et al. (2006).

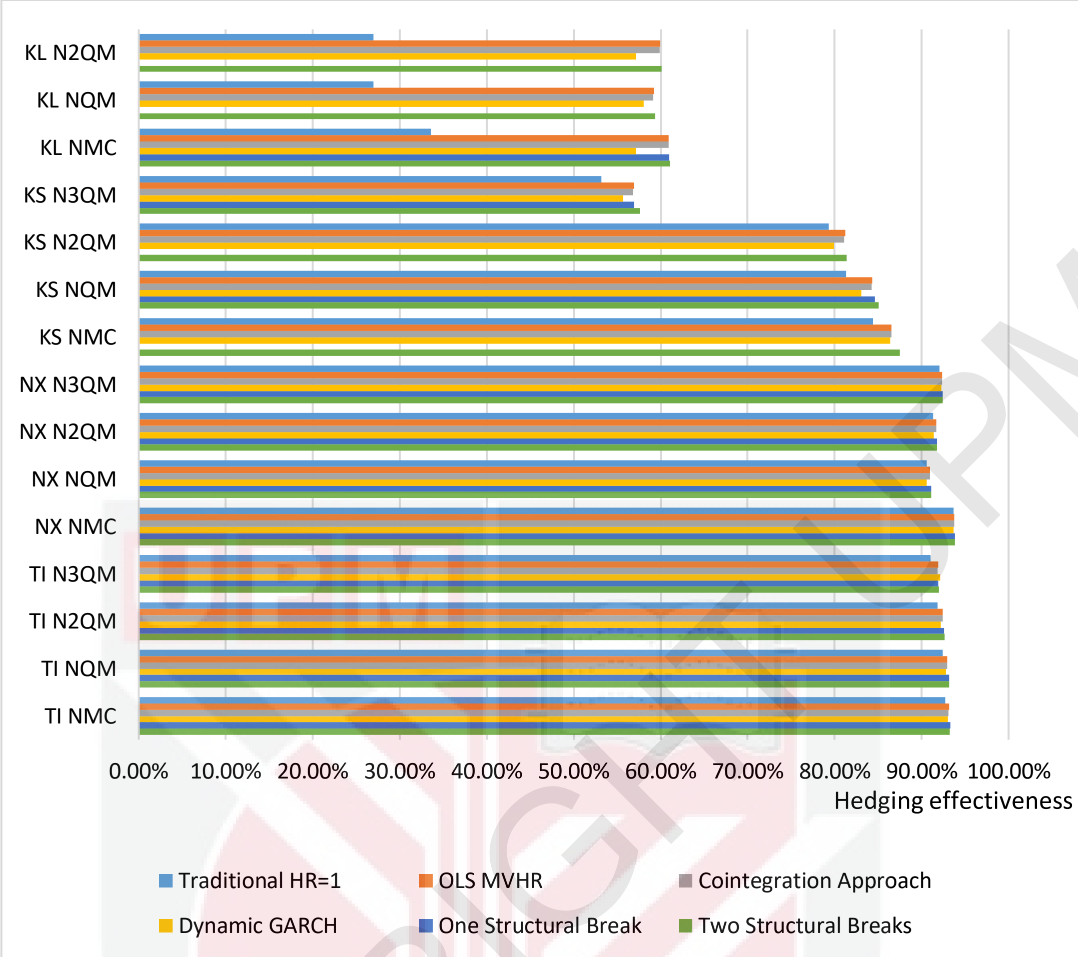

Figure 4.1 : Hedging effectiveness comparison

The findings of this study further point out that one can obtain the most precise hedge ratio and therefore most effective hedging strategy if the model allows for unknown structural breaks i.e. the cointegration approach with structural breaks provides the most effective MVHR. Merely in case of STI next three quarter month contract, time-varying hedge ratio provides a portfolio with lowest variance whereas in STI next month contract the cointegration approach with one structural breaks is superior.

The base theoretical support for this result is the necessity of allowing for substantial changes in the statistical relation between spot and futures contracts over time, as explored in Figlewski, Cecchetti and Cumby (1988). Nevertheless, there is no empirical study investigating the structural breaks for the selected markets, the result is align with the findings of Sim and Ralf (2001) and Pok et al. (2009) that indicate dissimilar optimal hedging strategies before and after crisis as well as in periods of higher information asymmetry.

4.5 Price Discovery and Hedging Effectiveness

The developed model and the empirical results of investigating the effect of maintaining a greater contribution of futures markets, and so a more accurate price discovery, on the effectiveness of hedging is presented in this section.

4.5.1 Data Set

The whole sample is employed to build the data set required for examining the relationship between price discovery and hedging effectiveness. Self-developed codes in R statistical software is applied on the sorted data with no outlier and missing value -as used in the previous sections- to divide the whole sample in each series into several series based on the quarters. Thus, for each year we made 4 series i.e. 60 series for a 15 years period.

Each of the series covers the daily closing prices of either spot or futures index for a specific quarter. The length of series are then about 60 to 65 days in which the financial markets operated. All the series are updated till 19th March 2013; therefore, the data thorough the last quarter is available. However, the very first quarter is dropped in some cases due to minimal number of trading days and the lack of precise data.

4.5.2 Estimations to Calculate Quarterly CFW and HE

To extrapolate the contribution of futures market (CFW) and the hedging effectiveness (HE) series over the full sample, the previously discussed models should be employed to estimate the coefficient of error correction term in the VECM model as well as the β hedge ratio. According to the optimal hedge ratio selection results, i.e. Section 4.2, the cointegration approach with structural breaks provides the superior results and should be preferred in this examinations, yet it does not make sense to consider structural break within a quarter. Therefore, the original error correction model used in Subsections 4.2.4 and 4.3.2 is estimated in each quarter.

The optimal lag lengths selected in the VAR model for each index, as stated in Table 4.3, is fixed for the estimations in all the quarters. It is basically to maintain the consistency as well as simplicity. The coefficient of futures returns and the error correction term from each regression, to be called the quarter's hedge ratio and speed of adjustment, are extracted to calculate the quarterly HE and CFW, respectively. As the last step, the obtained CFW and HE of each index are sorted in two series so the interrelationship between the two can be investigated.

4.5.3 Empirical results

The discussion in Section 3.5 indicates that the hypothesis of positive relationship between price discovery and hedging effectiveness is likely to hold in the analysis of emerging financial markets. To test this hypothesis we extrapolated two series of CFW and HE for each series of futures index and the underlying spot index.

Having looked at the basic statistics, both of the series are found, as expected, to have significant and positive Kurtosis implying higher peaks and fatter tails. On the contrary, while the CFW series entail positive Skewness, the HE series contain negative Skewness. The latter is more anticipated as many of the numbers are close to but less than 1. The mean of the CFW series is about 0.53 where the median is 0.51 to 0.52, indicating the dominant higher contribution of futures markets. The HE's mean is slightly more than 0.9, with standard deviation of around 0.1, in most of the series.

The stochastic structure of the series are firstly examined by means of several unit root tests. The results from the augmented Dickey-Fuller test, the Phillips-Perron test and the KPSS test point out that almost all of the series are stationary at level, provided that the intercept is considered in the test equation. Three series are stationery if both intercept and trend in test equation are considered, and three series are stationary at first difference.

Subsequently, the Johansen cointegration test is applied to avoid spurious inference. Both the Trace and Maximum Eigenvalue test statistics suggest that all of the models with intercept in cointegrating equation are cointegrated using a 1% significance level, except NX NQM in which CFW and HE are cointegrated at 5% level and TI NMC in which they are not cointegrated. The same result is obtained considering trend in the cointegrating equation and/or intercept in VAR, except in NX N3QM in which series are not found cointegrated if only intercept in the cointegrating equation is included. The results are reported in Table 4.13.

Table 4.13 : CFW and hedging effectiveness, cointegration and unit root tests

Underlying Instrument	Series	Cointegration test (Eigenvalue)	Unit Root test (ADF τ-statistics)	
			HE	CFW
STI	NMC	0.143968 (0.126)	-2.176347 (0.217)[a]	-4.840625 (0.000)
STI	NQM	0.434534 (0.000)	-2.541024 (0.112)[a]	-8.449952 (0.000)
STI	N2QM	0.314199 (0.002)	-3.007265 (0.041)	-6.840552 (0.000)
STI	N3QM	0.371317 (0.000)	-3.706251 (0.007)	-7.081416 (0.000)
NIKKEI 225	NMC	0.389388 (0.000)	-4.038893 (0.002)	-8.976303 (0.000)
NIKKEI 225	NQM	0.197859 (0.017)	-1.554854 (0.50)*	-9.775476 (0.000)
NIKKEI 225	N2QM	0.219978 (0.005)	-5.858204 (0.000)	-8.663089 (0.000)
NIKKEI 225	N3QM	0.131077 (0.123)*	-4.074788 (0.002)	-8.674647 (0.000)
KOSPI 200	NMC	0.419310 (0.000)	-7.009031 (0.000)	-6.994791 (0.000)
KOSPI 200	NQM	0.269325 (0.000)	-3.830768 (0.004)	-7.528625 (0.000)
KOSPI 200	N2QM	0.327637 (0.000)	-2.437083 (0.138)[a]	-4.591962 (0.001)
KOSPI 200	N3QM	0.297542 (0.007)	-2.805548 (0.066)	-6.723727 (0.000)
FBM KLCI	NMC	0.299691 (0.000)	-7.484798 (0.000)	-8.737495 (0.000)
FBM KLCI	NQM	0.974496 (0.000)	-3.041294 (0.065)	-4.411996 (0.10)*
FBM KLCI	N2QM	0.878775 (0.002)	-3.278128 (0.038)	-2.349380 (0.174)*

Notes: * indicates that the series is stationary if both intercept and trend in test equation is considered or the series are cointegrated if both intercept and trend is included in the cointegrating equation. [a] indicates the series is I(1).

Accordingly, the associated series with each index are employed to regress HE on CFW by fitting the data in an OLS estimator. Applying various lag lengths criteria in the OLS estimations including SIC and stepwise approach -with no dummy or exogenous variable, we found that only the value of HE in the preceding quarters might have credible impact when considered as explanatory variable. Generally, only the first lag of HE is significant in most of the series. The estimated coefficient of CFW in both of the regressions –with and without lag of HE– are studied for robustness testing purposes.

Table 4.14 : CFW and hedging effectiveness, regression results

Underlying Instrument	Series	1st regression	2nd regression with HE(-1)	
		CFW coefficient	HE(-1) coefficient	CFW coefficient
STI	NMC	-0.229088 (0.245)	0.819880 (0.081)[a]	-0.106987 (0.139)
STI	NQM	-0.105673 (0.248)	0.771317 (0.092)[a]	0.012032 (0.159)
STI	N2QM	-0.079637 (0.211)	0.692265 (0.106)[a]	0.049598 (0.156)
STI	N3QM	-0.128528 (0.043)[a]	0.614538 (0.101)[a]	-0.155016 (0.033)[a]
NIKKEI 225	NMC	0.016030 (0.017)	0.214578 (0.111)[c]	0.014516 (0.017)
NIKKEI 225	NQM	0.013883 (0.030)	0.531467 (0.092)[a]	0.010567 (0.024)
NIKKEI 225	N2QM	-0.020735 (0.109)	0.514071 (0.083)[a]	0.027915 (0.081)
NIKKEI 225	N3QM	0.052205 (0.031)[c]	0.448408 (0.119)[a]	0.041204 (0.027)
KOSPI 200	NMC	-0.502528 (0.200)[c]	-0.040000 (0.14)	-0.447832 (0.200)[b]
KOSPI 200	NQM	-0.022399 (0.019)	0.611831 (0.100)[a]	-0.023639 (0.015)
KOSPI 200	N2QM	-0.197660 (0.134)	0.401193 (0.140)[a]	-0.069936 (0.124)
KOSPI 200	N3QM	0.830756 (0.368)[a]	0.645543 (0.107)[a]	0.650717 (0.266)[a]
FBM KLCI	NMC	-0.212025 (0.169)	0.115582 (0.121)	-0.219791 (0.170)
FBM KLCI	NQM	0.444167 (0.274)	-0.057386 (0.298)	0.450483 (0.285)
FBM KLCI	N2QM	0.001761 (0.001)[c]	-0.441392 (0.332)	0.002666 (0.001)[c]

Notes: Figures in parentheses are standard errors and [a, b, c] indicate statistical significance at the 1%, 5% and 10% level.

The results, reported in Table 4.14, indicate that HE is mostly explained by its own value in the previous period and a positive relationship between CFW and HE is not attained as a solid statement in all of the series, yet we can conclude that the higher the CFW the higher the HE in longer horizons (according to the regressions in which the lag(s) of HE is also considered). In other words, when contracts with more than 6 months to maturity is used as a hedging instrument, greater contribution of futures market is essential in obtaining higher hedging effectiveness.

This outcome is consistent with the notion that all the expectations converge as we approach the maturity month; and so the futures market loose its dominant role (Taufiq et al., 2007b). The alternative justification for the slashed explanatory power of CFW in hedging using the contracts with shorter time to maturity is short-term hedging performance depends importantly on the distribution of the mispricing return

(Merrick, 1988) and mispricing tends to decrease when the contract approaches expiration date (Taufiq et al., 2007a), similar to the case of developed markets.

Ultimately, causal effects of CFW on HE -which is particularly the type of relation that we are interested in, is analysed in the selected markets. The result verifies the well-recognised bi-directional causality between CFW and HE. It is worth to mention that all the causalities are significant at 1 percent significance level. The F-Statistics is usually increased with the increase in the number of lags. Investigating the impact of the past information of each series, the result suggest that neither HE is Granger caused by the lags of CFW nor CFW is Granger caused by the lags of HE.

4.6 Summary of the results

Although the price discovery and hedging have been the focus of many studies at both theoretical and empirical levels, the impact of the accurate price discovery on higher hedging effectiveness has so far received much less attention. This research not only examines each of the mentioned issues carefully in the South East Asian emerging futures markets but also provides a novel approach and the empirical evidence to investigate the postulated positive effect of accurate price discovery on hedging effectiveness.

Exploiting the spot and futures indexes from all available contract months of the selected market, combined with the associated volume and open interest, it is found that futures markets have greater contribution in the price discovery process rather than spot markets. While both spot and futures NIKKEI 225 impound new information faster than the other indexes FBM KLCI is found with the highest contribution of futures market in the process of price discovery. The reason behind this is the Kuala Lumpur futures prices respond to shocks much faster than the underlying spot price. The second index with quick adjustment to new information is KOSPI 200, though it is far below the NIKKEI 225. More importantly, comparing the outcome for different series in each index suggests that the next quarter month and next two quarter month contracts have a slightly higher contribution to price discovery than next month or next three quarter month contracts. In other words, the futures contracts with moderate time to maturity play a dominant role.

In the next section, various models of identifying the optimal hedge ratio is investigated. We show that cointegration approach with structural breaks provides the most effective hedge ratio in which the constructed portfolio retains the lowest price risk. The approach achieves a remarkable range of 58 to 94 percent effectiveness accordance with different indexes and series i.e. the variance of the hedged portfolio is 0.06 to 0.42 of the variance of the unhedged portfolio. The greatest hedging effectiveness is achieved in NIKKEI 225 next month contract. In contrast, the weakest hedging strategy is traditional hedge in which the FBM KLCI next quarter month and next two quarter month contracts reached an effectiveness of 27 percent. Thus, methodologically, the results support the literature on the accuracy of OLS models compared to the dynamic hedge ratios calculated using a sophisticated GARCH model. It is further to the point that using dynamic hedge ratios is linked with incurring a sizeable transaction costs.

Finally, scrutinising the interrelationship of contribution of futures markets in determining the price and the effectiveness of hedging upholds the theory by presenting a strong cointegration of constructed CFW and HE series. The result also verifies the well-recognised bi-directional causality between CFW and HE. Ultimately, the results indicate that HE is mostly explained by its own value in the previous period and a positive relationship between CFW and HE is not attained as a solid statement in all of the series, yet we can conclude that the higher the CFW the higher the HE in longer horizons. In other words, when contracts with more than 6 months to maturity is used as a hedging instrument, greater contribution of futures market is essential in obtaining higher hedging effectiveness.

CHAPTER 5

CONCLUSIONS

5.1 Summary of Research

This dissertation has three primary objectives: 1) to investigate the relationship between spot and futures prices, 2) to identify the optimal method to calculate the hedge ratio, and 3) to evaluate the interrelationship between price discovery and hedging effectiveness in Asia Pacific emerging markets. More specifically, the theoretical and practical aspects of price discovery and hedging, or the role futures markets play in the process of price discovery, is evaluated utilising the spot and futures indexes from all of the available contract months of the selected markets: Malaysia's Kuala Lumpur Composite Index, Singapore's Straits Times Index, Japan's NIKKEI 225 Index traded on the Singapore Exchange, and South Korea's KOSPI 200 Index.

Daily data was collected for each futures index from their corresponding inception date to March of 2013. Data includes prices and the associated volume and open interest. A vector error correction model was applied to calculate the contribution of each market through the common factor weight (CFW) measure. The CFWs were obtained from the coefficients on the error correction terms.

In terms of Objective 1, the results reveal that generally futures markets contribute more to the price discovery process than spot markets. By comparing the selected markets, it was determined that both spot and futures NIKKEI 225 impounded new information faster than the other indexes. The second index with a quick adjustment to new information is KOSPI 200; however, its speed of adjustment is far below that of the NIKKEI 225. The FBM KLCI and STI are the slowest-moving indexes, in this regard.

The FBM KLCI was found with the highest contribution of futures market in the process of price discovery. The reason behind this is that the KL futures prices respond to shocks more quickly than the spot price. More importantly, comparing the outcome for the different series in each index suggests that the next quarter month and next two quarter month contracts have a slightly higher contribution to price discovery than the next month or the next three quarter month contracts. In other words, futures contracts with a moderate time to maturity play a dominant role.

In the second objective, various models for identifying the optimal hedge ratio are investigated. We found that a cointegration approach with two structural breaks provides the most effective hedge ratio in which the constructed portfolio retains the lowest price risk. The approach achieves a remarkable range of 58 to 94 percent effectiveness in accordance with the different indexes and series (i.e. the variance of the hedged portfolio is 0.06 to 0.42 of the variance of the unhedged portfolio).

The greatest hedging effectiveness is achieved in NIKKEI 225 next month contract. In contrast, the weakest hedging strategy is a traditional hedge in which the FBM KLCI next quarter month and next two quarter month contracts reached an effectiveness of 27 percent. Thus, methodologically, the results support the literature on the accuracy of the OLS models, compared to the dynamic hedge ratios calculated using sophisticated GARCH models. It is further to the point that using dynamic hedge ratios is linked with incurring a sizeable transaction cost.

Finally, several tests are applied to accommodate the possibility of obtaining a more effective hedge when accurate price discovery is attained, due to a greater contribution of futures markets. Scrutinising the stated price discovery and hedging effectiveness (HE) relationship using a novel approach (i.e. constructing the quarterly CFW and HE series), the results are found to uphold the theory by presenting a strong cointegration of the constructed CFW and HE series. The results also verify the well-recognised bi-directional causality between CFW and HE.

Ultimately, by using a regression analysis, the results indicate that HE is primarily explained by its own value in the previous period. The positive explanatory role of the contribution of the futures market is not attained as a solid statement in all of the series. However, we can conclude that the higher the CFW, the higher the HE in the longer horizons. In other words, when contracts with more than 6 months to maturity are used as a hedging instrument, a greater contribution of futures markets are essential in obtaining higher hedging effectiveness. The finding is robust, as it remains valid when applying different methods.

Lastly, these findings are strongly consistent with studies that use a theoretical approach in exploring the importance of the futures market, as well as in revealing the superiority of the error correction model in calculating the optimal hedge ratio. I believe that they can offer enhanced insight and a new perspective on financial risk management.

5.2 Further Research

While this study explored the most crucial points of the objectives, there are other important areas that could be investigated to further verify and improve the findings. These areas will subsequently be discussed.

5.2.1 Examining Additional Markets

The indexes employed in this investigation are the most common instruments employed as a hedging tool in Asia Pacific emerging markets, since the price weighted indexes reflect the stock average in each exchange. However, not only the futures hedging is initiated in commodity trading but also it is a principal part of the commodity markets. Therefore, it is important to observe the precision of our results in such markets.

Furthermore, the indexes are used regularly to hedge the price risk of other financial instruments and trading agreements. Consequently, it is beneficial to survey existing and potential market practitioners to determine the price risks they are involved in. Sufficient knowledge of the true requirements assist in spotting the correct instruments in a cross hedging scheme and investigate, determine and promote suitable hedging strategies.

In addition, the large number of observations employed for each index provides us with the capability to analyse the relationship between price discovery and hedging. It pays to examine samples that are restricted to some special periods, such as periods of high volatility or after an Asian or global financial crisis, as a sensitivity test. Lastly, studying the concept in less developed markets shall enhance our insight into how diverse the effects are in developed, emerging and undeveloped markets. As such, it is worth repeating a similar approach on these markets.

5.2.2 Applying Alternative Measures and Models

The concept gained less attention in emerging markets; however, many advanced methods are offered to examine the price discovery and optimal hedging strategy in the developed markets. We discussed that the selected methods are representative of the wide range of methods; that being said, it is beneficial to apply some alternative measures and methods as a robustness test. Adopting the information share of Hasbrouck (1995) to match the first objective, investigating the price discovery process, is the first recommended alternative measure. Using tail specific measures of hedging effectiveness is another development that can add strength to the results.

5.3 Research Implications

The dissertation provided a novel approach to examine how futures markets assist in mitigating price risks, together with the modifications applied to achieve more accurate knowledge about the price discovery and hedging. This is evidenced from the case of Malaysia's Kuala Lumpur Composite Index, Singapore's Straits Times Index, Japan's NIKKEI 225 Index traded in Singapore exchange, and South Korea's KOSPI 200 Index.

Extending the investigations to emerging markets, an area often ignored by researchers, we found that futures markets, principally contracts with a moderate time to maturity, contribute significantly in the price discovery process, as opposed to spot markets. By exploring several hedging strategies, we illustrated that the cointegration approach with structural breaks that incur small transaction costs, as compared to dynamic hedging strategies, provides the most effective hedge ratio in which the constructed portfolio retains the lowest price risk. We further provided empirical evidence to explain that the hedging performance will improve if the futures markets assist in the price adjustments appropriately.

The greater contribution of futures markets in the process of price discovery is particularly essential in obtaining higher hedging effectiveness over longer horizons. Therefore, it is necessary for researchers investigating the risk management strategies in different countries to consider the dominant role of the futures market and the informational linkage between the markets, particularly in their analysis of emerging markets.

The market practitioners, likewise, should pay more attention to the futures market data in their decision makings in regard to trading and risk management through futures instruments. Concerning practical aspects, the vital revising of the hedged portfolio, only after every credible structural change, is the profitable recommendation provided.

It is also imperative for governments to assure the good governance of futures markets by maintaining thoughtful policies and updating the regulations in a precise and timely manner, providing comprehensive informational support for the market participants, and promoting trading in the futures market to attract greater liquidity through both institutional and individual investors and to stimulate the market growth. If practitioners are aware of effective hedging strategies and futures markets play the informational role, they would initiate supplementary investments in the futures market. This would, in turn, increase the liquidity and make investors more capable of hedging their risks successfully.

REFERENCES

Abdul, J., Khairuddin, O. and Obiyathulla, I.B. (1999). Issues in Stock Index Futures Introduction and Trading: Evidence from the Malaysian Index Futures Market, Capital Markets Review, 7(1&2), 1-46.

Abhyankar, A. (1998). Linear and nonlinear Granger Causality: Evidence from the UK stock index futures market. Journal of Futures Markets, 18, 519-540.

Admati, A. R., and Pfleideter, P. (1988). A theory of intraday trading patterns. Volume and price variability. Review of Financial Studies, 1, 3-40.

Aldrich, H. E. (1979). Organizations and Environments, Prentice Hall, Englewood Cliffs, NJ.

Alexander, C. (1999). Optimal Hedging Using Cointegration, Philosophical Transactions of the Royal Society, London, Series A 357, 2039-2058.

Alexander, C., and Barbosa, A. (2007). Effectiveness of Minimum Variance Hedging, The Journal of Portfolio Management, 33(2), 46-59.

Anderson, R. and Danthine, J. (1980). Hedging and Joint Production; Theory and Illustrations. Journal of Finance, 35, 487-498.

Bai, Y., and Green, J. C. (2011). Determinants of cross-sectional stock return variations in emerging markets, Empirical Economics, 41, 81-102. doi: 10.1007/s00181-010-0437-9.

Baillie, R. T., Booth, G. G., TSE, Y. and Zabotina, T. (2002). Price discovery and common factor models. Journal of Financial Markets, 5, 309-321.

Baillie, R. T. and Myers, R. J. (1991). Bivariate GARCH Estimation of the Optimal Commodity Futures Hedge. Journal of Applied Econometrics, 6, 109-124.

Balke, N. S. and Fomby, T. B. (1997). Threshold Cointegration. International Economic Review, 38, 627-645.

Bell, D. E. and Krasker, W. S. (1986). Estimating Hegde Ratios. Financial Management, 15, 34-39.

Benet, B.A. (1992). Hedge period length and ex-ante futures hedging effectiveness: The case of foreign-exchange risk crosses hedges. Journal of Futures Markets, 12, 163-175.

Benninga, S., Eldor, R. and Zilcha, I. (1983). Optimal Hedging in the Futures Market under Price Uncertainty. Economics Letters, 13, 141-145.

Benz, E. A. and Hengelbrock, J. (2008). Liquidity and Price Discovery in the European CO2 Futures Market: An Intraday Analysis. 21st Australasian Finance and Banking Conference Bonn Graduate School of Business.

Bera, A. K., Garcia, P. and Roh, J. S. (1997). Estimation of Time-Varying Hedging Ratios for Corn and Soybeans: BGARCH and Random Coefficient Approaches. Sankhya, 59, 346-368.

Bhaduri, S., and Durai, S. (2008). Optimal hedge ratio and hedging effectiveness of stock index futures: evidence from India. Macroeconomics and Finance in Emerging Market Economies, 1(1), 121-134.

Bollerslev, T. (1986). Generalized autoregressive conditional heteroscedasticity. Journal of Econometrics, 31, 307-327.

Bollerslev, T. (1990). Modelling the Coherence in Short-Run Nominal Exchange Rates: A Multivariate Generalized ARCH Model. Review of Economics and Statistics, 72, 498-505.

Bollerslev, T.; Engle, R.F., and Woolridge, J.M. (1988). A Capital Asset Pricing Model with Time-Varying Covariances. Econometrica, 96, 116-131.

Booth, G., R. So, and Y. Tse. 1999. Price discovery in the German equity index derivatives markets. Journal of Futures Markets, 19(6), 619–43.

Brenner, R. J. and Kroner, K. F. (1995). Arbitrage, Cointegration, and Testing the Unbiasedness in Financial Markets. Journal of Financial and Quantitative Analysis, 30, 23-42.

Brooks, C., and Persand, G. (2002). The Effect of Asymmetries on Optimal Hedge Ratios. Journal of Business, 75, 333-352.

Burill, D. (2007) Modelling and Interpreting Interactions in Multiple Regression, The Ontario Institute for Studies in Education Toronto, Ontario Canada.

Carter, C. A. (1984). An Evaluation of Pricing Performance and Hedging Effectiveness of the Barley Futures Market. Western Journal of Agricultural Economics, 9(1)maynard, 1-13.

Castelino, M. G. (1992). Hedge Effectiveness: Basis Risk and Minimum-Variance Hedging. Journal of Futures Markets, 12, 187-201.

Chan, K. (1992). A further analysis of the lead-lag relationship between the cash market and stock index futures market. Review of Financial Studies, 5, 123-152.

Chen, N., Cuny, C. J., and Haugen, R. A. (1995). Stock Volatility and the Levels of the Basis and Open Interest in Futures Contracts, The Journal of Finance, 50(1), 281-300.

Chen, S. Y., Lin, C. C., Chou, P. H., and Hwang, D. H. (2002). A Comparison of Hedge Effectiveness and Price Discovery between TAIFEX TAIEX Index Futures and SGX MSCI Taiwan Index Futures. Review of Pacific Basin Financial Markets and Policies, 5(2), 277-300.

Chou, W.L.; Denis, K.K.F., and Lee, C.F. (1996). Hedging with the Nikkei index futures: The conventional model versus the error correction model. Quarterly Review of Economics and Finance, 36, 495-505.

Choudhry, T. (2003). Short-Run deviations and optimal hedge ratio: evidence from stock futures. Journal of Multinational Financial Mangement, 13, 171-192.

Choudhry, T. (2004). The hedging effectiveness of constant and time-varying ratios using three Pacific Basin stock futures. International Review of Economics and Finance, 13, 371-385.

Cita, J. and Lien, D. (1992). A Note on Constructing Spot Price Indices to Approximate Futures Prices. Journal of Futures Markets, 12, 447-457.

Derivatives Market Survey (2011). World Federation of Exchanges (WFE) and International Options Market Association (IOMA), www.world-exchanges.org. Retrieved on 21th July 2011.

Dey, M. K. (2005). Turnover and return in global stock markets. Emerging Markets Review, 6, 45-67.

Dwyer, G. P.J., Locke, P, and Yu, W. (1996). Index arbitrage and nonlinear dynamics between the S&P 500 futures and cash. Review of Financial Studies, 9(1), 301-332.

Ederington, L. H. (1979). The Hedging Performance of the New Futures Markets. The Journal of Finance, 34(1), 157-170. doi:10.2307/2327150

Ederington, L. H., and Salas, J. M. (2008). Minimum Variance Hedging when Spot Price Changes are Partially Predictable. The Journal of Banking and Finance, 32, 654-663.

Engle, R. F. and Kroner, K. F. (1995). Multivariate Simultaneous Generalized ARCH. Econometric Theory, 11, 122-150.

Engle, R. F., and Granger, C. W. J. (1987). Co-Integration and error-correction: Representation, estimation and testing. Econometrica, 55, 251-276.

Fan, J. H., Roca, E., and Akimov, A. (2014). Estimation and performance evaluation of optimal hedge ratio in the carbon market of the European Union Emissions Trading Scheme, Australian Journal of Management, 39(1) 73-91.

Fama, E. and French, K. (1987). Commodity Futures Prices: Some Evidence on the Forecast Power, Premiums and the Theory of Storage. Journal of Business, 60, 55-73.

Fazillah, M., Azizan, N. A., and Hui, T. S. (2008). The Relationship between Hedging through Forwards Futures and Swaps and Corporate Capital Structure in Malaysia. The ICFAI Journal of Derivative Markets, 5(2), 37-52.

Figlewski, S. (1984). Hedging Performance and Basis Risk in Stock Index Futures. The Journal of Finance, 39, 657-669.

Figlewski, S. (1985). Hedging with Stock Index Futures: Theory and Application in a New Market. The Journal of Futures Markets, 5, 183-199.

Figlewski, S., Cecchetti, S. G., and Cumby, R. E. (1988). Estimation of the Optimal Ftures Hedge. The Review of Economics and Statistics, 70(4), 623-30.

Figuerola-Ferretti, I., and Gonzalo, J. (2010). Modelling and measuring price discovery in commodity markets. Journal of Econometrics, 158(1), 95-107. doi:10.1016/j.jeconom.2010.03.013

Fleming, J., B. Ostdiek, and R. Whaley. (1996). Trading costs and the relative rates of price discovery in stock, futures and option markets, Journal of Futures Markets, 16(4), 353-387.

Floros, C., and Vougas, D.V. (2006). Hedging effectiveness in Greek stock index futures market, 1999-2001. International Research Journal of Finance and Economics, 5, 7-18.

Gagnon, L., G. J. Lypny, and McCurdy, T. H. (1998) Hedging foreign currency portfolios, Journal of Empirical Finance, 5, 197-220.

Garbade, K. D. and Silber, W. L. (1983). Price Movements and Price Discovery in Futures and Cash Markets. Review of Economics and Statistics, 65, 289-297.

Genberg, H., M. K. Salemi, and A. Swoboda. (1987). The Relative Importance of Foreign and Domestic Disturbances for Aggregate Fluctuations in the Open Economy - Switzerland, 1964-1981, Journal of Monetary Economics, 19, 45-67.

Ghosh, A. (1993a). Cointegration and error correction models: Intertemporal causality between index and futures prices. The Journal of Futures Markets, 13, 193-198.

Ghosh, A. (1993b). Hedging with stock index futures: Estimation and forecasting with error correction model. Journal of Futures Markets, 13, 743-752.

Gilbert, C. J. (1996). International Commodity Agreements: An Obituary Notice. World Development, 24(1), 1-19.

Gluen, Huseyin, and Mayhew, Stewart (1999). Stock Index Futures Trading and Volatility in International Equity Markets. Purdue CIBER Working Papers. Paper 144. http://docs.lib.purdue.edu/ciberwp/144

Goss, B. A. (1972). The Theory of Futures Trading, London, Routledge and K. Paul

Grammatikos, T. (1986). Intervalling Effects, and the Hedging Performance of Foreign Currency Futures, Journal of Financial Research, 5, 95-104.

Grammig, J., and F. Peter. (2008). International price discovery in the presence of market microstructure effects, CFR Working Paper 08-10, Centre for Financial Research, Cologne.

Granger, C. W. J. (1986). Developments in the Study of Cointegrated Economic Variables. Oxford Bulletin of Economics and Statistics, 48, 213-228.

Grossman, S. (1977). The Existence of Futures Markets, Noisy Rational Expectations, and Informational Externalities. Review of Economic Studies, 44(3), 431-449.

Hales, A. D. (2012). The role of liquidity in the market for American Depositary Receipts: Evidence from Latin America, Ph.D. Dissertation at The University of Texas - Pan American, No: 3542567.

Hasbrouck, J. (1995). One security, many markets. Determining the contributions to price discovery. Journal of Finance, 50, 1175-1199.

Hatemi-J A. (2009). CItest2b: GAUSS module to implement tests for cointegration with two unknown structural breaks, Statistical Software Components, nr. G00006, Boston College Department of Economics.

Hatemi-J A. (2008). Tests for Cointegration with Two Unknown Regime Shifts with an Application to Financial Market Integration, Empirical Economics, 35(3), 497-505.

Hatemi-J, A., and Roca, E. (2012). A Re-examination of the Unbiased Forward Rate Hypothesis in the Presence of Multiple Unknown Structural Breaks, Applied Economics, 44(11). doi: 10.1080/00036846.2010.543075

Hatemi-J, A., and Roca, E. (2010). Estimating Optimal hedge ratio with unknown structural breaks, Discussion Papers Finance, Griffith University.

Hatemi-J, A., and Roca, E. (2005). Exchange rates and stock prices interaction during good and bad times: evidence from the ASEAN4 countries. Applied Financial Economics, 15(8), 539-546. doi:10.1080/09603100500056635

Herbst, A. F., and Maberly, E. D. (1992). The Informational Role of End-of-the-Day Returns in Stock Index Futures. The Journal of Futures Markets, 12(5), 595-601.

Herbst, A.F., Kare, D.D., and Marshall, J.F. (1993). A Time-Varying Convergence Adjusted Minimum Risk Futures Hedge Ratio. Advances in Futures and Options Research, 6, 137-155.

Herbst, A.F.. J.P. McCormack. and E.N. West. (1987). Investigation of a Lead-Lag Relationship between Spot Stock Indices and their Futures Contracts. Journal of Futures Markets, 7(4), 373-381.

Hill, J., and Schneeweis. (1981). The hedging effectiveness of foreign currency futures. The Journal of Financial Research, 5, 95-104.

Hill, J. and T. Schneeweis. (1982a). Forecasting and Hedging Effectiveness of Pound and Mark Forward and Futures Markets. Management International Review, 22, 43-52.

Hill, J. and T. Schneeweis. (1982b). The Hedging Effectiveness and Minimum Risk Hedge Ratios in the Presence of Autocorrelation: Foreign Currency Futures. Journal of Financial Research, 5, 95-104.

Hill, J. and T. Schneeweis. (1984). Reducing Volatility with Financial Futures. Financial Analysts Journal, 40, 34-40.

Holmes, P. (1996). Stock Index Futures Hedging: Hedge ratio Estimation, Duration Effects, Expiration Effects and Hedge ratio Stability. Journal of Business Finance and Accounting, 23, 63-78.

Honda, Y. (1983). Production Uncertainty and the Input Decision of the Competitive Firm Facing the Futures Market, Economics Letters, 11, 87-92.

Hossari, G. (1994). The Arbitrage Pricing Theory, Malaysian Evidence, MIMEO.

Howard, C.T., D'Antonio, L.J. (1984). A risk-return measure of hedging effectiveness. The Journal of Finance and Quantitative Analysis, 19 (1), 101-112.

Huang, P. (2014). The Stock Index Futures Hedge Ratio with Structural Changes, Investment Management and Financial Innovations, 11 (1), 97-113.

Hull, J. C. (2003). Options, Futures, and other Derivatives, 5th edition, Prentice Hall.

Hwang, D. Y., Y. T. Lin, C. H. Shen, and S. S. Wu. (1996). Reexamining the Hedging Behavior and Investors' Risk Aversion in the Currency Futures Markets: Mean-Variance versus Extended Mean-Gini Approach. Advances in Pacific Basin Business, Economics, and Finance, 2, 345-358.

Jacks, D. S. (2007). Populists versus theorists: Futures markets and the volatility of prices. Explorations in Economic History, 44(2), 342-362. doi:10.1016/j.eeh.2006.04.002

Johnson, LL. (1960). The Theory of Hedging and Speculation in Commodity Futures, Review of Economic Studies, 27(3), 139-151.

Junaina, M., Bany-Ariffin, A. N. and Yahya, M. H. (2013). Derivatives Trading and Volatility Spill-Over: Evidence from a Developing Derivatives Market. Pertanika Journal of Social Science & Humanities, 21, 57 - 70.

Junkus, J. C. and C. F. Lee. (1985). Use of Three Stock Index Futures in Hedging Decisions. The Journal of Futures Markets, 5, 201-222.

Karpoff, J. M. (1987). The relation between price changes and trading volume: a survey, Journal of Financial and Quantitative Analysis, 22, 109-126.

Kavussanos, M., and Visvikis, I. (2008). Hedging Effectiveness of the Athens Stock Index Futures Contracts. The European Journal of Finance, 14, 243-270.

Kawaller, I. G., P. D. Koch, and T. W. Koch. (1987). The Temporal Price Relationship between S&P 500 Futures and the S&P 500 Index, The Journal of Finance, 42, 1309-1929.

Kerkvliet, J. and Moffett, M. (1991). The Hedging of an Uncertain Future Foreign Currency Cash Flow. Journal of Financial and Quantitative Analysis, 26, 545-578.

Kempf, A., and Korn, O. (1998). Trading system and market integration. Journal of Financial Intermediation 7(3), 220–39.

Kenourgios, D., Samitas, A., & Drosos, P. (2008). Hedge ratio estimation and hedging effectiveness: the case of the S&P 500 stock index futures contract, International Journal of Risk Assessment and Management, 9(1/2), 121-138.

Keynes, J. M. (1923). Some Aspects of Commodity Markets, Manchester Guardian Commercial, European Reconstruction Series, Section 13, 784-86.

Kocks, T. (2015) Futures Hedging of Commodity Risk, Designing hedging strategies with a focus on the study of the optimal hedge ratio, Master Thesis, School of Management and Governance, University of Twente, Netherlands.

Kolb, Robert W., and Overdahl, James A. (2006). Understanding futures markets, 6th Edition. Published by Wiley-Blackwell. ISBN: 978-1-4051-3403-3

Koutmos, G., and Pericli, A. (1998). Dynamic hedging of commercial paper with T-bill futures, Journal of Futures Markets, 18 (8), 925-938.

Koutmos, G., and Tucker, M. (1996). Temporal relationships and dynamic interactions between spot and futures stock markets, The Journal of Futures Markets, 16, 55-69.

Kroner, K. F. and Sultan, J. (1993). Time Varying Distribution and Dynamic Hedging with Foreign Currency Futures. Journal of Financial and Quantitative Analysis, 28, 535-551.

Lake, F., (1978). The Miller's Use of the commodity exchange, Peck, A. (Ed.), Views from the Trade. Board of Trade of the City of Chicago, Chicago.

Lapan, H., Moschini, G. and Hanson, S.D. (1991). Production, Hedging, and Speculative Decisions with Options and Futures Markets, American Journal of Agricultural Economics, 73, 66-74.

Lee, J. W. (2014). The hedging Performance of Treasury Futures. Journal of Accounting and Finance, 14(6), 91-97.

Lence, S. H. (1995). On the Optimal Hedge under Unbiased Futures Prices. Economics Letters, 47, 385-388.

Lence, S. H. and Hayes, D. J. (1994a). The Empirical Minimum-Variance Hedge. American Journal of Agricultural Economics, 76, 94-104.

Lence, S. H. and Hayes, D. J. (1994b). Parameter-Based Decision Making Under Estimation Risks: An Application in Futures Trading. Journal of Finance, 49, 345-357.

Lien, D. (2012). A Note on Utility Based Futures Hedging Performance Measure, The Journal of Futures Markets, 32(1), 92-98. doi: 10.1002/fut.20510.

Lien, D. (2010a). Effects of Omitting Information Variables on Optimal Hedge Ratio Estimation: A Note, The Journal of Futures Markets, 30(8), 795-800. doi: 10.1002/fut.20427.

Lien, D. (2010b). A Note on the Relationship between the Variability of the Hedge Ratio and Hedging Performance. The Journal of Futures Markets, 30(11), 1100-1104. doi:10.1002/fut

Lien, D. (2009). A Note on the Hedging Effectiveness of GARCH Models, International Review of Economics and Finance, 18, 110-112. doi:10.1016/j.iref.2007.07.004.

Lien, D. (2005). A Note on the Superiority of the OLS Hedge Ratio. Journal of Futures Markets, 25, 1121-1126.

Lien, D. (2004). Cointegration and the optimal hedge ratio: the general case, The Quarterly Review of Economics and Finance, 44, 654-658.

Lien, D. (1999). Stochastic Volatility and Futures Hedging. Advances in Futures and Options Research, 10, 253-265.

Lien, D. (1996). The Effect of the Cointegration Relationship on Futures Hedging: A Note. Journal of Futures Markets, 16, 773-780.

Lien, D., Lee, G., Yang, L., and Zhou, C. (2012). Evaluating the Effectiveness of Futures Hedging, Working paper No. 0036ECO-202-2012, College of Business, The University of Texas at San Antonio, September 2012.

Lien, D., and Luo, X. (1993). Estimating multi-period hedge ratios in cointegrated markets. Journal of Futures Markets, 13, 909-920.

Lien, D., and Luo, X. (1994). Multiperiod Hedging in the Presence of Conditional Heteroskedasticity. Journal of Futures Markets, 14, 927-955.

Lien, D., and Tse, Y. K. (1999). Fractional Cointegration and Futures Hedging. Journal of Futures Markets, 19, 457-474. \

Lien, D., and Tse, Y. K. (2000a). Hedging Downside Risk with Futures Contracts. Applied Financial Economics, 10, 163-170.

Lien, D., and Tse, Y. K. (2000b). A Note on the Length Effect of Futures Hedging. Advances in Investment Analysis and Portfolio Management, 7, 131-143.

Lien, D., and Tse, Y. K. (2002). Some recent developments in Futures Hedging. Journal of Economic Surveys, 16(3), 357-396. doi: 10.1111/1467-6419.00172

Lien, D., Tse, Y. K. and Tsui, A. K. C. (2002). Evaluating the Hedging Performance of the Constant-Correlation GARCH Models. Applied Financial Economics, 12(11), 791-798.

Lien, D., and Zhang, M. (2008). A Survey of Emerging Derivatives Markets. Emerging Markets Finance and Trade, 44(2), 39-69. doi:10.2753/REE1540-496X440203

Lim, C.S. (2004). Intraday Analysis of the Malaysian Stock Index Futures Market. Unpublished PhD Thesis, Faculty of Economics and Management, Universiti Putra Malaysia.

Lim, W.S. (2005). Empirical Support for Arbitrage Pricing Theory in an Emerging Market. Unpublished PhD Thesis, Graduate School of Management, Universiti Putra Malaysia.

Lo, A. W. and A. C. MacKinlay. (1988). Stock Market Prices Do Not Follow Random Walks: Evidence from a Simple Specification Test. The Review of Financial Studies, 1, 41-66.

Losq, E. (1982). Hedging with Price and Output Uncertainty. Working paper, Economic Letters, 10, 65-70.

Maekawa, K., and Setiawan, K. (2014). Estimation of Vector Error Correction Model with GARCH Errors: Monte Carlo Simulation and Application, International Conference on Economic Modeling, ECOMOD, Bali, Indonesia.

Mahdhir, A., Annuar, M. N., Shamsher, M., Huson Joher, A., and Taufiq, H. (2002). The Temporal Price Relationship between the Stock Index Futures and the Underlying Stock Index: Evidence from Malaysia. Pertanika Journal of Social Science and Humanities, 10(1), 73-84.

Martens, M., Kofman, P, and Vorst, T. C. F. (1998). A threshold error-correction model for intraday futures and index returns. Journal of Applied Econometrics, 13, 245-263.

Masih, A., and Masih, R. (1996). Energy consumption, real income and temporal causality: Results from a multi-country study based on cointegration and error-correction modeling techniques, Energy Economics, 18, 165-183.

Maynard, L., Hancock, S., & Hoagland, H. (2001). Performance of shrimp futures markets as price discovery and hedging mechanisms. Aquaculture Economics & Management, 5(3), 115-128. doi:10.1080/13657300109380282

Mayordomo, S., Peña, J. I. and Romo, J. (2011): The effect of liquidity on the price discovery process in credit derivatives markets in times of financial distress, The European Journal of Finance, 17(9-10), 851-881. doi:10.1080/1351847X.2010.538529.

McNew, K. P. and P. L. Fackler. (1994). Nonconstant Optimal Hedge Ratio Estimation and Nested Hypotheses Tests. The Journal of Futures Market, 14, 619-635.

Merrick, J. J. (1988). Hedging with Mispriced Futures. Journal of Financial and Quantitative Analysis, 23(4), 451-464.

Min, J. H. and M. Najand. (1999). A Further Investigation of the Lead-lag Relationship between the Spot Market and Stock Index Futures: Early Evidence from Korea. The Journal of Futures Markets, 19(2), 217-232.

Mishkin, F. S. (2000). Lessons from the Asian Crisis, NBER Working Papers 7102, National Bureau of Economic Research, Inc.

Moosa, I. (2003). The Sensitivity of the Optimal Hedge Ratio to Model Specification. Finance Letters, 1, 15-20.

Myers, R.J. (1991). Estimating time-varying optimal hedge ratios on futures markets. Journal of Futures Markets, 11, 139-153.

Myers, R.J., and Thompson, S.R. (1989). Generalized Optimal hedge ratio estimation. American Journal of Agricultural Economics, 71, 858-867.

Noryati, Ahmad (2010). Impact of Automated Trading in the Crude Palm Oil Futures Market on its Underlying Spot Market. International Research Journal of Finance and Economics, Issue 36. ISSN 1450-2887

Overdahl, J. A. and D. R. Starleaf. (1986). The Hedging Performance of CD Futures Market. The Journal of Futures Markets, 6, 71-81.

Park, S. Y., and Jei, S. Y. (2010). Estimation and hedging effectiveness of time-varying hedge ratio - flexible GARCH approaches, Journal of Futures Markets, 30, 71-99.

Park, T. H. and Switzer, L. N. (1995). Bivariate GARCH Estimation of the Optimal Hedge Ratios for Stock Index Futures. Journal of Futures Markets, 15, 61-67.

Paroush, J. and Wolf, A. (1986). Production and Hedging Decisions with Futures and Forward Markets, Economics Letters, 21, 139-143.

Peck, Anne E. (1975). Hedging and Income Stability: Concepts, Implications, and an Example. American Journal of Agricultural Economics, 57, 410-419.

Pennings, J. M. E., Garcia, P. (2010). Risk and Hedging Behavior: The Role and Determinants. The journal of Financial Research, 33(4), 373-401.

Phillips, P. C. B. (1997). Time Series Regression with a Unit Root, 55, 277-301.

Pirrong, S. C. (1997). Metallgesellschaft: A Prudent Hegder Ruined, or a Wildcatter on NYMEX? Journal of Futures Markets, 17, 543-578.

Pok, W. C., Poshakwale, S. S., and Ford, J. L. (2009). Stock index futures hedging in the emerging Malaysian market. Global Finance Journal, 20(3), 273-288. doi:10.1016/j.gfj.2009.06.002

Poskitt, R. (2007). Benchmark Tipping and the Role of the Swap Market in Price Discovery. Journal of Futures Markets, 27(10), 981-1001. doi:10.1002/fut

Quan, J. (1992). Two-Step Testing Procedure for Price Discovery Role of Futures Prices. Journal of Futures Markets, 12, 129-139.

Rao, V. K. (2000). Preference-Free Optimal Hedging Using Futures. Economics Letters, 66, 223-228.

Rolfo, J. (1980). Optimal Hedging under Price and Quantity Uncertainty: the Case of Coca Producer. Journal of Political Economy, 88, 100-116.

Samuelson, P.A. (1965). Proof that properly anticipated prices fluctuate randomly. Industrial Management Review, 6, 41-50.

Sang-Gyung, J., Marathe, A., Shawky, H. A. (2003). Liquidity and stock markets in emerging equity markets, Emerging Markets Review, 4, 1-24.

Schlusche, B. (2009). Price formation in spot and futures markets: Exchange traded funds versus index funds, Journal of Derivatives, 17(2), 26-40.

Schmidt, C. and Statman, M. (1980). Optimal use of futures markets when input and output prices are uncertain. Economic Letters, 6, 107-11.

Schwarz, T. and Szakmary, A. (1994). Price Discovery in Petroleum Markets: Arbitrage, Cointegration, and the Time Interval of Analysis. Journal of Futures Markets, 14, 147-167.

Seyller, Thomas (2008). The value of hedging. PhD Thesis, Stanford University.

Shamsher, M., Hassan, T., and Ariff, M. (2007). Research in an Emerging Malaysian Capital Market: A Guide to Future Direction, International Journal of Economics and Management, 1(2), 173-202.

Shyy, G., V. Vijayraghavan, and Scott-Quinn, B. (1996). A further investigation of the lead-lag relationship between the cash market and stock index futures market with the use of bid/ask quotes: The case of France. The Journal of Futures Markets, 16(4), 405-420.

Sim A. B., and Zurbruegg, R. (2001). Optimal Hedge Ratios and Alternative Strategies in the Presence of Cointegrated Time-Varying Risks, The European Journal of Finance, 7(3), 269-283. doi: 10.1080/1351840110045153.

Sims, C. (1980). Macroeconomics and Reality, Econometrica, 48(1), 1-48.

Smith, C. and Stulz, R. (1985). The Determinants of Firms' Hedging Policies. Journal of Financial and Quantitative Analysis, 20, 391-405.

Stein J. L. (1961). The simultaneous determination of spot and futures price. American Economic Review, 51, 1012-1025.

Syriopoulos, T., Makram, B., Bokhbaker, A. (2015). International Review of Financial Analysis, 39, 7-18.

Taufiq H. (2001). Overall Performance of Malaysian Futures Market: Evidence Using Crude Palm Oil And Stock Index Futures Contract. Unpublished PhD Thesis, Graduate School of Management, Universiti Putra Malaysia.

Taufiq, H., Shakira, S. and Shamser, M. (2006). Behavior of KLIBOR futures contracts and Impact of Financial Crisis: Malaysian Experience. Presented in Asian Finance Association Conference, Auckland New Zealand.

Taufiq, H., Shamsher, M. and Annuar M.N. (2007a). Stock Index Futures Prices and the Asian Financial Crisis, International Review of Finance.

Taufiq, H., Shamsher, M. and Fatimah M.A. (2007b). Informational Efficiency of the Malaysian Crude Palm Oil Futures Contracts. The ICFAI Journal of Derivative Markets, 4(2), 58-71.

Telser, L. G., and Higinbotham, H. N. (1977). Organized Futures Markets: Costs and Benefits. Journal of Political Economy, 85, 969-1000.

Theissen, A. (2012). Price Discovery in Spot and Futures Markets: A Reconsideration, The European Journal of Finance, 18(10), 969-987. doi: 10.1080/1351847X.2011.601643.

Tse, Y. (2001). Index arbitrage with heterogeneous investors: A smooth transition error correction analysis, Journal of Banking and Finance, 25(10), 1829-55.

Tse, Y. (1999). Price discovery and volatility spillovers in the DJIA index and futures markets. The Journal of Futures Markets, 19(8), 911-930.

Tse, Y. K. (1995). Lead-lag relationship between spot index and futures price of the Nikkei Stock average. Journal of Forecasting, 14, pp. 553–563.

Tse, Y., and Joseph, K. W. Fung. (2008). Efficiency of Single Stock Futures: An Intraday Analysis. The journal of Futures Markets, 28(6), 518-536. doi:10.1002/fut.20323

Viswanath, P.V. (1993). Efficient use of information, convergence adjustments, and regression estimates of hedge ratios, Journal of Futures Markets, 13, 43-53.

Wahab, M., and Lashgari, M. (1993). Price dynamics and error correction in stock index and stock index futures markets: A cointegration approach. The Journal of Futures Markets, 13, 711-742.

Wasserfallen, W. (1989). Macroeconomic News and the Stock market: Evidence from Europe. Journal of Banking and Finance, 13, 613-626.

Wilson, W. W. (1989). Price discovery and hedging in the sunflower market. Journal of Futures Markets, 9(5), 377-391. doi:10.1002/fut.3990090503

Wiese, V. (1978). Use of commodity exchanges by local grain marketing organizations. (Ed) Peck, A. Views from the Trade. Board of Trade of the City of Chicago, Chicago.

Wong, Kit Pong. (2005). Tax Asymmetry and Futures Hedging under Liquidity Constraints. Managerial and Decision Economics, 26, 271-281.

Working, Holbrook. (1948). The Theory of the Inverse Carrying Charge in Futures Markets, Journal of Farm Economics, 30, 1-28.

Working, Holbrook. (1953). Futures Trading and Hedging. American Economic Review, 43 (June), 314-343.

Working, Holbrook. (1962). New Concepts Concerning Futures Markets and Prices. American Economic Review, June 1962, 431-459.

Yan, B., and E. Zivot. (2010). A structural analysis of price discovery measures, Journal of Financial Markets, 13(1), 1-19.

Yang, Wenling. (2001). M-GARCH Hedge Ratio and Hedging Effectiveness in Australian Futures Markets. PhD Thesis, Edith Cowan University.

Yang, W., and Allen, D.E. (2004). Multivariate GARCH hedge ratios and hedging effectiveness in Australian futures markets. Accounting and Finance, 45, 301-321.

Zeileis, A., Kleiber, C., Kraemer, W., and Hornik, K. (2003). Testing and Dating of Structural Changes in Practice. Computational Statistics & Data Analysis, 44, 109-123.

BIODATA OF STUDENT

Hamed Mohammad Shafiee is an economist with a strong background in applied economic analysis, policy advisory, regulation, and strategic planning across the public and private sectors. His doctoral research, which forms the basis of this thesis, focused on the effectiveness of emerging derivative markets in the Asia Pacific region, with a particular emphasis on price discovery processes. The thesis was submitted in fulfilment of the requirements for the degree of Doctor of Philosophy in Economics from Universiti Putra Malaysia.

Prior to undertaking his doctoral studies, Hamed completed a Bachelor's degree and a Master's degree in Economics at Shahid Beheshti University and the University of Tehran, respectively, developing a strong academic foundation in theoretical and applied economics. His research and publications have contributed to financial risk management, monetary policy, wellbeing economics, and industry and local government policy. Over the last decade, he has held senior advisory roles at the NewZealand Productivity Commission, the Treasury, the Department of Internal Affairs and Deloitte.

Driven by a passion for improving public outcomes through sound economic thinking, Hamed aims to bridge the gap between rigorous academic research and practical policy development. In all his roles, he strives to bring a balanced perspective that values both robust data analysis and the broader social and economic contexts in which policies operate.

LIST OF PUBLICATIONS

Shafiee, H.M., Hassan, T. and Fah, C.F. (2017). Price Discovery and Hedging Effectiveness: The Case of Asia Pacific Emerging Markets, *Asia-Pacific Financial Markets* (submitted).

Shafiee, H.M., Hassan, T. and Fah, C.F. (2017). Price Discovery and the Impact of Market Development: The Case of Asia Pacific Emerging Markets, *International Journal of Economics and Management* (submitted).