Journal of Islamic Finance (Special Issue) (2017) 014 – 034
IIUM Institute of Islamic Banking and Finance
ISSN 2289-2117 (O) / 2289-2109 (P)

Dynamic Linkages Among SAMI Nations (Saudi Arabia, Turkey, Malaysia, Indonesia) Equity Markets

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Abstract

This research paper investigates the dynamic linkages among four selected equity markets from Organization of the Islamic Conference (OIC) members. The four countries comprised the proposed Muslim BRICS called SAMI: Saudi Arabia, Ankara (Turkey), Malaysia and Indonesia. The study explores the short and long run linkages between these stock markets for the period spanning from January 2000 to September 2014 split into two sub-periods before and after the global financial crisis. Through applying Johansen co-integration analysis we found that the Indonesian, Malaysian, Saudi Arabian and Turkish stock markets are co-integrated during both periods. Emphasis was on the after crisis period where two co-integrating equations have been recorded. Granger causality test employed based on VECM further revealed that only a unidirectional relationship exist in the pre-crisis period between Saudi Arabia and Indonesia. However, bidirectional causality relationships were detected between almost all the four stock markets during the post-crisis period

Keywords*: Dynamic linkage, Equity Market, OIC, SAMI, VECM*

1. Introduction

While there has been enormous research efforts relating to dynamic linkages among capital markets; focus has been on developed markets (Bessler and Yang, 2003); (Kurihara and Nezu, 2006); (Antoniou, Pescetto, and Stevens, 2007). This is in stark contrast to the dearth of empirical studies on the dynamic linkages among emerging and developing economies. However, recently, the attention of the investigators turned towards examining the linkages between stock markets in emerging economies, especially those that existed in the areas of close proximity or with a trade and economic agreements such as the ASEAN, BRICS, EU, MENA (Simpson, 2007); (Majid et al., 2009); (Arouri and Jawadi, 2009); (Marashdeh and Shrestha, 2010); (Karim and Karim, 2012); (Srinivasan, Kalaivani, and Devakumar, 2013) and (Dasgupta, 2013).

'Linkage' refers to any statistical relationship that occurs between two or more random time series such as prices, returns, volatility etc. The stock markets co-movement is often viewed as the incident when at least two stock markets simultaneously move together. That is, a positive correlation in their prices due to the change in their fundamentals or the investor behaviour (Barberis, Shleifer, and Wurgler, 2005). According to Bekaert and Harvey (1995), two markets are said to be completely integrated if irrespective of the market the traded assets that holds the same risk are expected to generate identical returns. Pukthuanthong and Roll (2009) gave another description of the markets integration based on the fact that returns are supposedly driven by very same global factors and no other independent specific return components should exist across countries.

Integration of capital markets has a high significance to policy makers and regulators as it could generate a considerable economic growth and productivity across the whole economy by catalysing both domestic savings and investment funds. Investigating the dynamic linkages and the integration level among stock markets, therefore, becomes one of the topics that policy makers and economists pay a lot of attention to given the paradox between its benefits and drawbacks. Among the advantages offered through

greater stock integration include but not limited to enhanced allocation of capital, increased efficiency of risk sharing, optimised portfolio diversification, reduced cost of capital and stimulated development of domestic equity markets. On the contrary, moving toward full integration brings with it the peril of some detriments like capital flight or flow out, credit crunch, contagion effect, etc. Without prejudice to its detriments, it is likely that the benefits of economic linkages among Muslim nations are huge.

Although there are socio-political auspices under which Muslim nations identify with each other, for instance under Organization for Islamic Conference (OIC), the fact that most members are either still developing or not geographically close to each other perhaps explains why studies on economic linkages among them seems scarce. Recent studies on linkages among emerging economies like those of Brazil, Russia, India, China, and South Africa (BRICS) notwithstanding their numerous socio-political and geographical differences only advertises the need for such assessment among notable Muslim-majority countries which at least, have one thing in common, Islam.

Kassim (2010) noted that studies that included OIC countries in addition to being infrequent have concentrated on examining the markets individually or at regional levels. Nevertheless, only few researches have investigated these countries collectively and among the few studies recorded in this regard are Ergun and Nor (2009); and Majid and Kassim (2010). As such, it seems a lacuna in this regard needs to be filled especially following the effects of the global financial crisis period which necessitates efficient investment portfolio diversification across geographical boundaries. Consequently, rather than taken as theoretically plausible, the degree of integration that exist among financial markets in the Muslim world can be empirically assessed so that investors and policymakers will have the needed and valid evidence and information to act accordingly.

This paper specifically investigates the pre and post financial crises dynamic linkages among stock markets of four emerging economies in the OIC countries namely Saudi Arabia, Turkey, Malaysia and Indonesia. These four countries are considered the biggest economies under the OIC countries by sharing 42 percent of the overall GDP among the OIC countries (Mika'il, 2014). Moreover, three among these four countries are members of the G20 countries and the anchors of their corresponding geographies; Indonesia for ASEAN countries, Saudi Arabia for Gulf Cooperation Council (GCC) countries and Turkey for Commonwealth of Independent States (CIS) countries (Siddiqui, 2011). Similarly, Malaysia is obviously a global hub for Islamic finance and the Halal industry.

2 Stock Market Integration Theories

Theoretically, market integration could be explained in multiple ways. Among the well-known theories that we guide the discourse are the Modern Portfolio Theory (MPT), the Law of One Price (LOP) and the Efficient Market Hypothesis (EMH).

The law of One Price (LOP) pioneered by the work of Cournot and Fisher (1897) and Marshall, Marshall, Marshall, and Marshall (1920) is known as the cornerstone when it comes to quantifying or measuring the integration of financial markets. The essential point of the LOP refers to the equilibrium situation where no opportunities can be held for arbitrage. This law involves some specific requirements as the absence of taxes, transaction fees, transportation costs and perfect information and so forth. In the case when the markets are integrated, the LOP denotes that in spite of the location of countries, the expected returns of their respective identical assets must be generated in similar way and comparably between those countries. Furthermore under this law, once the violation of equilibrium of prices occur among agents, the equality of price will be restored smoothly where the price differences shall be quickly eliminated through arbitrage (Stiglitz, 1993). In accordance with Chen and Knez (1995), two notions of markets integration can be defined. Firstly, to say that two markets are not integrated in any sense, when two portfolios could be constructed; one from each market having identical returns but generated differently with dissimilar prices. Secondly, in a stronger sense, no market integration can be held among markets if the cross market arbitrage opportunities continue to exist.

Efficient Market Hypothesis (EMH) holds that any financial market said to be efficient should ideally have the feature and the ability of rapid adjustment accordingly to any new information presented in the market (Fama, Fisher, Jensen, and Roll, 1969). According to Beechey, Gruen, and Vickery (2000) the assets' prices in an efficient financial market should be completely reflective of the all information available and convenient with the economic fundamentals. As suggested by Bekaert and Harvey (1995) in the context of market integration, the assets traded in fully integrated markets have equivalent expected returns since they are exposed to the same risks.

Modern Portfolio Theory (MPT) was propounded in the work of Markowitz (1952) and later developed by Lintner (1965), Sharpe (1966) and Mossin (1966). The MPT holds that markets are fully integrated if assets that have been characterized with the same risk have identical payoffs regardless of their markets' location where in this situation, risk refers to the exposure to some world common factors. The expected return for investors who are willing to take the risks should be evaluated in conjunction with the level of risk they agreed to hold. Therefore, the selection of the right portfolio is an issue that have been gaining a lot of interest overtime. Markowitz illustrated that in a given level of risk, the investors could identify specific combinations of multiple securities that may maximise the expected outcome. He referred to the continuum of such kind of portfolios in relation to standard deviation and expected return as the 'efficient frontier' (Noor Azlinna and Sorooshian, 2014). The MPT recommends that investment decisions shall be made upon the overall risk-reward specifics of portfolios rather on an appealing individual assets' risk-reward characteristics. With the mean standing for the foreseeable reward and variance for the expected risk, the Markowitz's mean-variance approach for the process of selecting portfolios implies maximizing the mean for any given variance or, alternatively, minimizing the variance for any given mean (Southall, 2008). As correlation among the assets weaken or become negative, the diversification with asset combinations turn to be more attractive and beneficial.

3. Data

This paper utilizes the daily stock market indices for Indonesia, Malaysia, Saudi Arabia and Turkey where the data for each stock market was obtained from Bloomberg database for the period of January 1st, 2000 to September 22nd, 2014 incorporating the latest available data at the time of data collection. The daily market indices included in this study are Jakarta Composite Index (JCI) for Indonesia, Kuala Lumpur Composite Index (KLCI) regarding Malaysia, Tadawul All Share Index (SASEIDX) for Saudi Arabia and Istanbul Stock Exchange National 100 Index (XU100) for Turkey. The data was collected on daily basis instead of weekly or monthly for the purpose of capturing all the interactions even those that last only for a small number of days (Eun and Shim, 1989). Each series was transformed to natural logarithm form prior to analysis following the studies of (Ergun and Nor, 2009) and (Ceylan and Doğan, 2004).

The data was split into two distinct periods. The first sample ranges from 1st January 2000, to 31st May 2007 containing 2708 observations, whereas the second sample period started from 1st June 2007 until 22nd September 2014 with 2671 observations corresponding to the study of (Abbes and Trichilli, 2015). Summary statistics about the log series are presented in Table1. The ISE National 100 Index has the highest mean in both periods. Regarding the standard deviation, Tadawul stock exchange was more volatile during the pre-period crisis while in the post crisis period Jakarta Composite Index registered higher dispersal than the other stock markets. Moreover, the Jarque-Bera test results rejected the null hypothesis of normality distribution for all the indices because their probabilities are significant (i.e. equal to zero) which is consistent with most of the studies related to the VECM for instance, (Abbes and Trichilli, 2015), (Srinivasan et al., 2013) etc. In addition, a variation in the sign of the skewness between the indices was recorded and based on the kurtosis test the series look leptokurtic giving an indication that the underlying data have higher peak and fatter tails than the normal distribution.

Table 1: Descriptive statistics of the indices

	Mean	Median	Std. Dev.	Skewness	Kurtosis	Jarque-Bera	Prob
Panel 1: Pre-crisis period							
LIND	6.552922	6.432750	0.509924	0.448137	1.874758	233.5061	0.000000
LMAL	6.699171	6.709292	0.184307	0.297956	2.967180	40.190000	0.000000
LSAU	8.455642	8.320051	0.713722	0.431798	1.720173	268.967100	0.000000
LTUR	9.799892	9.720433	0.536062	0.348393	1.762290	227.634100	0.000000
Panel 2: Post- crisis period							
LIND	8.053421	8.188063	0.373435	-0.747505	2.766033	254.835100	0.000000
LMAL	7.259205	7.301026	0.202806	-0.784797	3.060020	274.582200	0.000000
LSAU	8.871846	8.833206	0.200410	0.187501	2.838287	18.561020	0.000093
LTUR	10.916090	10.976230	0.312917	-0.982294	3.505534	457.983800	0.000000

4. Methodology

In the following part, the paper analyzed the dynamic linkages among the four SAMI countries: Malaysia, Indonesia, Turkey and Saudi Arabia, and investigated whether those markets are moving together in the long-run or not. The study employed several econometric approaches including unit root test, Johansen co-integration test, vector error correction model, Granger causality, variance decomposition and impulse responses analysis. Since the stationary characteristic of the series is an essential property for the other tests, unit root test was conducted first, afterward a lag order selection, using VAR lag selection criteria (AIC, SIC, HQ) and VAR residual serial correlation LM test, was also conducted to identify the proper lags needed to run the co-integration test based on the Johansen approach. Depending on the results of the latter test, the existence of a long-run relationship and co-integration equations were determined leading to further analyses. Following evidence of co-integration, the Granger causality test was conducted based on the vector error correction models in order to identify the direction of the causality. Subsequently, in respect of analysing the durations and speed of adjustment of the stock markets interactions, variance decomposition and impulse responses function were applied.

5. Results

5.1 Stationarity and unit root test:

Before examining the dynamic linkages between the stock indices, the stationary properties have to be tested. Therefore the Augmented Dickey Fuller test (ADF) and Philips-Perron test (PP) were applied firstly on the series. Both tests have the null hypothesis of that the series has a unit root. To perform the tests we need primarily to identify the estimation equation that must be utilized which could be based on the data plotted graphs (Appendix A) where we can notice that all log indices do not begin from the original point along with the upward and downward trend exhibited in the plots. Therefore, we employed unit root test with intercept and/or deterministic trend. Meanwhile, for the specification of the lagged number of dependent variables we set 12 lags as max and let Eviews software automatically select the appropriate lag.

Table 2: Results of unit root tests

Panel 1: Pre-crisis period

Index	ADF		PP	
	Intercept	**Intercept & Trend**	**Intercept**	**Intercept & Trend**
		Level		
LIND	1.2432	-3.205351*	1.234869	-2.980255
LMAL	0.183505	-1.475826	0.249639	-1.335106
LSAU	-0.991787	-0.43934	-0.979558	-0.395213
LTUR	-0.358171	-2.511652	-0.316854	-2.482754
		1st Difference		
LIND	-28.15268***	-28.35727***	-49.85004***	-49.95113***
LMAL	-26.40199***	-26.48828***	-46.89294***	-46.91683***
LSAU	-17.49333***	-17.51511***	-50.59682***	-50.60190***
LTUR	-52.77474***	-52.79270***	-52.78591***	-52.80843***

*Note: *******, ** and * denotes significance at **1%**, 5%, and 10% significance level, respectively.*

Panel 2: Post-crisis period

Index	ADF		PP	
	Intercept	**Intercept & Trend**	**Intercept**	**Intercept & Trend**
		Level		
LIND	-0.7716	-1.856036	-0.714338	-1.775505
LMAL	-0.446145	-2.094118	-0.490039	-2.121411
LSAU	-0.921118	-1.199292	-0.955652	-1.241059
LTUR	-1.071193	-2.000639	-1.079534	-2.035063
		1st Difference		
LIND	-47.78294***	-47.77505***	-47.66362***	-47.65495***
LMAL	-47.95426***	-47.96612***	-48.10783***	-48.10235***
LSAU	-21.36010***	-21.39854***	-48.86560***	-48.84631***
LTUR	-17.79396***	-17.79239***	-51.05865***	-51.05154***

*Note: ***, ** and * denotes significance at 1%, 5%, and 10% significance level, respectively.*

Critical values for ADF and PP test				
	ADF		PP	
	Intercept	Intercept & Trend	Intercept	Intercept & Trend
		Level		
1% level	-3.432576	-3.961437	-3.432574	-3.961433
5% level	-2.862409	-3.411469	-2.862408	-3.411467
10% level	-2.567278	-3.127592	-2.567277	-3.127591
		1st Difference		
1% level	-3.432576	-3.961437	-3.432575	-3.961434
5% level	-2.862409	-3.411469	-2.862409	-3.411468
10% level	-2.567278	-3.127592	-2.567277	-3.127591

Foremost, we analyzed the results under the pre-crisis period (Panel 1.Table 2). In terms of ADF and PP test with intercept term, for all the level series we cannot reject the null hypothesis of unit root at 1percent significance. Likewise, when including the intercept and trend we still cannot reject the null hypothesis for all the variables at the same level of confidence. Besides, at the first difference and in both terms (intercept, trend and intercept) we rejected the null hypothesis for all the series with 1 percent significance for the ADF test together with the PP test. Secondly, for the period after the crisis (Panel 2, Table 2), at level and including intercept and/or trend for all the series we also cannot reject the null hypothesis of a unit root process at all levels of significance. However, when the variables were tested at first difference with both estimations we clearly can reject the null hypothesis in ADF and PP test at 1 percent significance level. Based on the tests' results all the series seem to be integrated of order one (i.e. I(1)).

5.1 Co-integration among the four stock markets (the Johansen test):

As mentioned earlier, risk management and diversification are very important concepts that any investor should both fully understand and exploit. This becomes more pertinent especially after the sub-prime crisis that affected almost all the world. The crisis shed more light on how the international stock markets have become more integrated with each other but mostly among the developed nations. Therefore, investors in the last decade tend to expand their portfolios to include the assets in emerging stock markets looking for more opportunities and diversification benefits. To measure if two or more equity markets are correlated and to some extent capture the diversification degree, the co-integration tests are employed. In the previous section, we used several approaches to test the stationarity of the log indices and found that each series has a unit root. In this section we mainly employed the Johansen procedure to examine the co-integration between the four market indices.

5.2 Lag length selection:

The selection of the lag length with the identification of the deterministic components has to be executed before applying the Johansen test. In this paper we relied on the information criteria associated with the residuals autocorrelation LM test in order to choose the convenient lag length. The results are presented in Table 3.

Table 3: The selection of lag length based on VAR models

VAR Lag Order Selection Criteria

	Pre-crisis			Post-crisis		
Var Lag	**AIC**	**SC**	**HQ**	**AIC**	**SC**	**HQ**
0	-1.543279	-1.534526	-1.540113	-5.214986	-5.206132	-5.211781
1	-23.82998	**-23.78621***	**-23.81415***	-25.37879	-25.33452	-25.36276
2	-23.83623	-23.75746	-23.80774	-25.4433	**-25.36361***	-25.41446
3	-23.84012	-23.72633	-23.79897	-25.47802	-25.36291	**-25.43636***
4	**-23.84729***	-23.69848	-23.79347	-25.48043	-25.32991	-25.42596
5	-23.84162	-23.65781	-23.77514	-25.47833	-25.2924	-25.41104
6	-23.84489	-23.62606	-23.76575	-25.48122	-25.25987	-25.40111
7	-23.84488	-23.59105	-23.75308	-25.48513	-25.22836	-25.3922
8	-23.84077	-23.55192	-23.7363	-25.48614	-25.19396	-25.3804
9	-23.84198	-23.51812	-23.72485	-25.48687	-25.15927	-25.3683
10	-23.83304	-23.47416	-23.70325	**-25.49051***	-25.1275	-25.35913
11	-23.82507	-23.43119	-23.68262	-25.48601	-25.08758	-25.34181
12	-23.81861	-23.38971	-23.6635	-25.48281	-25.04897	-25.3258

Residuals autocorrelation LM test results

	Pre-crisis		Post-crisis	
Lag	**LM-stat**	**Prob**	**LM-stat**	**Prob**
1	40.19033	0.0007	104.1537	0.0000
2	45.22957	0.0001	110.6323	0.0000
3	44.85945	0.0001	48.04819	0.0000
4	16.12355	**0.4444***	29.41856	0.0213
5	35.24555	0.0037	39.39539	0.0010
6	34.74310	0.0043	46.23578	0.0001
7	22.02405	0.1424	34.00204	0.0054
8	34.05665	0.0053	34.57055	0.0045
9	7.173534	0.9698	34.49171	0.0047
10	9.025338	0.9124	20.82831	**0.1852***
11	13.78808	0.6145	29.49793	0.0208
12	9.250780	0.9027	21.06932	0.1759

The findings in Table 3 for the before crisis period AIC suggests VAR models with four lags but SIC and HQ indicates that the best lag to be used is one. However, when looking at the residuals autocorrelation test results we could not reject the null hypothesis of no serial correlation at the correspondent lag order until the fourth lag which aligns with the AIC results. Hence we follow (Kassim, 2010) and choose four lags based on Akaike information criterion (AIC) for the pre-crisis period. Similarly and following the same method we selected ten lags as the appropriate lag length under the post-period crisis.

Based on the Pantula principle and the deterministic components in Johansen test, the findings of estimating the models 2, 3, and 4 are depicted in Table 4. We applied the Pantula principle on both samples. In respect of the pre-crisis period we start with the most restrictive model (Model 2) as suggested by (Hjelm and Johansson, 2005) and we examined the null hypothesis of zero co-integrating vectors which we rejected as shown in the table 4. Thereafter, we tested the same hypothesis for the Models 3 and

4. That is, looking at the trace statistics value which is greater than the critical value in both models implied that the null hypothesis can be rejected.

Furthermore, we examined the null hypothesis of at most one co-integration vector in all three models starting from Model 2 to Model 4. All the hypotheses up to this point were all rejected. We continued the same procedure for the null hypothesis of at most two co-integrating vectors and starting with Model 2 the trace statistics value i.e. 16.16377 was found to be lesser than its critical value 20.26184 at 5 percent level of significance. Therefore, given that for the first time the null hypothesis of at most two co-integrating vectors cannot be rejected, the process was stopped leading to the conclusion that Model 2 is appropriate for Johansen co-integration test.

Regarding the after crisis period, we followed the same procedure as in the pre-crisis panel and we began by examining the null hypothesis of zero co-integrating vectors from the Model 2 to the Model 3. The values of the trace statistics depicted in the table 4 suggests that the null hypothesis can be rejected in all models which lead us to proceed to inspect the second null hypothesis of at most one co-integrating vectors as regards the Model 2. This time the null hypothesis cannot be rejected due to the fact that the trace statistics value i.e. 30.95514 was lower than its critical value 35.19275.

Table 4: Pantula Principle

Panel 1: Pre-crisis period						
No. Cointegration	**Model 2**		Model 3		Model 4	
	Trace st	Cr.Va	Trace st	Cr.Va	Trace st	Cr.Va
0	87.8983	54.07904	80.74894	47.85613	102.4254	63.87610
1	37.70209	35.19275	30.63253	29.79707	51.86986	42.91525
2	**16.16377****	20.26184	9.925851	15.49471	12.04314	25.87211
3	3.872357	9.164546	1.020412	3.841466	1.222061	12.51798
Panel 2: Post-crisis period						
No. Cointegration	**Model 2**		Model 3		Model 4	
	Trace st	Cr.Va	Trace st	Cr.Va	Trace st	Cr.Va
0	58.50899	54.07904	56.23689	47.85613	63.97354	63.87610
1	**30.95514****	35.19275	30.27989	29.79707	35.99280	42.91525
2	17.39099	20.26184	17.20318	15.49471	18.44836	25.87211
3	5.046493	9.164546	5.006063	3.841466	6.118698	12.51798

5.3 The Johansen approach:

The results of the Johansen co-integration test (Table 5) indicate that there is enough evidence that Indonesia, Malaysia, Saudi Arabia and Turkey stock markets are co-integrated which is in line with previous studies e.g. (Ergun and Nor, 2009) and that was in both periods, before and after the global crisis, where two co-integrating vectors and one co-integrating vector is recorded respectively in each period.

Table 5: The Johansen co-integration test

Pre-crisis period						
No. of CE(s)	Trace	C.value	Prob	Max-Eigen	C.value	Prob
None *	**87.89834**	54.07904	**0.0000**	**50.19625**	28.58808	**0.0000**
At most 1 *	**37.70209**	35.19275	**0.0263**	21.53832	22.29962	0.0636
At most 2	16.16377	20.26184	0.1669	12.29141	15.89210	0.1697
At most 3	3.872357	9.164546	0.4314	3.872357	9.164546	0.4314

	Post-crisis period					
No. of CE(s)	Trace	C.value	Prob	Max-Eigen	C.value	Prob
None *	**58.50899**	54.07904	**0.0191**	27.55385	28.58808	0.0673
At most 1	30.95514	35.19275	0.1335	13.56415	22.29962	0.5026
At most 2	17.39099	20.26184	0.1186	12.34450	15.89210	0.1669
At most 3	5.046493	9.164546	0.2784	5.046493	9.164546	0.2784

** denotes rejection of the hypothesis at the 0.05 level*

***MacKinnon-Haug-Michelis (1999) p-values*

5.4 Granger causality test

As stated by Granger if a co-integration exists between variables, there has to be at least one direction causality relationships. Since we already found evidence of co-integration among the stock markets under study during pre and post-crisis period, then we are going in this section to estimate the Granger causality test based on Vector Error Correction Model for both periods. The results are shown in the tables 6.

For the first panel that concerns the period before the sub-prime crisis, only one short run causal relation was detected by the Chi-square statistic between Saudi Arabia and Indonesia at 5 percent level of significance. Also for the equation of Indonesia, both short and long run relationships were supported based on both the Chi-square statistics for the lagged independent variable and t-statistics of the Error Correction Term. Hence, we may say that Saudi Arabia has a short run unidirectional relationship with Indonesia.

Table 6: Granger Causality based on VECM (Pre-crisis)

Panel 1: Pre-crisis period

Dependent variable	**Independent variables**				
	X^2-statistics of lagged 1st difference term (p-value)				ECT_{t-1}
	D(LIND)	D(LMAL)	D(LSAU)	D(LTUR)	**[t-ratio]**
D(LIND)		5.980673	**10.13591****	4.830859	**0.002709*****
	----	(0.2006)	(0.0382)	(0.3051)	[2.90431]
D(LMAL)	6.974771		3.149375	1.503716	**0.003740*****
	(0.1372)	----	(0.5331)	(0.8260)	[5.97307]
D(LSAU)	1.439752	6.406451		1.094014	**-0.002499****
	(0.8373)	(0.1708)	----	(0.8952)	[-2.22816]
D(LTUR)	2.806347	3.497309	5.897789		-0.003238
	(0.5907)	(0.4783)	(0.2069)	----	[-1.72819]

*Note: *** and ** denotes significant at 1% and 5% significance level, respectively. The figure in the squared brackets […] denote as t-statistic and the figure in the parenthesis (…) represent as p-value*

Concerning the second panel, several relations were detected. Firstly, Indonesia Granger causes both Saudi Arabia and Turkey at 1 percent level while t it also Granger causes Malaysia at 5 percent level. Further, relying on the error correction term, Indonesia recorded a long run relationship with all three countries at 1 percent significance level. Similarly, the Chi-square statistic results show that short run relationships are observed between Malaysia stock market index and the other three markets. Likewise, Turkey stock market index exhibited the same relation with the remaining three countries. Besides, movement in Saudi Arabia stock market affect movements in the markets of Indonesia and Turkey in the short run while it significantly responds to shocks from the three stock markets in the long run. In conclusion, all the markets except Saudi Arabia has bi-directional short run relationship with the others,

whilst the Tadawul stock exchange seems to have only a bi-directional causality relation with the Indonesian and Turkish stock markets.

Table 7: Granger Causality based on VECM (Post-crisis)

Panel 2: Post-crisis period

Dependent variable	**Independent variables**				
	X^2-statistics of lagged 1st difference term (p-value)				ECT_{t-1}
	D(LIND)	D(LMAL)	D(LSAU)	D(LTUR)	**[t-ratio]**
D(LIND)		**73.81170*** **	**36.49854*** **	**43.06700*** **	**-0.009350*** **
	----	(0.0000)	(0.0001)	(0.0000)	[-3.77343]
D(LMAL)	**18.95440** **		13.93102	**42.52569*** **	0.000932
	(0.0408)	----	(0.1762)	(0.0000)	[0.72780]
D(LSAU)	**53.74734*** **	**17.46359***		**16.85290***	**-0.004533** **
	(0.0000)	(0.0647)	----	(0.0777)	[-1.99142]
D(LTUR)	**71.96807*** **	**79.09733*** **	**48.94249*** **		-0.00492
	(0.0000)	(0.0000)	(0.0000)	----	[-1.63630]

*Note: *** and ** denotes significant at 1% and 5% significance level, respectively. The figure in the squared brackets […] denote as t-statistic and the figure in the parenthesis (…) represent as p-value*

5.5 Impulse response functions

The impulse response function reports the impact of an external shock that happened in one of the variables acting as the source of the shock on the other variables in the model system. This is important since the Granger causality test cannot reveal the sign or the time of the relationship. Therefore, we have to generate the impulse response function to get more details about the spill-overs. Figures 5 and 6 depict the generalized impulse response functions: 30-period responses of one variable to a unit of shock or innovations of another variable.

During the pre-crisis period, the responses in general were not that much higher where the strongest positive response was the Malaysian market response to the Indonesian market shocks that lasted for thirty periods. There were slight or small negative responses to the impulses from Indonesia to Malaysia, Indonesia and Malaysia to Saudi Arabia and from Saudi Arabia to Turkey. Lastly, the responses to the shocks between Turkey and Malaysia were positive and reciprocal, yet the Malaysian stock market response to the innovations from Turkey was the strongest.

Moving to the post financial crisis period, the responses were recorded in almost all the stock markets. We start with the behaviour of the markets against the shocks coming from the Indonesian market. The graphs show that all responses were positive during the period and the strongest was the Malaysian response followed by Turkey and Saudi Arabia. Regarding the Malaysian stock market impulses, the three markets displayed positive responses but with a low magnitude compared to Indonesia and lasted for the whole thirty period as well. Reaching to the demeanours of the markets versus the Saudi Arabia shocks, we found them almost not happening except for Malaysia which showed a small positive response. Finally, the results revealed that the stock markets of Malaysia, Indonesia and Saudi Arabia registered positive responses with nearly same magnitude against the Turkish equity market innovations.

5.6 Variance decomposition analysis:

Analyzing the variance decomposition will provide us with the required information regarding the relative significance of each random impulse and shock to any variable included in the model system. Thereby, for any given market it will give us the information about internal and external shock waves in that market. In Tables 8 and 9 we present the variance decomposition of the four stock markets in our two models (pre and post-crisis) for thirty period horizon. The percentage of the forecasted error variance has been depicted in the tables below for each variable which is assigned to its own innovations and to the innovations in the other system variables.

The analyses results related to the period before the financial crisis indicate that 97.53 percent of Indonesian, 84.23 percent of Malaysian, 98.98 percent of Saudi Arabian, and 95.47 percent of Turkish stock markets' own variances are explained by its own impulses. This suggests that all variations in the markets are described by their own innovations excluding Malaysia by which about 6.74% of its disparity is explained by the shocks in Indonesia starting from the beginning of the period where the percentage reached 12.81 percent by the end of the horizon. Therefore, it can be mentioned that the Malaysian equity market in this pre-crisis period is endogenous to some extent compared to other markets.

With regards to the after global crisis period, the outcomes of the variance decomposition test denote that only the Indonesian stock market still can explain about 94.25 percent of the variations in its own shocks and more than that it can also describe around 44.2 percent of the Malaysian, 13.61 percent of the Saudi Arabian and 19.11 percent of the Turkish markets' variances.

Table 8: Variance decomposition during the Pre-crisis period

	Indonesia	**Malaysia**	**Saudi Arabia**	**Turkey**
Indonesia				
1	100.0000	0.000000	0.000000	0.000000
10	99.79937	0.006849	0.066621	0.127157
20	98.96232	0.070689	0.074613	0.892376
30	**97.53067**	0.196398	0.067229	2.205705
Malaysia				
1	6.747129	93.25287	0.000000	0.000000
10	7.804709	91.33372	0.100721	0.760852
20	10.10626	88.18951	0.069066	1.635156
30	**12.81614**	**84.23370**	0.170464	2.779702
Saudi Arabia				
1	0.026934	0.015892	99.95717	0.000000
10	0.734762	0.015477	99.19065	0.059114
20	0.684218	0.017500	99.11182	0.186458
30	0.594969	0.061605	**98.98071**	0.362713
Turkey				
1	1.258483	1.202024	0.007635	97.53186
10	1.932332	1.221920	0.147834	96.69791
20	2.217681	1.371404	0.289509	96.12141
30	2.534280	1.521440	0.465604	**95.47868**

Table 9: Variance decomposition during the Post-crisis period

	Indonesia	**Malaysia**	**Saudi Arabia**	**Turkey**
Indonesia				
1	100.0000	0.000000	0.000000	0.000000
10	96.02901	0.287987	0.480653	3.202354
20	95.14246	1.186426	0.304990	3.366122
30	**94.25795**	2.180511	0.229165	3.332373
Malaysia				
1	29.54441	70.45559	0.000000	0.000000
10	46.46691	50.17535	0.531972	2.825773
20	44.70792	51.29762	0.728871	3.265591
30	**44.20559**	**51.42365**	0.614851	3.755908
Saudi Arabia				
1	4.381372	0.001228	95.61740	0.000000
10	12.03312	0.857718	82.57475	4.534413
20	13.13695	1.971776	78.22144	6.669830
30	**13.61699**	3.020009	**76.29712**	7.065873
Turkey				
1	12.09117	1.773727	0.996539	85.13856
10	16.25175	1.448881	0.583599	81.71577
20	18.12990	3.176596	0.336312	78.35719
30	**19.11965**	4.252342	0.244389	**76.38362**

6. Conclusion

This study explores the short and long run dynamic linkages employed in a multivariate framework among four Organisation for Islamic Conference emerging stock markets which comprises Indonesia, Malaysia, Saudi Arabia and Turkey. Based on the transformed daily stock indices into natural logarithms, long run relationship among the four stock market indices has been examined through the application of the Johansen co-integration test. Afterward, Granger causality test based on vector error correction model is implemented to investigate the short run relations along with their possible directions.

Furthermore information is collected from the generalized impulse response functions as well as the persistent and temporary variance decomposition analyses. The data sample was split into two in order to distinguish between the periods before and after the global crisis. The Johansen co-integration results showed evidences that the Indonesian, Malaysian, Saudi Arabian and Turkish stock markets are co-integrated during both periods with the emphasis on the after crisis period where the tests indicated the existence of two co-integrating equations.

Additionally, Granger causality test revealed in relation to the pre-crisis period only one unidirectional short run relation existed between Saudi Arabia and Indonesia. However, bidirectional causality relationships were detected between all the four stock markets except for Saudi Arabia and Malaysia where only a unidirectional relation was registered between them. Moreover, the study based on the former two tests can conclude that the global crisis has affected the relationship among the four countries in a way that they become more integrated in both short and long run.

Furthermore, by looking at the outcomes of impulse response functions and the variance decomposition we notice that the Indonesian market is somewhat leading the other markets where the results showed that the other stock markets have strong positive responses against the innovations from

Indonesia especially after the subprime crisis. Also, the equity markets of Malaysia, Saudi Arabia and Turkey moved to becoming more endogenous in the post-crisis period where the external shocks from Indonesia explained about 44.2 percent, 13.61 percent and 19.11 percent of the stock markets' variances respectively.

Supporting the time varying aspect of financial markets integration proposed by Bekaert and Harvey (1995), the S.A.M.I nations' equity markets showed an increase in the level of integration in the period following the crisis. This finding may provide an indication on the stock markets behaviour which could be of great importance to the different economic agents and industry players in order for them to undertake prudent measures and mechanisms in the area of risk management and hedging for the purpose of safeguarding their investments in times of uncertainty (Kassim, 2010).

The extent of stock markets integration has significant bearings for the policy makers in their process of formulating the appropriate policies. This may help to ensure the effectiveness of the adopted policies intended to stabilise the economy when addressing the markets imbalances and stimulate the economic growth. Furthermore, in order to mitigate the effect of financial fluctuations, a policy coordination and financial reform policies are needed among these countries which promotes information efficiency in the equity market (Hooy and Lim, 2013) such as lessening or removing the investment and trade barriers.

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Appendix

Figure 1:. Log stock price indices during the pre-crisis period

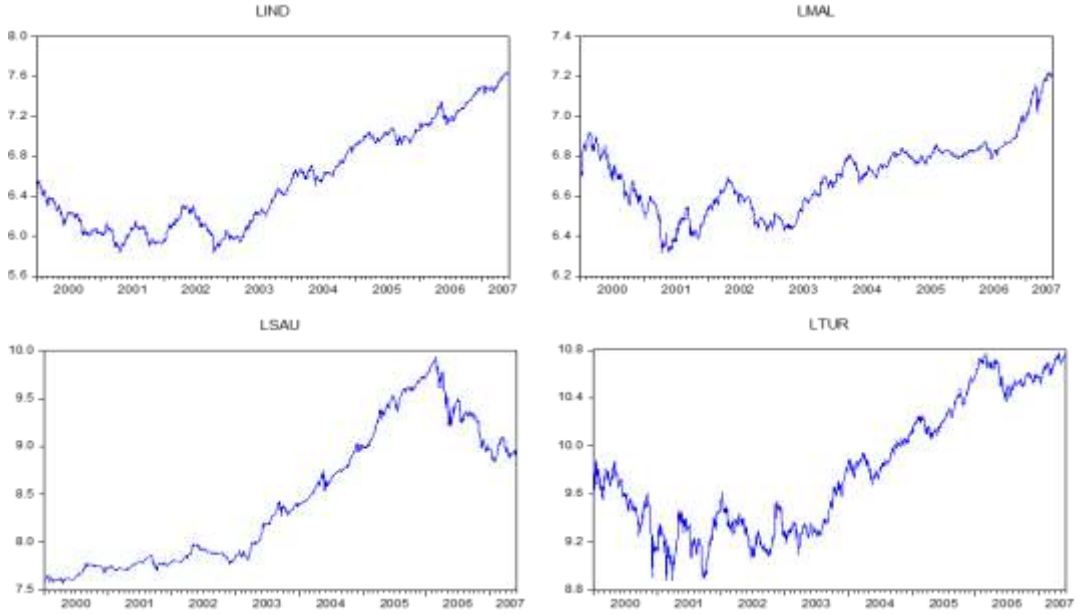

Figure 2:. Log stock price indices during the post-crisis period

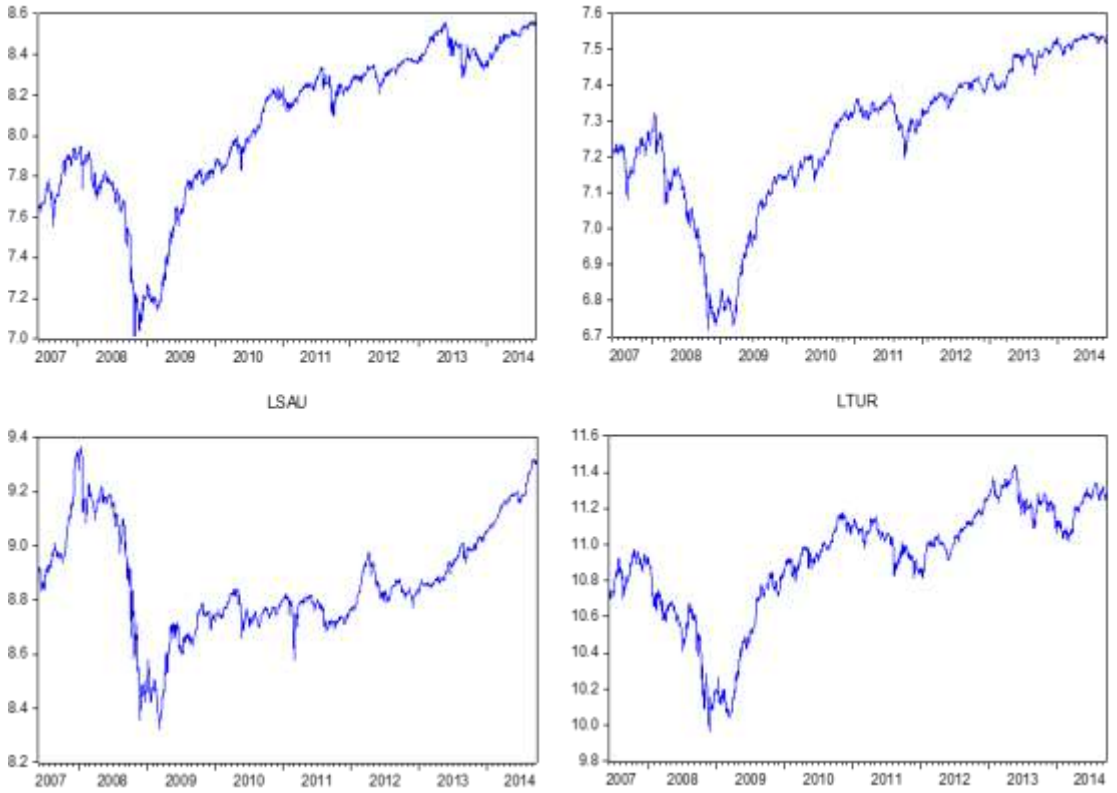

Figure 3. Log stock price indices during the post-crisis period

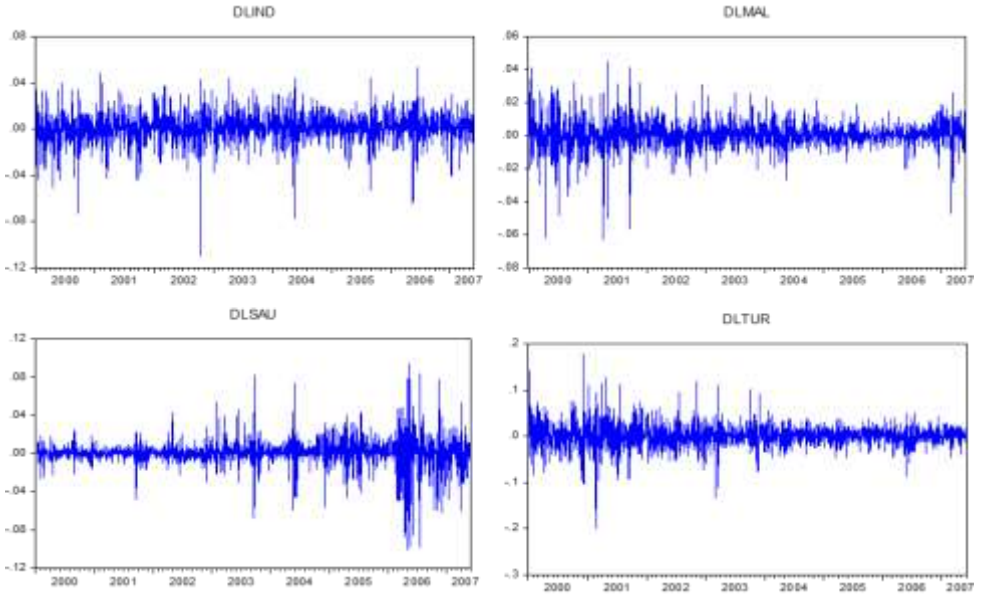

Figure 4. First difference of stock indices during the pre-crisis period

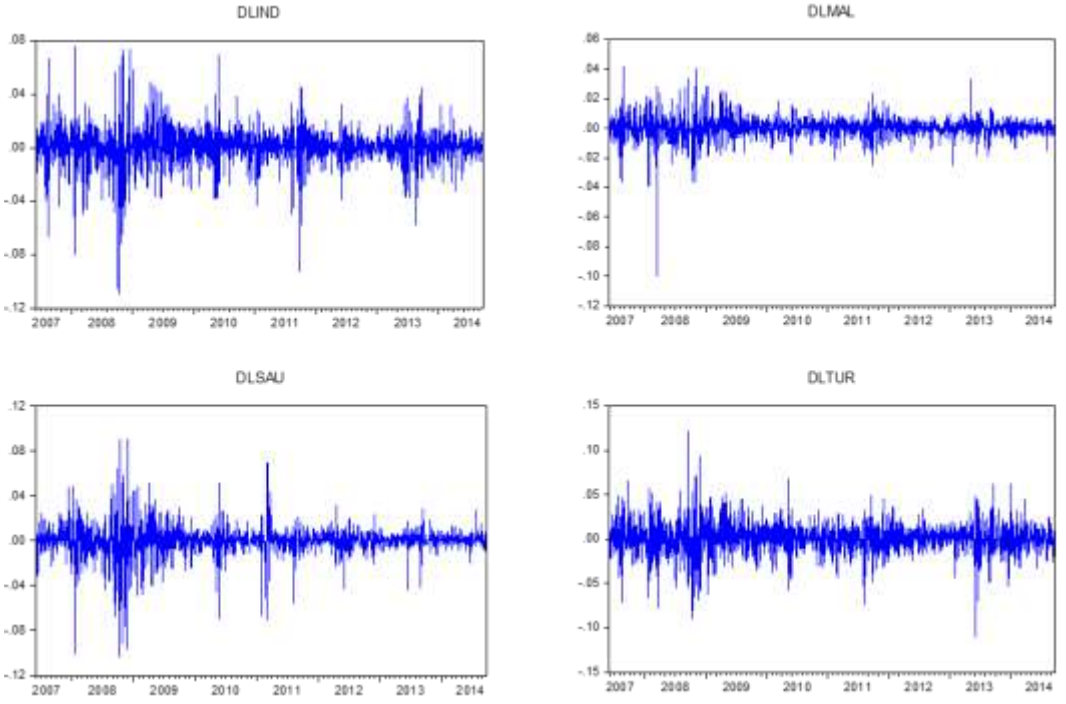

Figure 5. First difference of stock indices during the post-crisis period

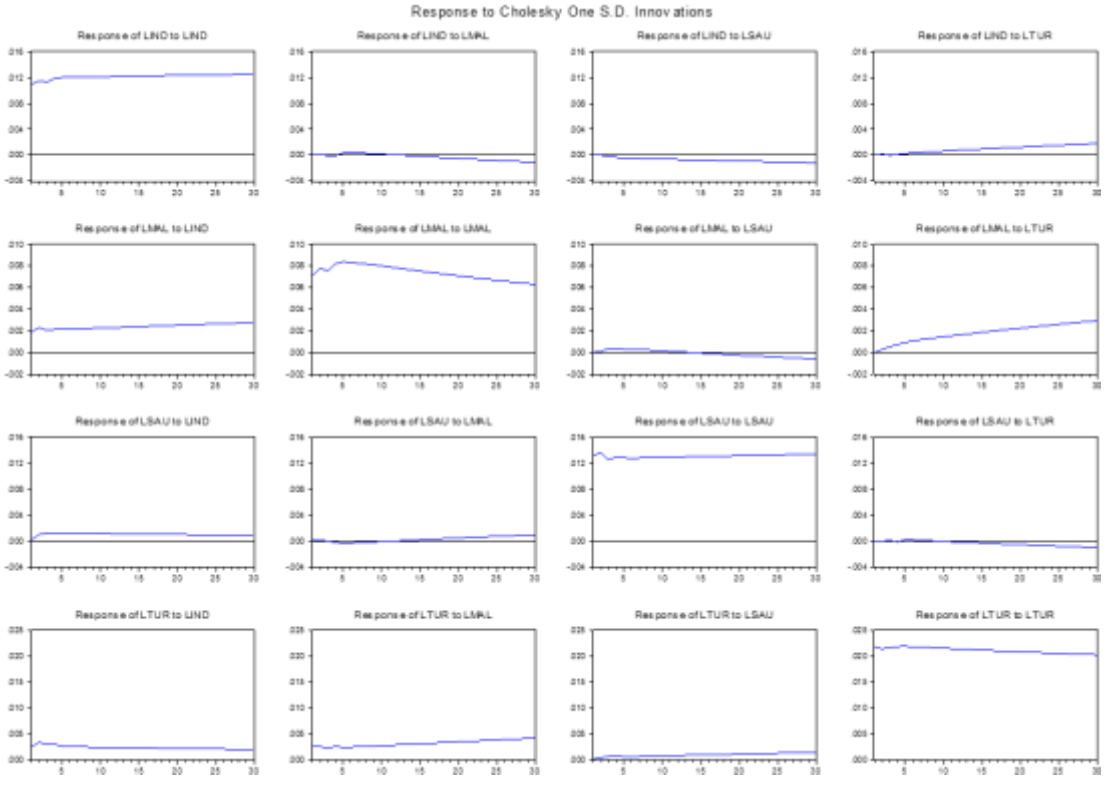

Figure 6 Impulse response functions during the post-crisis period

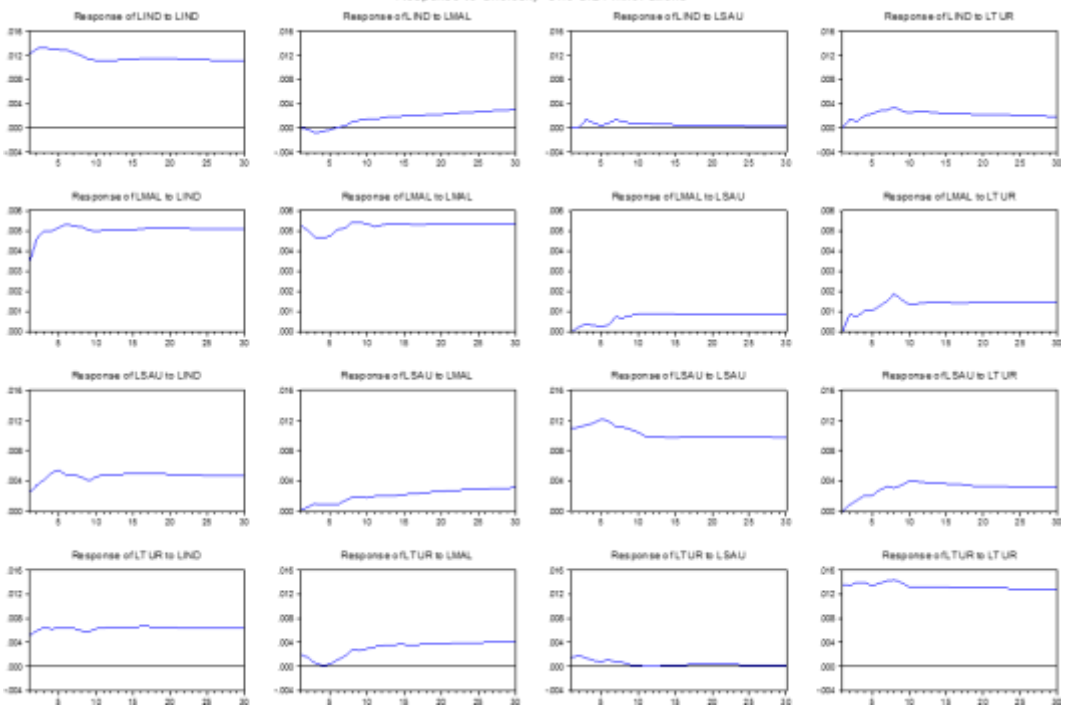

Figure 7 Variance decomposition during the pre-crisis period

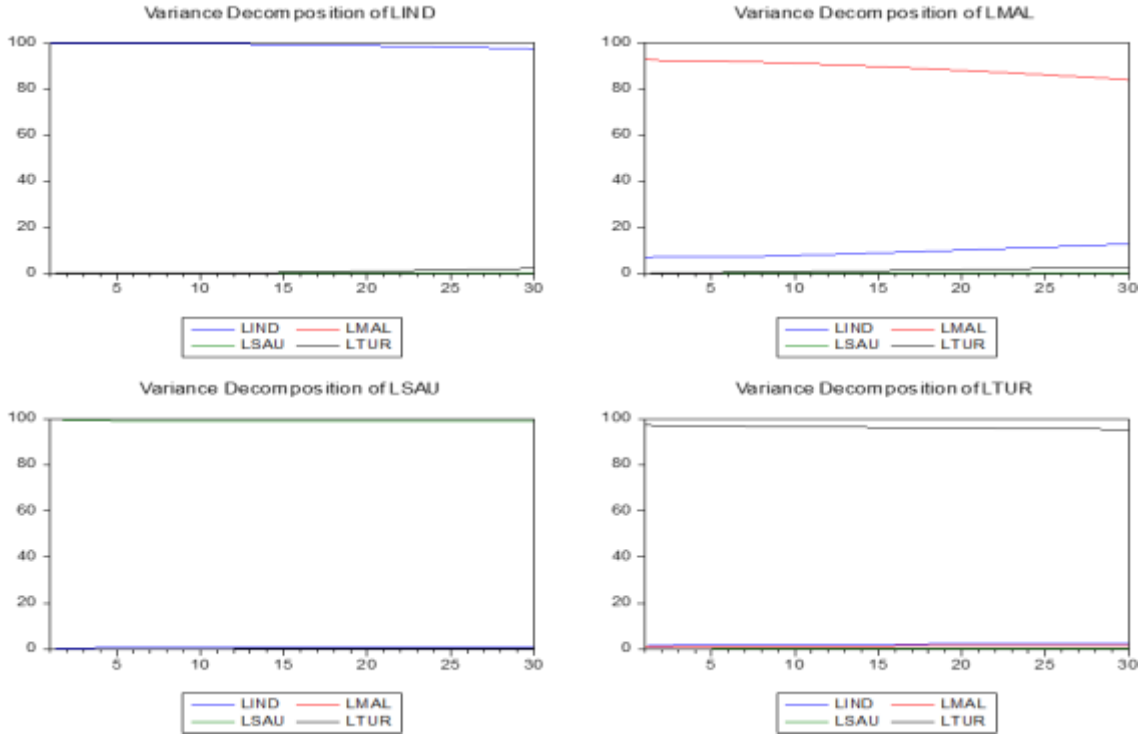

Figure 8. Variance decomposition during the post-crisis period