INTERNATIONAL PRICE RELATIONSHIPS AND VOLATILITY TRANSMISSIONS BETWEEN STOCK INDEX AND STOCK INDEX FUTURES

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Abstract

This study investigates the international price relationship and volatility transmissions between stock index and stock index futures of Malaysia, Hong Kong and Japan. Vector Autoregression (VAR) GJR-GARCH model was applied to the nine years daily price. Japanese markets are the main information producer to the market price changes. International market interdependence only affected the domestic volatility transmission of spot and futures market in Hong Kong. Asymmetric effects exist in all markets and the volatility persistence in each market is high. Finally, the overall conditional correlation estimates for spot and futures markets are higher in the unrestricted model form compared to the restricted model form.

Keywords: *spot-futures, lead-lags, volatility, VAR GJR-GARCH, Asian financial markets*
JEL classification numbers: *F37, G11, G15*

INTRODUCTION

In early 1990's, the development of communication technology and the implementation of fewer trade barriers between countries had initiated a new era in financial markets. The recent globalisation of financial markets had motivated some investors to invest in different countries in order to gain some benefits from diversification, instead of relying on only one country. This caused the management of asset and liability to become globally integrated between countries. The issuance of international securities is often used as a substitute for more traditional funding channels. Investors, market analysts, fund managers, and even shareholders are welcomed these developments as they have some potential to burst competition and lead efficient allocation of capital nationally and internationally with lower-cost financial services. The process of globalisation in financial markets caused difficulty for investment management. Market participants mainly use stock indexes to help them in investment management; for example, as a benchmark to evaluate the portfolio performance, to create the portfolio (Index Fund Portfolio), and to evaluate the current and to predict the future market performance. In addition, market participants also trade the stock index futures as a part of their portfolio. They use stock index futures in the hedging, speculating and arbitraging activities.

A growing body of research has attempted to establish the nature and extent of interdependence between stock index and stock index futures. Previous research on the relationship of stock index and stock index futures and volatility transmission has only been done within one country (Min and Najand, 1999; Yu, 2001; Bologna and Cavallo, 2002). More recently, researchers have moved further beyond this barrier by investigating countries in the same geographical area; for example Antoniou et al. (2003) investigate this relationship among European Union countries. However, none of these studies have considered the international market interdependence on the relationship between spot markets and futures markets between countries in Asia. There is a question as to whether or not globalisation affects the price relationship and volatility transmission between stock index and stock index futures within Asian stock markets.

The focus of this study is to investigate the lead-lag relationships and volatility transmissions between stock indexes and stock index futures in Asia. This investigation will be carried out on the first three countries to introduce domestic stock index futures contracts in Asia[1]: Malaysia, Hong Kong, and Japan. The objectives of this study are: (1) To investigate the lead-lag relationship between the stock index and stock index futures; (2) To determine the transmission of volatility across international market; and (3) To measure the correlation between the stock index markets and stock index futures markets across the countries. The models obtained from this study are expected to help investors and fund managers in allocating their capital in more efficient ways in both domestic and international markets. Market participants can use the models derived from this study as guidance in making investment decisions. Furthermore, results from this study have some potential to be used by market analysts for predicting future market movement. Market analysts can give better recommendations on the stock market if they know which markets are leading the other markets. In an academic point of view, the findings of this study are expected to give a better understanding of the relationship between spot markets and futures markets. Finally, the results can be useful to regulators of stock markets and futures market in regulating those markets.

A growing body of research has attempted to establish the nature of and extent of interdependence between stock index and stock index futures. Yang and Bessler (2004) tried to find the international price transmission in stock index futures markets. They used the nine major stock index futures markets in the world. The result shows that the Japanese market is isolated from other major stock index futures markets. The US and UK markets appear to share leadership roles in stock index futures markets. Furthermore, the UK and German markets rather than the United State exert significant influences on most European markets, which show a pattern of regional integration in Europe. Ryoo and Smith (2004) investigated the impact of trading in KOSPI 200 Index Futures on the spot markets. They found that there is weak evidence that the spot market leads the futures market but there is a strong evidence for futures markets to lead the spot market in Korea.

Ramasamy and Shanmugam (2003) tried to investigate the lead and lag relationship of spot-futures relationship in Malaysia. They found that the stock index futures return leads the stock index, return by one day during stable period but the lag becomes two days during high volatility period. Meanwhile, the stock index return lead the stock

[1] Bursa Malaysia Derivatives Berhad (2005)

index futures return by one day in both stable and high volatility period. A study done by Bologna and Cavallo (2002) examined the effect of the introduction stock index futures on the volatility of the Italian Stock Exchange. They found that the introduction of stock index futures in Italy led to a reduction in stock market volatility and enhanced the efficiency of the spot markets. This finding is consistent with those theories stating that active and developed futures markets enhance the efficiency of the corresponding spot markets. Gwilym and Buckle (2001) investigated the lead-lag relationship between the FTSE-100 Stock Index and its related derivative contracts. The study shows that both stock index futures and stock index options lead the spot market. However, the study found that only call option markets appear to marginally lead both the index futures and the put option markets. The Frino et al (2000) study on the lead-lag relationship between equities and stock index futures around information releases. The result from this study shows that a strengthening in the lead of the stock index futures returns over stock index returns around macroeconomics information releases.

Frina and West (1999) study focused on the lead-lag relationship between stock index and stock index futures in Australia from 1992 to 1997. They found that futures returns lead index returns by twenty to twenty- five minutes and that there is some evidence of feedback from the equity markets to the futures markets. A year-by-year analysis shows that the futures market leads over the equities market has decreased over time and the relationship between the two markets has generally strengthened, which is consistent with an increase in the level of integration between the markets. Min and Najand (1999) investigated the possible lead-lag relationship in returns and volatility between cash and futures markets in Korea. The findings suggested that futures market leads the cash market, and there is a bidirectional volatility interaction between spot and futures markets. They also found that trading has significant explanatory power for volatility changes in cash and futures markets.

Tang et al. (1992) in their study of the interrelationship between Hang Seng Index Futures contract and the underlying Hang Seng index in Hong Kong, found that the Hang Seng Index Futures caused the Hang Seng Index price to change in the pre-crash period. However, a bi-directional relationship was found between these two variables during post-crash period. Chan (1992) investigated the intraday lead/lag relationships between returns of the Major Market cash index and returns of Major Market cash index futures with S&P 500 index futures. His study suggested that the futures market leads the cash market. He also showed evidence that when more stocks move together, the futures leads the cash index to a greater degree and the futures market becomes the main source of market-wide information. Kalok (1992) analysed the lead-lag relationship between the cash market and stock index futures market using Major Market Cash Index returns, Major Market Index Futures returns and S&P 500 Futures returns. He found strong evidence that futures markets lead the cash index and the asymmetric lead-lag relation holds between the futures and all component stocks, including those that trade in almost every five-minute interval. The study also shows that when more stock move together, the futures leads the cash index to a grater degree. Butterworth (2000) used symmetric and asymmetric GARCH methods to investigate the effect of futures trading on the FTSE Mid 250 index. The result suggested a symmetric model that adequately captures the response of volatility to the news. Furthermore, the study found that following the onset of futures trading the quantity of information flowing into the market increased. However, the rate at which news is impounded into prices fell, with an associated rise in the persistence of information.

Zhong et al. (2004) investigates the effect of Mexican Stock Index futures to the spot market. The study found that the futures market in Mexico is a useful price discovery vehicle and has also been a source of instability for the spot market. Bae et al. (2004) examined the effect of introducing the KOSPI 200 Stock Index Futures to the spot price volatility and market efficiency of KOSPI 200 stocks and non-KOSPI 200 stocks. The study found that the introduction of KOSPI 200 Stock Index Futures caused greater market efficiency in underlying stocks. In addition, the study showed that KOSPI 200 stocks experience lower price volatility compared to the non-KOSPI 200 stocks after the introduction of the stock index futures. Bhar (2001) used a bivariate EGARCH model in investigating the links between the equity market and the index futures market in Australia. He found that conditional means returns from both markets are influenced by the long-run equilibrium relationship.

Faff and McKenzie (2002) investigated the impact of the introduction of stock index futures trading on the daily returns of the underlying index for seven countries. Their results support the argument that the introduction of futures trading leads to reduced seasonality means returns. Yu (2001) in a study on the impact of futures contract on the volatility of the spot markets suggested that, following the introduction of index futures, the volatility of stock returns in the USA, France, Japan and Australia rose significantly while no significant changes in the volatility were found in the United Kingdom and Hong Kong. Gulen and Mayhew (2000) studied the stock index futures trading and volatility in international market using 25 countries. They tried to examine the stock market volatility before and after the introduction of stock index futures. The study found that the futures trading is related to an increase in conditional volatility in the US and Japan. However, in other market the result shows either no significant effect or a volatility dumping effect.

The last three studies looked at the relationship between domestic spot and futures markets and ignored the international interdependence between the countries. Antoniou et al. (2003) in the study of relationships spot and futures markets within the same geographical area found that there are significant multidirectional lead-lag relationships and volatility transmission between spot and futures market in the United Kingdom, Germany and France.

METHODS

The data analysis in this study is divided mainly into two types: (1) Single Country Analysis (Restricted Model); and (2) Multi Country Analysis (Unrestricted Model). The variables included in the single country analysis are the stock index and stock index futures in each country. The main objective of the single country analysis is to find the lead-lag relationship and volatility transmission between the futures contract and its underlying asset. This type of analysis is also known as Restricted Model because the relationship of stock index and stock index futures is restricted to one country only. The second type of analysis is Multi Country Analysis which includes all countries investigated. The main objective of this analysis is to find the international relationship and market interdependence of stock index and stock index futures in Asia. Multi Country Analysis can be considered as an Unrestricted Model because it allows for an examination of price relationship and volatility transmissions across spot and futures in different countries.

The model will be use to achieve the objective of this study is a multivariate VAR GJR-GARCH Model. It is a combination on Vector Autoregressive Models (VAR) popularised by Sims (1980) and GJR-GARCH Models. GJR-GARCH model is a model introduced by Glosten, Jagannathan and Runkle (1993). It is an extension GARCH model developed independently by Bollerslev (1986) and Taylor (1986). This model is considered because it allows simultaneous estimation of mean and variance equation in different country of stock index and stock index futures markets. The multivariate VAR GJR-GARCH model used in this study can be expressed in the following way:

$$R_{i,t} = \beta_{i,0} + \sum_{j=1}^{n} \beta_{i,j} R_{j,t-1} + \sum_{k=1}^{n} \beta_{i,Dk} D_k + \varepsilon_{i,t}$$

$$\varepsilon_{i,t} \sim N(0, \sigma_t^2) \quad (1)$$

$$\sigma_{i,t}^2 = \alpha_i + \alpha_{i,0}\sigma_{i,t-1}^2 + \alpha_{i,i}\varepsilon_{i,t-1}^2 + \sum_{j=1}^{n} \alpha_{i,j}\varepsilon_{j,t-1}^2 + \gamma\varepsilon_{i,t-1}^2 I_{i,t-1}^2 \, . \quad (2)$$

$$\sigma_{i,j,t} = \rho_{i,j}\sigma_{i,t}\sigma_{j,t} \quad (3)$$

For i,j=1….n and $i \neq j$

Equation (1) shows the returns of n stock index and stock index futures as a vector autoregression. In this equation a mean return of market i at time t is a function of own past return, cross-market pass return and dummy variables represent the day-of-the-week effect. The dummy variables of the day-of-the-week effects are represents each trading days in one week. D1 is equal to 1 if the day is Monday and 0 if the day is not Monday. Coefficient $\beta_{i,j}$ shows the lead-lag relationship between stock index markets and stock index futures market within the country and across the countries for different i and j. Coefficient $\beta_{i,Dk}$ shows the effect of positive return to the $R_{i,t}$ if it is occur in day k. Equation (2) describes the conditional variance for i at time t as a linear function of its lagged conditional variance term, its past squared error term, past squared error term of market j and dummy variable which represent the asymmetric effect. Coefficient $\alpha_{i,0}$ shows effect of previous volatility to the current volatility in the market. Coefficient $\alpha_{i,i}$ shows the effect of previous price shock in its own market to the current volatility of the market. In addition, coefficient $\alpha_{i,j}$ shows the spill over effect of current price shock in market j to the volatility of market i. The sum of coefficient $\alpha_{i,0}$ and $\alpha_{i,i}$ shows the degree of volatility persistence. The last coefficient in equation 2 which is γ shows the asymmetric impact to the volatility of the market. The positive value of γ means the volatility of market i is greater following bad news.

The VAR GJR-GARCH is not in the usual linear form. Therefore, the model estimation using Ordinary Least Squares method cannot be use with this model. The suitable method in estimating GARCH model is maximum likelihood method. The log-likelihood function[2] under the assumption of joint-normal distribution is:

$$l(\theta) = -\frac{TN}{2} Log\, 2\pi - \frac{1}{2}\sum_{t=1}^{T}\left(\log|H_t| + \Xi_t' H_t^{-1} \Xi_t\right). \quad (4)$$

Where

θ = the vector of parameters to be estimated.

Ξ_t' = the vector of innovations at time t.

N = number of equation to be estimate.

[2] Brooks (2002)

T = number of sample used.

H_t = the time varying variance-covariance matrix, where equations 2 is the diagonal elements and equations 3 is the cross diagonal elements.

The maximisation processed for log-likelihood function is carried out by employing the algorithm proposed by Broyden, Fletcher, Goldfarb and Shanno (1965). The maximisation process also known as BFGS method.

The data used in this study are daily closing price of spot markets and continuous closing daily price of futures markets in Malaysia, Hong Kong and Japan. The daily closing price for stock index and continuous daily closing price for stock index futures were obtained from DATASTREAM. The data collected for this study is for nine years, from 1 January 1996 to 31 December 2004. The dates covered in this study are the only dates in which all six variables traded. Table 1 shows the variables used in this study.

Daily return for each variable are calculated using continuously compounded return. The continuously compounded return[3] calculated as the logarithmic difference in the daily closing price.

Table 1: Name of Variables

Country	Stock Index	Stock Index Futures
Malaysia	Bursa Malaysia Stock Index (BMI)	Bursa Malaysia Stock Index Futures (BMIF)
Hong Kong	Hang Seng Index (HSI)	Hang Seng Index Futures (HSIF)
Japan	Nikkei 225 Average Index (NKI)	Nikkei 225 Average Index Futures (NKIF)

RESULTS DISCUSSION

Table 2: Descriptive Statistics of Spot and Futures Index Series:January 1996-December 2004

Variable	Malaysia		Hong Kong		Japan	
	Stock Index	Stock Index Futures	Stock Index	Stock Index Futures	Stock Index	Stock Index Futures
Mean (%)	-0.00191	-0.00195	0.00730	0.00709	-0.01173	-0.01174
t-stat (μ=0)	-0.10	-0.09	0.41	0.35	-0.78	-0.75
Variance (%)	0.0069	0.0001	0.0066	0.0085	0.0046	0.0049
Skewness (SK=0)	0.52 ***	-0.90 ***	0.24 ***	0.71 ***	0.07	0.05
Kurtosis (KU=0)	33.12 ***	53.55 ***	10.72 ***	13.23 ***	1.67 ***	1.71 ***
Bera-Jarque (JB=0)	92799.19 ***	242614.44 ***	9732.64 ***	14969.39 ***	239.95 **	248.17 ***

Notes: 1. *** *Significance at the 1% level*
2. ** Significance at the 5% level
Table 0 * Significance at the 10% level

[3] Brooks (2002)

Table 2 shows the descriptive statistic for all the variables used in this study for period from January 1996 to December 2004. From this table, it shows that BMI, NKI, BMIF and NKIF have a negative mean while HSI and HSIF have a positive mean. Furthermore, the means are not significantly different from zero. On average, the variance for each variable is considered low (below than 0.01%). The skewness for each variable indicates that BMI, HSI and HSIF have a positively skewed distribution while BMI has a negatively skewed distribution. The skewness for NK and NKF show that these two variables have a symmetrical distribution. The penultimate row in this table shows the value of kurtosis for each variable. The value of kurtosis from the descriptive statistics shows that all the variables have a leptokurtic distribution. The last row in the descriptive statistics tables shows the value of Bera-Jarque normality test. The Bera-Jarque value for all variables confirmed that all the returns of the variables do not follow a normal distribution.

Table 3 shows the unconditional correlation matrix between six variables in this study. This table shows that all the stock index markets have a strong correlation with its futures markets.(KL and KLF = 0.88; HS and HSF =0.95; NK and NKF = 0.96). The pairwise correlations between the markets across the country are considered low (below than 0.5) and these suggesting that a better opportunity of diversification in constructing a portfolio.

Table 3: Unconditional Correlation Matrix between Spot and Futures Prices January 1996-December 2004

Estimated Unconditional Correlation

		Malaysia		Hong Kong		Japan	
		Spot	Futures	Spot	Futures	Spot	Futures
Malaysia	Spot	1					
	Futures	0.88656	1				
Hong	Spot	0.39804	0.40191	1			
Kong	Futures	0.36367	0.38931	0.95463	1		
Japan	Spot	0.21477	0.25451	0.44150	0.43825	1	
	Futures	0.21178	0.25971	0.43345	0.43431	0.95764	1

Table 4: Single Country Analysis (Restricted Model)

Panel A: Estimated Coefficients for VAR GJR -GARCH Model

Malaysia				Hong Kong				Japan			
Stock Index		Stock Index Futures		Stock Index		Stock Index Futures		Stock Index		Stock Index Futures	
$\beta_{1,0}$	-3.27e-5 (0.66846)	$\beta_{2,0}$	-4.92e-5 (0.61306)	$\beta_{3,0}$	3.65e-5 (0.75353)	$\beta_{4,0}$	7.29e-6 (0.95566)	$\beta_{5,0}$	-1.56e-4 (0.18812)	$\beta_{6,0}$	-1.65e-4 (0.18489)
$\beta_{1,1}$	0.0282 (0.47999)	$\beta_{2,2}$	-0.2255*** (0.00000)	$\beta_{3,3}$	-0.1323*** (0.00016)	$\beta_{4,4}$	-0.2533*** (0.00000)	$\beta_{5,5}$	-0.2038*** (0.00000)	$\beta_{6,6}$	0.2258*** (0.00000)
$\beta_{1,2}$	0.1070*** (0.00107)	$\beta_{2,1}$	0.2680*** (0.00000)	$\beta_{3,4}$	0.1802*** (0.00000)	$\beta_{4,3}$	0.2614*** (0.00000)	$\beta_{5,6}$	0.1949*** (0.00000)	$\beta_{6,5}$	-0.2660*** (0.00000)
α_1	6.48e-7** (0.02875)	α_2	8.14e-7** (0.02142)	α_3	8.24e-7** (0.01364)	α_4	8.92e-7*** (0.00643)	α_5	1.70e-6*** (0.00003)	α_6	2.27e-6*** (0.00001)
$\alpha_{1,0}$	0.8771*** (0.00000)	$\alpha_{2,0}$	0.8779*** (0.000000	$\alpha_{3,0}$	0.9057*** (0.00000)	$\alpha_{4,0}$	0.9140*** (0.00000)	$\alpha_{5,0}$	0.8592*** (0.00000)	$\alpha_{6,0}$	0.8512*** (0.00000)
$\alpha_{1,1}$	0.0480** (0.01383)	$\alpha_{2,2}$	0.0173 (0.27825)	$\alpha_{3,3}$	3.53e-7 (0.99977)	$\alpha_{4,4}$	0.0320 (0.10508)	$\alpha_{5,5}$	4.70e-3 (0.66752)	$\alpha_{6,6}$	0.0632*** (0.00000)
$\alpha_{1,2}$	0.0137 (0.31681)	$\alpha_{2,1}$	0.0911*** (0.00000)	$\alpha_{3,4}$	0.0348*** (0.00238)	$\alpha_{4,3}$	-0.0131 (0.33092)	$\alpha_{5,6}$	0.0636*** (0.00001)	$\alpha_{6,5}$	-6.45e-7 (0.99804)
γ_1	0.0832*** (0.00001)	γ_2	0.0662*** (0.00256)	γ_3	0.0722*** (0.00000)	γ_4	0.0656*** (0.00002)	γ_5	0.0705*** (0.00001)	γ_6	0.0853*** (0.00001)

Panel B: Estimated Volatility Persistence

		$\alpha_{i,0}$	$\alpha_{i,i}$	Sum of $\alpha_{i,0}$ and $\alpha_{i,i}$
Malaysia	Spot	0.8771*** (0.00000)	0.0480** (0.01383)	0.92510
	Futures	0.8779*** (0.000000	0.0173 (0.27825)	0.89520
Hong Kong	Spot	0.9057*** (0.00000)	0.00000 (0.99977)	0.9057
	Futures	0.9140*** (0.00000)	0.0320 (0.10508)	0.94600
Japan	Spot	0.8592*** (0.00000)	0.00470 (0.66752)	0.86390
	Futures	0.8512*** (0.00000)	0.0632*** (0.00000)	0.9144

Panel C: Estimated Conditional Correlation

		Malaysia		Hong Kong		Japan	
		Spot	Futures	Spot	Futures	Spot	Futures
Malaysia	Spot	1					
	Futures	0.8694*** (0.00000)	1				
Hong Kong	Spot	0.3455*** (0.00000)	0.4195*** (0.00000)	1			
	Futures	0.3207*** (0.00000)	0.4076*** (0.00000)	0.9567*** (0.00000)	1		
Japan	Spot	0.2839*** (0.00000)	0.3435*** (0.00000)	0.4636*** (0.00000)	0.4595*** (0.00000)	1	
	Futures	0.2819*** (0.00000)	0.3391*** (0.00000)	0.4710*** (0.00000)	0.4653*** (0.00000)	0.9669*** (0.00000)	1

Notes:
1. *** Significant at the 1% level
2. ** Significant at the 5% level
3. * Significant at the 10% level

Panel A in Table 4 shows the estimated coefficients for vector auto-regression model on the single country analysis. From the table we can see that the only market not affected by its lagged return is Bursa Malaysia Stock Index. The previous returns of Bursa Malaysia Stock Index Futures, Hang Seng Stock Index, Hang Seng Stock Index

Futures and Nikkei 225 Stock Index are negatively affected the current return of these markets respectively. However, the Nikkei 225 Stock Index Futures is positively affected by its lagged return.

The coefficients $\beta_{i,j}$ in the mean equations for all variables are significant. These show that there are feedback effects between stock index markets and stock index futures markets within Malaysia, Hong Kong and Japan. This finding is similar with the research done for Germany and France by Antoniou et al (2003). However, the results are different from the theory in which according to Antoniou at al. (2003), the futures market act as a price discovery vehicle for the spot market imperfection and thus lead the spot market. This theory is supported by most of literature which find that the price movement in futures market leads the price movement in spot market, not vice versa (Ryoo and Smith, 2004; Zhong et al., 2004; and Gwilym and Buckle, 2001).

The second part of Panel A in Table 4 shows the estimated coefficient for the conditional variance equation in the restricted model. The coefficients $\alpha_{i,0}$ for all variables are statistically significant. These mean that the current volatility of all markets investigated are affected by its own lagged volatility. In addition, the results also show that only Bursa Malaysia Stock Index and Nikkei 225 Stock Index Futures affected by previous price shock in each market respectively. The findings also show that there are significant unidirectional volatility transmissions from stock index futures markets to the stock index markets in Hong Kong and Japan. However, coefficient $\alpha_{2,1}$ shows that there is statistically significant unidirectional volatility transmission from stock index market to the stock index futures market in Malaysia. The findings in Hong Kong and Japan are same with the theory where the change in the volatility of stock index futures markets will effect the change in the volatility of stock index markets (Bologna and Cavallo, 2002; and Yu, 2001).

The last coefficients in Panel A show the asymmetric effects in each market. The coefficients γ_i are significant for all market. These findings can be inferred that asymmetry is present in all stock index and stock index futures market within Malaysia, Hong Kong and Japan. All the stock index markets and stock index futures markets in the countries investigated have a positive sign of coefficient for asymmetric effects. The positive sign shows that the volatility in the market is higher during the bear market compare to the bull markets. The positive sign also can be interprets that a bad news are followed by higher volatility than a good news. Panel B in Table 4 shows the estimated volatility persistence for each market in Malaysia, Hong Kong and Japan. The results show that the volatility persistence in stock index markets and stock index futures markets within Malaysia, Hong Kong and Japan are significantly high because the sum of coefficient $\alpha_{i,0}$ and $\alpha_{i,i}$ for each market is close to unity. The findings are similar with the findings of study done by Antoniou et Al. (2003) on UK, France and Germany.

Panel C in Table 4 shows the estimated conditional correlation of restricted model for stock index markets and stock index futures markets within Malaysia, Hong Kong and Japan. The correlation coefficients show that there is a high correlation between stock index markets and its corresponding stock index futures markets. However, the market correlations across the countries are low.

Table 5: Multi Country Analysis (Unrestricted Model)

Panel A: Estimated Coefficients of VAR GJR -GARCH Model

Malaysia				Hong Kong				Japan			
Stock Index		Stock Index Futures		Stock Index		Stock Index Futures		Stock Index		Stock Index Futures	
$\beta_{1,0}$	-2.82e-5 (0.63221)	$\beta_{2,0}$	-3.72e-5 (0.62092)	$\beta_{3,0}$	6.24e-5 (0.47861)	$\beta_{4,0}$	4.11e-5 (0.67957)	$\beta_{5,0}$	-1.68e-4** (0.07994)	$\beta_{6,0}$	-1.76e-4* (0.06961)
$\beta_{1,1}$	6.03e-3 (0.78860)	$\beta_{2,2}$	-0.1732*** (0.00000)	$\beta_{3,3}$	-0.0947 (0.16334)	$\beta_{4,4}$	-0.2996*** (0.00000)	$\beta_{5,5}$	-0.3045*** (0.00000)	$\beta_{6,6}$	-0.1896*** (0.00000)
$\beta_{1,2}$	0.1285*** (0.00000)	$\beta_{2,1}$	0.2224*** (0.00000)	$\beta_{3,1}$	-0.0587*** (0.00000)	$\beta_{4,1}$	-0.0977*** (0.00000)	$\beta_{5,1}$	-0.0150 (0.44633)	$\beta_{6,1}$	-0.0119 (0.55894)
$\beta_{1,3}$	0.0190 (0.53195)	$\beta_{2,3}$	0.0717* (0.06133)	$\beta_{3,2}$	0.0607*** (0.00000)	$\beta_{4,2}$	0.1054*** (0.00000)	$\beta_{5,2}$	7.94e-3 (0.63604)	$\beta_{6,2}$	-2.11e-3 (0.90526)
$\beta_{1,4}$	-0.0166 (0.55635)	$\beta_{2,4}$	-0.0728** (0.03416)	$\beta_{3,4}$	0.1466** (0.01085)	$\beta_{4,3}$	0.2955*** (0.00008)	$\beta_{5,3}$	-8.91e-3 (0.81820)	$\beta_{6,3}$	-0.0137 (0.73451)
$\beta_{1,5}$	-0.0466*** (0.00006)	$\beta_{2,5}$	-0.0809*** (0.00000)	$\beta_{3,5}$	-0.1993*** (0.00000)	$\beta_{4,5}$	-0.1958*** (0.00000)	$\beta_{5,4}$	0.0418 (0.21291)	$\beta_{6,4}$	0.0426 (0.22038)
$\beta_{1,6}$	0.0407*** (0.00002)	$\beta_{2,6}$	0.0647*** (0.00001)	$\beta_{3,6}$	0.1795*** (0.00000)	$\beta_{4,6}$	0.1874*** (0.00000)	$\beta_{5,6}$	0.2699*** (0.00000)	$\beta_{6,5}$	0.1276*** (0.00000)
α_1	1.54e-7 (0.33545)	α_2	2.92e-7 (0.19099)	α_3	9.41e-7*** (0.00091)	α_4	1.09e-6*** (0.00077)	α_5	1.29e-6*** (0.00007)	α_6	1.73e-6*** (0.00001)
$\alpha_{1,0}$	0.8659*** (0.00000)	$\alpha_{2,0}$	0.8638*** (0.00000)	$\alpha_{3,0}$	0.8890*** (0.00000)	$\alpha_{4,0}$	0.8976*** (0.00000)	$\alpha_{5,0}$	0.8712*** (0.00000)	$\alpha_{6,0}$	0.8620*** (0.00000)
$\alpha_{1,1}$	0.0454** (0.01331)	$\alpha_{2,2}$	0.0112 (0.42488)	$\alpha_{3,3}$	7.94e-9 (0.99748)	$\alpha_{4,4}$	0.0198 (0.18016)	$\alpha_{5,5}$	-1.10e-3 (0.57750)	$\alpha_{6,6}$	0.0436*** (0.00001)
$\alpha_{1,2}$	1.89e-7 (0.75854)	$\alpha_{2,1}$	0.0745*** (0.00008)	$\alpha_{3,1}$	-3.62e-3 (0.28779)	$\alpha_{4,1}$	3.11e-9 (0.99932)	$\alpha_{5,1}$	7.10e-10 (0.99772)	$\alpha_{6,1}$	-1.24e-3 (0.13503)
$\alpha_{1,3}$	-0.0260*** (0.00021)	$\alpha_{2,3}$	-1.19e-8 (0.99864)	$\alpha_{3,2}$	4.72e-3 (0.29144)	$\alpha_{4,2}$	0.0151** (0.01068)	$\alpha_{5,2}$	4.27e-10 (0.99811)	$\alpha_{6,2}$	-5.48e-10 (0.99971)
$\alpha_{1,4}$	7.08e-3* (0.08722)	$\alpha_{2,4}$	0.0351*** (0.00000)	$\alpha_{3,4}$	0.0344*** (0.00028)	$\alpha_{4,3}$	0.0191* (0.07264)	$\alpha_{5,3}$	5.41e-3 (0.19251)	$\alpha_{6,3}$	1.22e-10 (0.99999)
$\alpha_{1,5}$	1.06e-3 (0.66888)	$\alpha_{2,5}$	-5.42e-9 (0.99890)	$\alpha_{3,5}$	3.06e-03 (0.47784)	$\alpha_{4,5}$	5.38e-3 (0.24740)	$\alpha_{5,4}$	-4.71e-3** (0.03124)	$\alpha_{6,4}$	0.0134*** (0.00275)
$\alpha_{1,6}$	-1.16e-3 (0.66893)	$\alpha_{2,6}$	-9.47e-4 (0.78042)	$\alpha_{3,6}$	9.27e-4 (0.79058)	$\alpha_{4,6}$	-4.75e-8 (0.99886)	$\alpha_{5,6}$	0.0519*** (0.00001)	$\alpha_{6,5}$	3.74e-9 (0.99834)
γ_1	0.0670*** (0.00000)	γ_2	0.0601*** (0.00137)	γ_3	0.0787*** (0.00000)	γ_4	0.0711*** (0.00000)	γ_5	0.0654*** (0.00000)	γ_6	0.0791*** (0.00000)

Panel B: Estimated Volatility Persistence

		$\alpha_{i,0}$	$\alpha_{i,i}$	Sum of $\alpha_{i,0}$ and $\alpha_{i,i}$
Malaysia	Spot	0.8659*** (0.00000)	0.0454** (0.01331)	0.91130
	Futures	0.8638*** (0.00000)	0.0112 (0.42488)	0.87500
Hong Kong	Spot	0.8890*** (0.00000)	0.00000 (0.99748)	0.88900
	Futures	0.8976*** (0.00000)	0.0198 (0.18016)	0.91740
Japan	Spot	0.8712*** (0.00000)	-0.00011 (0.57750)	0.87109
	Futures	0.8620*** (0.00000)	0.0436*** (0.00001)	0.90560

Panel C: Estimated Conditional Correlation

		Malaysia		Hong Kong		Japan	
		Spot	Futures	Spot	Futures	Spot	Futures
Malaysia	Spot	1					
	Futures	0.8704*** (0.00000)	1				
Hong Kong	Spot	0.3489*** (0.00000)	0.4218*** (0.00000)	1			
	Futures	0.3234*** (0.00000)	0.4103*** (0.00000)	0.9660*** (0.00000)	1		
Japan	Spot	0.2799*** (0.00000)	0.3412*** (0.00000)	0.4643*** (0.00000)	0.4596*** (0.00000)	1	
	Futures	0.2756*** (0.00000)	0.3351*** (0.00000)	0.4724*** (0.00000)	0.4658*** (0.00000)	0.9674*** (0.00000)	1

Notes:
1. *** Significant at the 1% level
2. ** Significant at the 5% level
3. * Significant at the 10% level

Panel A in Table 5 shows the estimated coefficients of VAR GJR-GARCH model for the unrestricted model. The results show that Bursa Malaysia Stock Index and Hang Seng Stock Index are not affected by its lagged return. The previous returns of Bursa Malaysia Stock Index Futures, Hang Seng Stock Index Futures, Nikkei 225 Stock Index and Nikkei 225 Stock Index Futures are negatively affected the current return of these markets respectively. The findings also show that there are feedback effects between stock index market and stock index futures markets within Malaysia, Hong Kong and Japan. These findings are similar with the findings in the restricted model. These suggest that the feedback effects between spot and futures market within Malaysia, Hong Kong and Japan are not affected by the market interdependence across countries. The table also shows the international price relationship between spot and futures markets investigated. The findings show that in Malaysia, the price of spot market is only affected by only one futures market investigated which is the price of Nikkei 225 Stock Index Futures but the price of futures market is affected by two spot markets investigated; price of Hang Seng Index Futures and Nikkei 225 Stock index. The spot and futures market in Hong Kong is respectively affected by the futures and spot markets in other countries investigated. The spot and futures markets in Japan are not affected by any market in Malaysia and Hong Kong.

The findings also show the relationships between the spot markets and between the futures markets investigated. The results show that Nikkei 225 Stock index affect the spot market in Malaysia and Hong Kong. The Malaysian spot market is only effect the spot market in Hong Kong. None of the spot markets investigated affected by the spot market in Hong Kong. The findings also show that there is a feedback effect between Bursa Malaysia Stock Index Futures and Hang Seng Index Futures. In addition, there are unidirectional relationships from Nikkei 225 Stock Index Futures to the Bursa Malaysia Stock Index Futures and Hang Seng Stock Index Futures. The results for international price relationships in this study are different from the study done by Antoniuo et Al. (2003) where they found that there are feedback effects between most of the markets in the United Kingdom, France and Germany. The second part of Panel A in Table 5 shows the estimated coefficients for the conditional variance equation in the unrestricted model form. It shows that the volatility of each markets investigated are affected by its own pass volatility. The results also show that only Bursa Malaysia Stock Index and Nikkei 225 Stock Index Futures affected by its own price shock. These findings are similar with the findings in the findings of restricted model. The results for domestic volatility transmission in the unrestricted model between spot and futures markets in Malaysia and Japan are also similar with the results in the restricted model. However, the result for domestic volatility transmission in Hong Kong is different from the restricted model. There is a feedback effect in the volatility transmission between spot and futures market within Hong Kong.

The table also shows the international volatility transmission between markets in Malaysia, Hong Kong and Japan. It shows that there are significant unidirectional volatility transmissions from Hang Seng Stock Index Futures to the Bursa Malaysia Stock Index and to the spot and futures markets in Japan. There is also evidence that the volatility of Malaysian spot markets is affected by the volatility of Hong Kong spot markets. In addition, the findings show that there is a feedback effect in the volatility transmission between futures markets in Malaysia and Hong Kong.

The last coefficients in Panel A show the asymmetric effects are present in all markets investigated. The positive sign shows that the volatility in the market is higher during the bear market compare to the bull markets. The positive sign also can be interpreted that a bad news are followed by higher volatility than a good news. These findings are same with the findings of the restricted model. Panel B in Table 5 shows the estimated volatility persistence for each market in Malaysia, Hong Kong and Japan. The results show that the volatility persistence in stock index markets and stock index futures markets within Malaysia, Hong Kong and Japan are significantly high because the sum of coefficient $\alpha_{i,0}$ and $\alpha_{i,i}$ for each market is close to unity. The volatility persistence of unrestricted model in all markets except for Nikkei 225 Stock Index are lower compared to the volatility persistence in the restricted model form. Panel C in Table 5 shows the estimated conditional correlation of unrestricted model for stock index markets and stock index futures markets within Malaysia, Hong Kong and Japan. The correlation coefficients show that there is a high correlation between stock index markets and its corresponding stock index futures markets. However, the market correlations across the countries are low. The correlation coefficients between the markets are higher in the unrestricted model compared to the restricted model.

CONCLUSIONS

The introduction of new information technology and the implementation of fewer trade barriers between countries accelerate the process of globalization in financial markets. The effect of globalization in financial markets is believed have an impact to the relationship between the markets across the country. The earlier researches on the relationship between stock index and stock index futures have been done within only one country. In the more recent times, researchers have tried to find the international price relationships and volatility transmission between spot and futures markets.

This study has attempted to find the international price relationship and volatility transmission between stock index and stock index futures in the first three Asian countries to introduce stock index futures: Malaysia, Hong Kong and Japan. The results from employing the VAR-GJR GARCH to the spot and futures markets in Malaysia, Hong Kong and Japan suggest that the domestic price relationships of spot and futures markets in the three countries investigated are not affected by the international market interdependence. This supports by the same findings for the domestic price relationships in the restricted model and the unrestricted model. The study also presents evidence that Nikkei 225 Stock Index and Nikkei 225 Stock Index Futures are the main information producers to the market price changes in Malaysia and Hong Kong. Therefore, analysts or investors should look at the Japanese market in forecasting the market price movement in Malaysia and Hong Kong.

The estimated conditional variance equations in this study suggest that the international market interdependence only affected the domestic volatility transmission of spot and futures markets in Hong Kong. This supports by the different findings for the domestic volatility transmission in the restricted model and the unrestricted model. In addition, the results can be summarised that the volatility of Hang Seng Stock Index Futures markets are the main factor that should be include if the investors want to analyse the risk of markets in countries investigated. This study also highlight that asymmetric effects exist in all markets in both restricted and unrestricted models. The results shows that the risk in the spot and futures markets in Malaysia, Hong Kong and Japan is higher during the bear markets compare to the bull market. The conditional variance equations also shows that in both restricted and unrestricted model , the volatility persistence in each market are consider as high. This suggests that the volatility of markets in Malaysia, Hong Kong and Japan take a long time to get back to the usual volatility level.

The final result of this study shows that the overall conditional correlation estimates between the spot and futures in Malaysia, Hong Kong and Japan. The correlation coefficients show that there is a high correlation between stock index markets and its corresponding stock index futures markets. This means that investors can use the stock index futures contracts as hedging tools for its corresponding stock index. In addition, the overall correlation coefficients between the markets are higher in the unrestricted model compared to the restricted model. According to Antoniou et al. (2003) this results suggest that the investors who ignore the market interdependence across the countries in hedging activity, are likely to produce biased estimates of hedge ratios. Investors should consider the international market interdependence if they do not want to overestimate the hedging effectiveness of these markets. The overall correlation coefficients between the markets across the countries are low and these suggesting that a better opportunity of diversification in constructing portfolio.

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