

The structure of linkages and causal relationships between BRIC and developed equity markets

Norasyikin Abdullah Fahami⁺

Mara University of Technology

Abstract. The study aims to examine the structure of linkages and causal relationship between the world's fastest emerging economies (Brazil, Russia, India and China) and the selected developed countries namely, the United States (US), the United Kingdom and Japan. The leading indices of these stock markets are used as proxies of the market. The period of analysis is being divided into three sample period; the pre-crisis period spans from January 10, 2005 to July 22, 2007, during the crisis period spans from July 29, 2007 to January 10, 2010 and post-crisis period spans from January 11, 2010 until recently July 21, 2011. As for the methodology, the study conducted Augmented Dickey Fuller (ADF) and Phillip Pheron (PP) tests as preliminary evaluation before proceed with Johansen Juselius (JJ) cointegration test and Granger causality test. The results show that all the stock markets under study are cointegrated in pre-crisis, during crisis and post crisis period. However, increasing causalities are recorded among stock markets in the crisis period as compared to pre- and post-crisis period. The results were in line with studies by Kassim (2010) and Chittedi (2009). China was the most influential stock market before the crisis period, whereas United States influenced most of the major equity markets during the period of turbulence. These indicate that, what happen to US stock market bring impact to the other equity markets worldwide despite the emergence of BRIC countries.

Keywords: BRIC countries, developed countries, cointegration, Granger causality.

1. Introduction

Interrelationship and dynamic linkages among countries has been the topic of interest for many researchers, practitioners and policy makers especially after Asian financial crisis 1997/1998. This is due to the linkages have serious implications for international portfolio diversifications and macroeconomic policy of concerned countries. According to Markowitz (1952), investors can improve the performance of their portfolios by allocating their investments into different classes of financial securities and industrial sectors that would not move together in the event of valuable new information. Others who extend the domestic CAPM suggest that diversifying internationally enables investors to reach higher efficient frontier than doing so domestically. While, macroeconomic policy is utmost important since an escalating integration among the national stock markets implies that international financial instabilities are easily transmitted to domestic financial markets, a phenomenon called as 'financial contagion' (Ibrahim, 2005).

Numerous studies beginning with Taylor and Tonks (1989), Chowdhry (1997) and Masih and Masih (2001) are among other researchers who have utilized Granger (1969) and Johansen Juselius (1990) techniques to assess international stock market cointegration in their studies. Noted that, majority of the studies focuses on the developed equity markets until recently, the equity markets of emerging economies has arouse remarkable interest among researchers. Examples of these studies are Ibrahim (2005), Yusof and Majid (2006), Majid et. al (2008) and Majid and Kassim (2009). They documented that United State (US) market is the most influential market in leading other equity markets.

⁺ Corresponding author. Tel.: + 604-9882789; fax: +604-9882526.
E-mail address: syikin109@perlis.uitm.edu.my

Among other emerging economies that received much attention are BRICs countries. Jim O'Neill of Goldman Sachs who coined the acronym expects that over the next 50 years, Brazil, Russia, India and China - the BRICs economies could become a much larger force in the world economy.

Bhar and Nikolova (2009) who explored the level of cointegration of the BRIC with their respective regions and the world in the post-liberalization period has found that India has the highest level of integration on a regional and world level amongst the BRIC countries followed by Brazil, Russia and lastly China. The study also suggested the existence of diversification opportunities for China, given its closed nature of the financial system. Another study on co-movement among selected stock market conducted by Modi et. al (2010) found that the correlation of BSE (India) with BVSP (Brazil), MXX (Mexico), FTSE100 (UK), DJIA and NASDAQ (US) is low. Therefore, these combinations provide attractive portfolio diversification opportunities for Indian investors. Besides, the author also conducted Granger causality test which revealed that MXX, Dowjones and Nasdaq are least dependent on other markets, whereas Dowjones is the most influential market for the period July 1, 1997 to June 30, 2008 of study. Aloui et. al (2011) who also evaluate on the co-movements between the BRIC markets and the US during the period of the global financial crisis indicate that dependency on the US is higher and more persistent to Brazil-Russia than for China-India. In their study, the author paired Brazil and Russia - countries which are highly dependent on commodity prices and China-India whose economic growth is largely influenced by finished-products export-price level. The authors who utilize copula functions in their study also revealed the high level of dependence persistence for all market pairs during both bullish and bearish markets. Using weekly and monthly index returns of the US and BRIC stock markets, Lian and Brown (2010) conducted the study simply using unit root and cointegration test for the period of study; October 13 1995 to October 13 2009. Their findings indicate that there is no evidence of cointegration on pair markets US-Brazil, US-Russia and US-India. However, there is some cointegration between US-China market pair and some cointegration between the US and the BRIC indexes altogether. Chittedi (2009) who utilized the Granger causality, Johansen co integration test and Error Correction Modelling (ECM) in the study has found the co integration relationship between BRIC countries and developed countries namely US, UK and Japan. The author also indicates that US and China leads other markets during the period of study, 1998-2008. India to a great extent is far less integrated with the global markets and is fortunate in its leadership at the policy level.

However, there are only a handful of papers dealing with the synchronization of BRIC equity markets with the global financial crisis in 2008/2009. Thus, this paper aims to empirically examine the structure of linkages and causal relationship among BRIC countries and developed equity market surrounding the recent global financial turmoil. Following Chittedi (2009), this paper extends the line of research by comparing the co-movements of these BRIC and some traditional developed stock return indices on pre-crisis, during crisis and post-crisis period. The outcome of this study is expected to shed the lights on the international portfolio diversification and macroeconomic policy on risk management of the concerned countries. This present study also contributes to the related literature in that we provide a general framework for addressing the extent of extreme interdependences and contagion effects between emerging and developed markets, and among emerging markets themselves in the context of the 2007-2009 global financial crisis.

This paper is structured as follows; Section 2 provides review of previous literature; Section 3 describes data and methodology used in the study; Section 4 presents empirical results and discussion and finally, Section 5 concludes the study, providing some implications and proposing a few recommendations for future research.

2. Data and Methodology

In analyzing the structure of linkages and causal relationship among BRIC and developed countries, seven prominent stock indices of each countries are selected; Brazil (Bovespa), Rusia (RTS), India (S&P CNX 500), China (SSE Composite), USA (S&P 500), UK (FTSE 100), Japan (Nikkei 500). Data on weekly closing stock indices of seven equity markets are gathered from the *Datastream* covering the period before, during and after the global financial crisis. Since the study intends to analyze the impact of financial crisis on the integration of these stock markets, the period of study is divided into three sample periods; the pre-crisis period - January 10, 2005 to July 22, 2007, during crisis - July 29, 2007 to January 10, 2010 and post-crisis period - January 11, 2010 until recently July 21, 2011 (data collection day). The date for during crisis period

is based on the existing study concerning US subprime crisis for example Dungey et al (2008) and Kassim (2010). All these indices are denominated in local currency units, of which stock returns for these markets are calculated and transformed into natural logarithm.

In order to accomplish the objectives of this paper, a group of econometrics approaches are used. Begins with unit root test, the main reason to conduct unit root test is to acquire a meaningful, valid and non-spurious regression. The most popular of these tests are the Augmented Dickey-Fuller (ADF) test and the Phillips-Perron (PP) test. The ADF and PP tests differ mainly in how they treat serial correlation in the test regressions. ADF tests use a parametric autoregressive structure to capture serial correlation whereas, PP tests use non-parametric corrections based on estimates of the long-run variance. The main distinction between the ADF and PP tests lies in their treatment of any “nuisance” serial correlation of which the PP test tends to be more robust to a wide range of serial correlations and time-dependent heteroskedasticity (Syriopoulos, 2004). In both ADF and PP tests, the null hypothesis is that a series is nonstationary (existence of unit root) whereas rejection of the unit root hypothesis supports stationarity.

Even though there are bountiful econometrics technique to assess the cointegration between variables, Gonzalo (1994) has supported the Johansen procedure which presumed to be relatively superior over other method for testing the order of cointegration. Thus, to test for structure of linkages among BRIC and developed equity markets, Johansen and Juselius (1990), henceforth the Johansen Juselius (JJ) cointegration test, is adopted. The aim is to determine the existence of a long-run equilibrium among a set of nonstationary time series.

While, the dynamic relation between stock markets is examined by using the concept of Granger’s (1969) causality test. Formally, a time series x_t – one stock market Granger-causes another time series y_t – another stock market if series can be predicted with better precision by using past values or rather than by not doing so.

3. The Findings

In the preliminary stage, the concern is to establish the degree of integration of the variables using the ADF and PP techniques. The various results of unit root tests are presented in **Table 1**.

Table 1: Unit Root Tests

Variables	Pre-crisis		During crisis		Post-crisis	
	ADF	PP	ADF	PP	ADF	PP
USA	-13.5621*	-13.5540*	-6.90336*	-13.5111*	-10.0585*	-10.0585*
UK	-12.4695*	-12.8474*	-7.45534*	-11.2654*	-10.1812*	-10.1812*
JPN	-10.2986*	-10.2973*	-10.4166*	-10.4180*	-4.81430*	-10.6581*
BRZ	-13.4088*	-13.3166*	-11.4182*	-11.4166*	-11.1082*	-11.0913*
RUS	-8.53763*	-9.54998*	-2.21587	-9.96558*	-10.6112*	-10.6112*
IND	-13.3166*	-9.63911*	-10.2074*	-10.2964*	-10.5632*	-10.4899*
CHN	-11.9592*	-11.9502*	-11.5106*	-11.5040*	-3.77897*	-9.18670*

Note: Significant at 1 percent confidence level (*); the lag length included in the models are based on Akaike information criteria; the above tests of ADF and PP are based on model with constant and trend. All the figures are at level.

According to ADF test, the series are stationary at level except for Rusia during the period of global financial crisis. However, PP test suggest that all variables are stationary at their level, rejecting the null hypothesis of containing unit root in each variables. PP test is used to make up for the shortcomings of the ADF test which assumes that the errors are statistically independent and have a constant variance and caused some of the data used may or may not fit this assumption.

Next, the structures of linkages among stock market returns are examined using the JJ co-integration test. The estimation was based on two statistics, namely trace and maximal eigenvalue. We choose the lag length for the VAR so that the error terms are serially uncorrelated. By using the Ljung-Box-Pierce Q -statistics to test the null hypothesis of serially uncorrelated errors, we found that setting the lag length to 4 is sufficient to whiten the noise process. The results of co-integration test are reported in **Table 2**.

Table 2: JJ Cointegration Tests

Null hypothesis	Pre-crisis		During crisis		Post-crisis	
	Trace	Max	Trace	Max	Trace	Max
$H_0: r = 0$	329.4708 ^a	82.29393 ^a	337.1278 ^a	89.02304 ^a	241.3597 ^a	58.07676 ^a
$H_0: r \leq 1$	247.1769 ^a	64.16436 ^a	248.1048 ^a	76.38569 ^a	183.2829 ^a	54.02363 ^a

$H_0: r \leq 2$	183.0125 ^a	56.54154 ^a	171.7191 ^a	54.13960 ^a	129.2593 ^a	43.31939 ^a
$H_0: r \leq 3$	126.4710 ^a	42.45336 ^a	117.5795 ^a	41.57341 ^a	85.93988 ^a	31.09441 ^a
$H_0: r \leq 4$	84.01761 ^a	32.94877 ^a	76.00605 ^a	32.95886 ^a	54.84547 ^a	24.61663 ^a
$H_0: r \leq 5$	51.06884 ^a	27.66762 ^a	43.04720 ^a	26.16520 ^a	30.22884 ^a	16.34540 ^a
$H_0: r \leq 6$	23.40122 ^a	23.40122 ^a	16.88199 ^a	16.88199 ^a	13.88344 ^a	13.88344 ^a

Note: r denotes the number of cointegrating vectors. Numbers in parentheses next to $r = 0$ until $r \leq 7$ represent the 5% critical values of the test statistic. An (a) indicates rejection of the null hypothesis of no-cointegration at 5% level of significance.

As observed from the table, the trace and max statistics indicates the presence of at least seven cointegrating equation among stock market returns before crisis, during crisis and after the crisis. This means that these variables are tied together in the long-run thus, suggesting the opportunity for the international portfolio diversification has been diminishing through time. This empirical result clearly supports the finding by Chittedi (2009) who also found cointegration relationship between BRIC countries and developed market (US, UK and Japan) during the period January 1998 – August 2009.

Despite there is a long-run relationship among stock market return in each country, the causality direction is undetermined. Therefore, the causality test is conducted to confirm the causal direction. As seen in **Table 3**, it is noted that China is the most influential stock market before the crisis period. This is due the Chinese economy has become important to the global economy as it is a great provider of natural and human resources as well as cheap product demanded by the whole world. The study also in line with Chittedi (2009) which indicates that US and China lead other markets during their period of study (1998-2008).

Table 3: Granger Causality Tests

<i>Dependent variables</i>	<i>USA</i>	<i>UK</i>	<i>JPN</i>	<i>BRZ</i>	<i>RUS</i>	<i>IND</i>	<i>CHN</i>
<i>Pre-crisis period (January 9, 2005 to July 22, 2007)</i>							
USA		0.9544	1.0824	2.5730	0.1368	3.6927	0.0712
UK	1.6476		0.2142	0.7486	1.2869	1.7562	0.9200
JPN	0.8936	1.6803		0.3163	0.7110	0.5581	0.4980
BRZ	0.3659	0.1394	0.0582		1.4243	2.5753	1.6838
RUS	6.5661**	3.4549	0.3350	9.6199***		2.8805	0.1887
IND	2.3413	0.9435	1.1648	3.5972	0.4708		2.4858
CHN	6.0212**	10.554***	2.7546	0.7006	5.1114*	6.9919**	
<i>During-crisis period (July 29, 2007 to January 10, 2010)</i>							
USA		19.374***	29.573***	19.191***	16.433***	5.1153	2.6667
UK	7.3668		9.7849**	4.4469	5.7213	1.1938	1.4892
JPN	1.3868	1.7152		2.9951	0.3147	0.1302	1.3131
BRZ	2.5472	2.5662	2.1350		4.9158	1.8453	5.2129
RUS	14.063***	6.4437	6.8166	5.4908		3.0711	2.9089
IND	8.7671*	9.3528*	7.8970*	8.2728*	8.6255*		1.0266
CHN	9.9905**	1.9503	6.2291	8.7645*	3.8285	7.1167	
<i>Post-crisis period (January 14, 2010 to July 21, 2011)</i>							
USA		2.3896	0.4531	3.5149	0.1620	0.1346	0.3625
UK	2.0885		1.5673	7.4861**	0.5833	0.7400	5.3389*
JPN	3.3562	4.2826		7.4089**	2.6702	3.2526	3.8274
BRZ	0.4920	1.2091	0.2503		5.1483*	3.5669	2.5804
RUS	2.6551	5.1654*	0.3814	3.6115		1.3610	9.2252***
IND	3.1647	1.6267	0.9697	3.6615	1.2507		2.4871
CHN	0.7474	0.4013	1.4051	0.6158	0.4207	1.2890	

Note: The boldface categories denote the dependent variables; *, ** and *** indicate rejection region of the causality at the 10%, 5% and 1% confidence levels, respectively.

The Granger causality test also reveals that there is increasing causalities recorded among stock markets during crisis period than the pre-crisis period. The result supports the findings by Kassim (2010), Fidrmuc and Korhonen (2010), Wang and Huyghebaert (2010) and Yang et al. (2003) who also incorporate the effect of financial crisis to the level of integration among stock markets under study. US equity market is found to be the most influential stock market during the crisis. This is due to that US is the origin of the global financial crisis 2008/2009 and have affected other countries as a result of globalization and liberalisation. While, lesser causalities are recorded after the crisis period.

4. Summary and Conclusions

This paper which extends the study conducted by Chittedi (2010) has incorporated the global financial crisis 2008/2009 to analyze its impact towards BRIC and developed equity markets linkages. The period of

study has been divided into pre crisis, during crisis and post crisis period spans from January 2005 until recently July 2011. The finding reveals increasing causalities among equity markets during crisis in comparison to pre and post crisis period. China was the most influential stock market before the crisis period, whereas US influenced most of the major equity markets during the period of turbulence except China and India. Thus, both countries remain attractive international market portfolio to the international investor.

These findings support the study by He et al. (2007) who documented that in open economies, the international factors playing increasing important role and often determine domestic policies to insulate economy from adverse external economic shocks. Another implication of the finding is that the degree of integration and causalities direction among countries tends to change over time, especially around periods marked by financial crises (see also Bekaert and Harvey, 1995). Extending their proposition to the case of the global financial crisis, it is found that BRIC and developed market integration can be time variant.

5. References

- [1] Aloui, R. Aissa, M. S. B. and Nguyen, D. K. Global financial crisis, extreme interdependences, and contagion effects: the role of economic structure? *Journal of Banking and Finance*, 2011, 35: 130 – 141.
- [2] Bekaert, G and Harvey, C. R. Time-varying world market integration, *Journal of Finance*, 1995, 50: 403-44
- [3] Bhar, R. And Nikolova, B. Return, volatility spillovers and dynamic correlation in the BRIC equity markets: An analysis using a bivariate EGARCH framework, *Global Finance Journal*, 2009, 19: 203 - 218.
- [4] Chittedi, K. R. Global stock markets development and integration: with special reference to BRIC countries” *MRPA Paper*, 2009, no. 18602. Assessed at: <http://mrpa.uni-muenchen.de/18602/>
- [5] Chowdhury, A. R. Stock market interdependencies: evidence from the Asian NIEs, *Journal of Macroeconomics*, 1994, 16: 629-651.
- [6] Dungey Dungey, M., Renee, F., Gonzales-Hermosillo, B. and Martin, V. L. Are all crisis alike? *Working Paper*, 2008. Assessed at: <http://dungey.bigpondhosting.com>
- [7] Gonzalo, J. Five alternative methods of estimating long-run equilibrium relationships”, *Journal of Econometrics*, 1994, 60: 203-33.
- [8] Granger, C. W. Investigating causal relations by econometric and cross-sectional method, *Econometrica*, 1969, 37(3), 424-438.
- [9] He, D., Cheung, L. and Chang, J. Sense and nonsense on Asia’s export dependency and decoupling thesis. *Working Paper 03*, Hong Kong Monetary Authority, 2007.
- [10] Ibrahim, M. H. Financial integration and diversification among ASEAN equity markets: a Malaysia perspective, *Capital Market Review*, 2005, 8(1), 25-40.
- [11] Fidrmuc, J. and Korhonen, I. The impact of the global financial crisis on business cycles in Asian emerging economies, *Journal of Asian Economies*, 2010, 21: 293-303.
- [12] Johansen, S. and Juselius, K. Maximum likelihood estimation and inference on cointegration with applications to demand for money, *Oxford Bulletin of Economics and Statistics*, 1990, 52: 169-210.
- [13] Kassim, S. H. Global financial crisis and integration of Islamic stock markets in developed and developing countries, *V.R.F Series*, 2010, 461. Assessed at: <http://www.ide.go.jp/English/Publish/Download/Vrf/>
- [14] Lian, A. and Brown, D. Equity market integration between the US and BRIC countries: evidence from unit root and cointegration test, *Research Journal of International Studies*, 2010, 16, 15-24.
- [15] Majid, M. S. A. and Kassim S. H. Impact of the 2007 US financial crisis on the emerging equity markets, *International Journal of Emerging Markets*, 2009, 4(4): 341-57.
- [16] Majid, M. S. A., Meera, A. K. M. and Omar, M. A. Interdependence of ASEAN-5 stock markets from the US and Japan”, *Global Economic Review*, 2008, 37(2): 201-25.
- [17] Markowitz, H. Portfolio selection, *Journal of Finance*, 1952, 7, 77-91.
- [18] Masih, R. and Masih, A. M. M. Long and short term dynamic causal transmission among international stock markets, *Journal of International Money and Finance*, 2001, 20, 563-87.
- [19] Modi, A. G., Patel, B. K. and Patel, N. R. The study on co-movement of selected stock markets, *International Research Journal of Finance and Economics*, 2010, 47, 164-179.
- [20] Syriopoulos, T. International portfolio diversification to Central European stock markets, *Applied Financial Economics, Taylor and Francis Journals*, 2004, 14(17): 1253-1268.
- [21] Taylor, M. P. and Tonks, I. The internationalisation of stock markets and the abolition of UK exchange control, *The Review of Economics and Statistics*, 1989, 71, 332-36.

- [22] Wang, L. and Huyghebaert, N. The co-movement of stock markets in East Asia: Did the 1997-1998 Asian Financial Crisis really strengthen stock market integration? *China Economic Review*, 2010, 98-112.
- [23] Yang, J., Kolari, J. W. and Min, I. Stock market integration and financial crises: the case of Asia, *Applied Financial Economics*, 2003,13: 477-486.
- [24] Yusof, R. M and Majid, M.S.A. Who moves the Malaysian stock market – the US or Japan? Empirical evidence from the pre-, during, and post- 1997 Asian financial crisis” *Gadjah Mada International Journal of Business*, 2006, 8, 367 – 406.