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On the Effects of the BRICS on World Economic Growth

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Abstract: The purpose of this empirical study is to examine the potential effects of the BRICS on other nations' economic growth over the period 1960-2013. This investigation deploys the Saikkonen and Lütkepohl cointegration methodology to validate long run relations between Brazil and China's economic growth and other nation's output growth. The study further uses the Toda and Yamamoto approach to Granger causality to examine long run causal links between the BRICS's economic growth. The results show that all countries exhibit long run relations with China and Brazil's economic growth. In addition, the results prove that Brazil's economic growth is induced by South Africa, China and India's economic growth.

Keywords: economic growth; BRICS; developing economies; economic integration.

1 Introduction

The acronym BRICS refers to a set of fast developing nations namely: Brazil, Russia, India, China and South Africa. Economic growth exhibited by these economics has been quite impressive in the last decades particularly for China and India. China's economic growth has been exponential over the years. Today China is the second largest economy in the world. Additionally China's influence has been robust in areas such as exports variety, carbon dioxide emissions, global sustainable development and skills transfer in many economies. Exponential economic growth is desirable but it has shortcomings. For instance, the BRICS are currently concerned with reducing emissions without hampering economic prosperity. China is currently the largest emitter of carbon dioxide globally. India also registered the highest emissions growth recently. Nonetheless, the BRICS are leading world economic growth.

The common aspect among the BRICS is that they are industrialised exporters. Economists postulated that countries such as China and India are a clear example of the export-led growth hypothesis. Export-led growth economies rely heavily on exports to drive sectors of the economy. Mineral exporting economies such as South Africa have to consider the prudent use of their resources and economic development. Over the years many economies have relied on the BRICS for their imports. Numerous studies have been examined to investigate the influence of the BRICS in matters such as inflation spill overs and market returns. Sustainable development is desirable however, countries need to cooperate for this endeavour to be realised. An economy cannot be self-sufficient in all sectors. The question is how does economic growth of the BRICS affect a given economy? How do the BRICS interact in their attempts to reach sustainable development? This paper aims to answer all these questions. This study focuses on Brazil and China to determine the long run effects of these economies' growth on other nations. The reason for focusing on China and Brazil are follows. China is currently the second largest economy and her global influence is profound. Brazil is also highly influential in South America. The other reason is geographical location. Brazil is located far west while China is in Asia.

This is important to determine global influence of these economies without being biased to Asian economies only such as Russia, India and China. The second aim is to investigate the causal relations between members of the BRICS's economic growth patterns. The reason for this aim is that the BRICS need to depend on each other in various sectors for their own

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sustainable development. In this way their global influence will be prodigious (synergy).In this paper, the cointegration method proposed by Saikkonen and Lütkepohl (2000) as well as the Toda and Yamamoto (1995) causality procedure are applied. This investigation is structured as follows. Next is the literature review which provides a detailed analysis of previous studies. This will be followed by data description, methodology and empirical results. Lastly a discussion and conclusion of the study follows with practical implications. An overview of the development of the BRICS shows that China grew rapidly and was followed by Brazil, India and South Africa subsequently over the period 1960-2013.

2 Literature Review

Studies pertaining to economic growth have been numerous. Chang et al (2013) examined the effects of exports and globalization on economic growth using the corrected least square variable model for five South Caucasus countries (Azerbaijan, Armenia, Georgia, Russia and Turkey). The study affirmed that exports with higher energy content and globalization induce economic growth. The results of this study are plausible because GDP depends on exports. In addition, exports which require a lot of energy in their production tend to be massive income drivers such as automobiles. The results are further supported by Amador (2012). The author noted that the BRICS members Brazil, India and China possess high energy content in manufacturing exports. This may well explain their rapid economic growth over the last decade.

Sharma (2003) investigated the determinants of India's export performance in a simultaneous equation framework. The study examined data over the period 1970-1998 and the real appreciation of the Rupee was found to adversely affect India's exports performance. Under this circumstance, economic growth is also affected because output depends on the positivity of net exports. As the Rupee appreciates, Indian exports become more expensive to importing economies thus registering a decline in demand. This results in a decline in GDP. Falvey et al (2004) highlighted that trade of goods and services can result in knowledge and skills being transferred from one country to the other. This is especially true in the case of China and India who now have major influence in skills transfer to other economies. Falvey et al (2004) examined both exports and imports for 21 OECD countries for the period 1975 to 1990 and the results affirmed spillovers through imports. It is then plausible that even though the BRICS may be influential exporters, they may also receive skills from importing economies. Consequently, this will result in higher economic growth. Swiston (2010) aimed to investigate Central America's integration with the US over the 2008 to 2009 global recession. The study used structural Vector Autoregression models to validate that a 1% shock to US economic growth shifts economic activity in Central America by 0.7 to 1% on average. The author explained that the results were driven by factors such as financial conditions and external market demand for Central American exports. Exporting economies particularly the BRICS therefore have a significant influence in other countries' prosperity. Skills transfer can also assist developing economies profoundly. Achmad and Hamzani (2015) noted that in an open economy, the development of industrial sectors can also facilitate the production of exports of goods and services. If a developing economy industrialises based on trade, it is probable that its net exports will also rise leading to high economic growth following Achmad and Hamzani (2015).This paper contributes by determining the effects of the BRICS on other countries' economic growth. The investigation applies the cointegration method proposed by Saikkonen and Lütkepohl (2000). This study evaluates data from 1960 to 2013 to validate such relationships. The examination further uses the Toda and Yamamoto (1995) approach to determine the direction of causation between economic growths among the BRICS.

3 Methodology

This study examines the relations between GDP for sixty different economies with the BRICS over the period 1960 to 2013. The data was obtained from a web source named The Global Economy (http://www.theglobaleconomy.com/). Russia was not included in this analysis due to absence of material data. Actual GDP was in billion dollars (U$). The actual data was converted to natural logarithms before proceeding with empirical analysis. The reason is technically, it is easier to monitor the volatility of logarithmic values over the material period as compared to using raw data. It is imperative that the data set is examined for unit roots. The Augmented Dickey Fuller test (see Dickey and Fuller, 1979) was selected to test for stationarity of the variables. The testing procedure of the ADF is derived from the following generalized model:

$$\Delta y_t = \alpha + \beta_t + \gamma y_{t-1} + \delta \Delta y_{t-1} + \cdots + \delta_{p-1} \Delta y_{t-p+1} + \varepsilon_t,$$

The model applied in this study is:

$$\therefore \Delta y_t = \alpha + \beta_t + \gamma y_{t-1} + \sum_{i=1}^{k} \delta_i \Delta y_{t-1} + \varepsilon_t. \quad (1)$$

The definition of terms is as follows. The regression constant is α and β is the coefficient of the time trend. Following Asemota and Bala (2011) ε_t was defined as the white noise error term. Eviews 7 was used to test the stationarity of the series. The stationarity test was carried out to determine the behaviour of the series over the material period (1960-2013). The Augmented Dickey Fuller test validates if the series has unit roots. The reason is to examine if the data set is suitable for further empirical analysis using cointegration tests. In this paper, stationarity was tested at the 1%, 5% and 10% critical levels. The critical values for the tests were -4.140858, -3.496960 and -3.177579. Superscripts 1,2,3 represent the presence of unit roots at each level (1=1%; 2=5%, 3=10%). Note that all the series under investigation were nonstationary. Nonstationarity could be explained by rapid economic growth over the material period (1960-2013). Table 1 presents the results of the stationarity test.

Table 1: Augmented Dickey Fuller (ADF) Test Results

Country	ADF Test Statistics		
	1% level	**5% level**	**10% level**
Brazil	-2.402113 [1](-4.140858)	-2.402113[2](-3.496960)	-2.402113[3](-3.177579)
Belize	-1.808152 [1](-4.140858)	-1.808152[2](-3.496960)	-1.808152[3](-3.177579)
Bolivia	-2.511779 [1](-4.140858)	-2.511779[2](-3.496960)	-2.511779[3](-3.177579)
Canada	-0.978457 [1](-4.140858)	-0.978457[2](-3.496960)	-0.978457[3](-3.177579)
Chile	-3.673869 [1](-4.140858)	-3.673869(-3.496960)	-3.673869(-3.177579)
Colombia	-2.428655 [1](-4.140858)	-2.428655[2](-3.496960)	-2.428655[3](-3.177579)
Costa Rica	-2.528498 [1](-4.140858)	-2.528498[2](-3.496960)	-2.528498[3](-3.177579)
Dominica	-2.316012 [1](-4.140858)	-2.316012[2](-3.496960)	-2.316012[3](-3.177579)
Ecuador	-2.290930 [1](-4.140858)	-2.290930[2](-3.496960)	-2.290930[3](-3.177579)
Guatemala	-3.553112 [1](-4.140858)	-3.553112(-3.496960)	-3.553112(-3.177579)
Guyana	-0.796204 [1](-4.140858)	-0.796204[2](-3.496960)	-0.796204[3](-3.177579)
Honduras	0.158081 [1](-4.140858)	0.158081[2](-3.496960)	0.158081[3](-3.177579)
Jamaica	-3.165784 [1](-4.140858)	-3.165784[2](-3.496960)	-3.165784[3](-3.177579)
Mexico	-2.741484 [1](-4.140858)	-2.741484[2](-3.496960)	-2.741484[3](-3.177579)
Nicaragua	-3.140482 [1](-4.140858)	-3.140482[2](-3.496960)	-3.140482[3](-3.177579)
Panama	-2.084095 [1](-4.140858)	-2.084095[2](-3.496960)	-2.084095[3](-3.177579)
Peru	-2.389856 [1](-4.140858)	-2.389856[2](-3.496960)	-2.389856[3](-3.177579)
Puerto Rico	1.861587 [1](-4.140858)	1.861587[2](-3.496960)	1.861587[3](-3.177579)
Saint Vincent	-1.559270 [1](-4.140858)	-1.559270[2](-3.496960)	-1.559270[3](-3.177579)
Suriname	-1.292000 [1](-4.140858)	-1.292000[2](-3.496960)	-1.292000[3](-3.177579)
Trinidad & Tobago	-1.317052 [1](-4.140858)	-1.317052[2](-3.496960)	-1.317052[3](-3.177579)
USA	1.773539 [1](-4.140858)	1.773539[2](-3.496960)	1.773539[3](-3.177579)
Uruguay	-3.131048 [1](-4.140858)	-3.131048[2](-3.496960)	-3.131048[3](-3.177579)
Venezuela	-1.498755 [1](-4.140858)	-1.498755[2](-3.496960)	-1.498755[3](-3.177579)
Algeria	-0.989750 [1](-4.140858)	-0.989750[2](-3.496960)	-0.989750[3](-3.177579)
Benin	-2.530252 [1](-4.140858)	-2.530252[2](-3.496960)	-2.530252[3](-3.177579)
Botswana	-0.423076 [1](-4.140858)	-0.423076[2](-3.496960)	-0.423076[3](-3.177579)
Burkina Faso	-1.629912 [1](-4.140858)	-1.629912[2](-3.496960)	-1.629912[3](-3.177579)
Cameroon	-1.061231 [1](-4.140858)	-1.061231[2](-3.496960)	-1.061231[3](-3.177579)
Chad	-1.534980 [1](-4.140858)	-1.534980[2](-3.496960)	-1.534980[3](-3.177579)
Ghana	-0.700408 [1](-4.140858)	-0.700408[2](-3.496960)	-0.700408[3](-3.177579)
Ivory Coast	-1.836463 [1](-4.140858)	-1.836463[2](-3.496960)	-1.836463[3](-3.177579)
Lesotho	-2.334822 [1](-4.140858)	-2.334822[2](-3.496960)	-2.334822[3](-3.177579)
Liberia	-1.903387 [1](-4.140858)	-1.903387[2](-3.496960)	-1.903387[3](-3.177579)
Malawi	-2.139807 [1](-4.140858)	-2.139807[2](-3.496960)	-2.139807[3](-3.177579)
Madagascar	-1.774836 [1](-4.140858)	-1.774836[2](-3.496960)	-1.774836[3](-3.177579)
Mauritania	-2.015906 [1](-4.140858)	-2.015906[2](-3.496960)	-2.015906[3](-3.177579)
Morocco	-1.526097 [1](-4.140858)	-1.526097[2](-3.496960)	-1.526097[3](-3.177579)
Niger	-2.234723 [1](-4.140858)	-2.234723[2](-3.496960)	-2.234723[3](-3.177579)
Nigeria	-1.007071 [1](-4.140858)	-1.007071[2](-3.496960)	-1.007071[3](-3.177579)
Congo	-1.616850 [1](-4.140858)	-1.616850[2](-3.496960)	-1.616850[3](-3.177579)
Seychelles	-1.380275 [1](-4.140858)	-1.380275[2](-3.496960)	-1.380275[3](-3.177579)
Sierra Leone	-1.571073 [1](-4.140858)	-1.571073[2](-3.496960)	-1.571073[3](-3.177579)
South Africa	-2.134646 [1](-4.140858)	-2.134646[2](-3.496960)	-2.134646[3](-3.177579)
Sudan	-1.542140 [1](-4.140858)	-1.542140[2](-3.496960)	-1.542140[3](-3.177579)
Swaziland	-1.881155 [1](-4.140858)	-1.881155[2](-3.496960)	-1.881155[3](-3.177579)
Togo	-1.193167 [1](-4.140858)	-1.193167[2](-3.496960)	-1.193167[3](-3.177579)
Uganda	-3.420546 [1](-4.140858)	-3.420546[2](-3.496960)	-3.420546(-3.177579)
Zambia	-1.032484 [1](-4.140858)	-1.032484[2](-3.496960)	-1.032484[3](-3.177579)

Zimbabwe	-1.829366 [1](-4.140858)	-1.829366[2](-3.496960)	-1.829366[3](-3.177579)
China	-0.804449 [1](-4.140858)	-0.804449[2](-3.496960)	-0.804449[3](-3.177579)
Hong Kong	-0.593099 [1](-4.140858)	-0.593099[2](-3.496960)	-0.593099[3](-3.177579)
India	-1.686225 [1](-4.140858)	-1.686225[2](-3.496960)	-1.686225[3](-3.177579)
Israel	-1.830077 [1](-4.140858)	-1.830077[2](-3.496960)	-1.830077[3](-3.177579)
Japan	-0.125997 [1](-4.140858)	-0.125997[2](-3.496960)	-0.125997[3](-3.177579)
Malaysia	-1.651926 [1](-4.140858)	-1.651926[2](-3.496960)	-1.651926[3](-3.177579)
Nepal	-2.366434 [1](-4.140858)	-2.366434[2](-3.496960)	-2.366434[3](-3.177579)
Oman	-1.219531 [1](-4.140858)	-1.219531[2](-3.496960)	-1.219531[3](-3.177579)
Pakistan	-2.469553 [1](-4.140858)	-2.469553[2](-3.496960)	-2.469553[3](-3.177579)

The ADF test statistics are reported above. The critical values are as follows: -[4.140858] is the critical value at 1% level; -[3.496960] is the critical value at 5% level and -[3.177579] is the critical value at 10% level. The numbers in brackets are critical values. Superscripts 1, 2, 3 indicate statistical significance at 1%, 5%, and 10% critical levels. The results are based on the model: $\Delta y_t = \alpha + \beta_t + \gamma y_{t-1} + \sum_{i=1}^{k} \delta_i \Delta y_{t-1} + \varepsilon_t$. Eviews 7 was used to compute the ADF unit root test. The null hypothesis for the test is “series x, has a unit root”.

3.1 Saikkonen and Lütkepohl (2000) Cointegration Model

In this study, it is important to examine the long run relations between the series. This paper applies the recent cointegration method proposed by Saikkonen and Lütkepohl (2000). Cointegrated variables will be attracted to each other therefore resulting in long run affiliations. Even though the Johansen cointegration test and the Saikkonen and Lütkepohl test are almost similar, there are technical differences. Firstly, the Saikkonen and Lütkepohl test is different technically because it estimates the deterministic term first and then subtracts it from the time series observations unlike the Johansen method. Saikkonen and Lütkepohl (2000) commenced their model by considering a $VAR\ (p)$ process of the form:

$$y_t = v + A_1 y_{t-1} + \cdots + A_p y_{t-p} + \varepsilon_t \qquad t = p+1, p+2, \ldots,$$

Following Saikkonen and Lütkepohl (2000) allow A_J to be $n \times n$ coefficient matrices while ε_t is an $n \times 1$ is a stochastic error term assumed to be a martingale difference sequence with $E(\varepsilon_t | \varepsilon_{s,} s < t) = 0$. The non-stochastic positive definite conditional covariance matrix was defined as $E(\varepsilon_t \grave{\varepsilon}_t | \varepsilon_{s,} s < t) = \Omega$. The resulting final error correction model formed by subtracting y_{t-1} on both sides of the $VAR\ (p)$ above is

$$\Delta\tilde{y}_t = v + \Pi\tilde{y}_{t-1} + \sum_{j=1}^{p-1} \Gamma_j \Delta\tilde{y}_{t-j} + \varepsilon_t \qquad t = p+1, p+2, \ldots, \tag{2}$$

The definition of terms is $\Pi = -(I_n - A_1 - \cdots - A_p)$ while $\Gamma_j = -(A_{j+1} + \cdots + A_p)\ (j = 1, \ldots, p-1)$. The test validates if $H(r_0): rk(\Pi) = r_0$.

3.2 The Toda and Yamamoto (1995) Approach to Granger Causality

The aim of this paper is to investigate the long run causation between income series. However, in this study the other challenge is determining the direction of causal affiliations between income series of the BRICS. The Toda and Yamamoto (1995) approach is the most suitable because it does not require pre-tests for cointegration. The Toda and Yamamoto (1995) technique can apply even if the series does not have unit roots. Granger causality has several limitations. Originally, if the variables under consideration are driven by a common third process with different lags, there is a possibility of failing to reject the alternative hypothesis of Granger causality. In addition, Granger causality is often based on the assumption that causal relations are a result of cointegration. The advantage of the Toda and Yamamoto (1995) approach is that the VAR’s formulated in the levels can be estimated even if the processes may be integrated or cointegrated of an arbitrary order. Wolde-Rufael (2005) observed that the Toda and Yamamoto (1995) approach fits a standard vector autoregressive model in the levels of the variables. In consequence, this minimizes risks associated with the likelihood of wrongly identifying the order of integration of the series (Mavrotas and Kelly, 2001).

The literature has developed a number of cointegration methods following the contributions of Saikkonen and Lütkepohl (2000); Johansen and Juselius (1990); Johansen (1988b, 1991a); Granger (1981); Granger and Weiss (1983); Engle and Granger (1987); Granger and Engle (1985); Stock (1987); Phillips and Durlauf (1986); Phillips and Park (1986); Phillips and Ouilaris (1986); Stock and Watson (1987); Park (1992a, 1990b); Phillips and Hansen (1990); Hovarth and Watson (1995); Saikkonen (1992) and Elliot (1998). Toda and Yamamoto (1995) noted that if economic variables are not cointegrated then the VAR should be estimated in first–order differences of the variables to validate the conventional asymptotic theory. In consequence, the Toda and Yamamoto (1995) approach is applicable even if the VAR may be stationary, integrated of an arbitrary order or cointegrated of an arbitrary order.

This study applies the Toda and Yamamoto (1995) approach as discussed by Wolde-Rufael (2005). The testing procedure starts by augmenting the correct VAR order k by the maximal order of integration d_{max} (Wolde-Rufael, 2005). Following this, a $(k + d_{max})^{th}$ order of the VAR is estimated and the coefficients of the last lagged d_{max} vector are ignored (Caporale and Pittis, 1999; Rambaldi and Doran, 1996; Rambaldi, 1997; Zapata and Rambaldi, 1997). Denote two income series as LX and LY. The VAR system of the variables can now be shown as:

$$LX_t = \alpha_0 + \sum_{i=1}^{k} \alpha_{1i} LX_{t-i} + \sum_{j=k+1}^{d_{max}} \alpha_{2j} LX_{t-j} + \sum_{i=1}^{k} \emptyset_{1i} LY_{t-i} + \sum_{j=k+1}^{d_{max}} \emptyset_{2j} LY_{t-j} + \lambda_{1t} \tag{3}$$

$$LY_t = \beta_0 + \sum_{i=1}^{k} \beta_{1i} LY_{t-1} + \sum_{j=k+1}^{d_{max}} \beta_{2j} LY_{t-j} + \sum_{i=1}^{k} \delta_{1i} LX_{t-i} + \sum_{j=k+1}^{d_{max}} \delta_{2j} LX_{t-j} + \lambda_{2t}$$

4 Empirical Results

The Saikkonen and Lütkepohl test was carried out at 90%, 95% and 99% critical levels using JMulti (4) statistical package.The Saikkonen and Lütkepohl (2000) cointegration tests for cointegrating equations using the VECM stated earlier. The test uses 3 critical levels (that is 90%, 95% and 99%). If a **ρ**-value is less than the critical levels of 0.9, 0.95 and 0.99 then there is cointegration between the variables. Superscripts 1,2,3 show cointegration at different levels which are 90%, 95% and 99%. Note that all countries show cointegration with both Brazil and China's GDP over the period 1960-2013. LR is the likelihood ratio. The results show that there is a long run relationship between all the countries' economic growth and the two countries income (Brazil and China). Tables 2 and 3 represent the results of the cointegration test. Note that **ρ**-values less than the critical levels of 90%, 95% and 99% represent cointegration.

Table 2: Results of the Saikkonen and Lütkepohl Cointegration Test (Brazil)

Country	r_0	LR	90%	95%	99%	ρ-value	r_0	LR	90%	95%	99%	ρ-value
Belize	0	6.4300	13.880	15.760	19.710	0.72400^{1,2,3}	1	1.0200	5.470	6.790	9.730	0.78630^{1,2,3}
Bolivia	0	5.7100	13.880	15.760	19.710	0.80480^{1,2,3}	1	2.4600	5.470	6.790	9.730	0.43960^{1,2,3}
Canada	0	9.5800	13.880	15.760	19.710	0.37820^{1,2,3}	1	1.1600	5.470	6.790	9.730	0.74950^{1,2,3}
Chile	0	13.7900	13.880	15.760	19.710	0.10320^{1,2,3}	1	1.7400	5.470	6.790	9.730	0.59920^{1,2,3}
Colombia	0	9.6900	13.880	15.760	19.710	0.36730^{1,2,3}	1	2.1800	5.470	6.790	9.730	0.49880^{1,2,3}
Costa Rica	0	12.5200	13.880	15.760	19.710	0.15880^{1,2,3}	1	2.4500	5.470	6.790	9.730	0.44130^{1,2,3}
Dominica	0	12.5300	13.880	15.760	19.710	0.15810^{1,2,3}	1	1.9300	5.470	6.790	9.730	0.55330^{1,2,3}
Ecuador	0	11.7100	13.880	15.760	19.710	0.20560^{1,2,3}	1	2.1100	5.470	6.790	9.730	0.51280^{1,2,3}
Guatemala	0	9.6700	13.880	15.760	19.710	0.36960^{1,2,3}	1	1.9300	5.470	6.790	9.730	0.55370^{1,2,3}
Guyana	0	7.2800	13.880	15.760	19.710	0.63000^{1,2,3}	1	0.5600	5.470	6.790	9.730	0.90580^{2,3}
Honduras	0	11.0400	13.880	15.760	19.710	0.25240^{1,2,3}	1	1.6400	5.470	6.790	9.730	0.62440^{1,2,3}
Jamaica	0	8.8800	13.880	15.760	19.710	0.44970^{1,2,3}	1	2.1100	5.470	6.790	9.730	0.51210^{1,2,3}
Mexico	0	14.7400	13.880	15.760	19.710	0.07330^{1,2,3}	1	2.6500	5.470	6.790	9.730	0.40310^{1,2,3}
Nicaragua	0	11.4900	13.880	15.760	19.710	0.22050^{1,2,3}	1	2.3100	5.470	6.790	9.730	0.46940^{1,2,3}
Panama	0	7.0600	13.880	15.760	19.710	0.6560^{1,2,3}	1	2.2500	5.470	6.790	9.730	0.48350^{1,2,3}
Peru	0	7.9600	13.880	15.760	19.710	0.55130^{1,2,3}	1	1.3900	5.470	6.790	9.730	0.68920^{1,2,3}
Puerto Rico	0	7.8200	13.880	15.760	19.710	0.56830^{1,2,3}	1	0.1400	5.470	6.790	9.730	0.98890^{3}
Saint Lucia	0	8.5400	13.880	15.760	19.710	0.48620^{1,2,3}	1	0.9300	5.470	6.790	9.730	0.81230^{1,2,3}
Suriname	0	6.0700	13.880	15.760	19.710	0.76730^{1,2,3}	1	1.9000	5.470	6.790	9.730	0.56040^{1,2,3}
T & Tobago	0	7.3500	13.880	15.760	19.710	0.62200^{1,2,3}	1	2.1000	5.470	6.790	9.730	0.51630^{1,2,3}
USA	0	17.0800	13.880	15.760	19.710	0.02980^{1,2,3}	1	1.7800	5.470	6.790	9.730	0.59080^{1,2,3}
Uruguay	0	13.8200	13.880	15.760	19.710	0.10210^{1,2,3}	1	2.6200	5.470	6.790	9.730	0.40970^{1,2,3}
Venezuela	0	5.0400	13.880	15.760	19.710	0.86730^{1,2,3}	1	2.6200	5.470	6.790	9.730	0.40940^{1,2,3}
Algeria	0	6.9300	13.880	15.760	19.710	0.67160^{1,2,3}	1	1.4800	5.470	6.790	9.730	0.66570^{1,2,3}
Benin	0	7.7200	13.880	15.760	19.710	0.57920^{1,2,3}	1	3.7300	5.470	6.790	9.730	0.24260^{1,2,3}
Botswana	0	9.0800	13.880	15.760	19.710	0.42830^{1,2,3}	1	0.7100	5.470	6.790	9.730	0.87010^{1,2,3}
Burkina Faso	0	7.5000	13.880	15.760	19.710	0.60500^{1,2,3}	1	2.8300	5.470	6.790	9.730	0.37240^{1,2,3}
Burundi	0	4.3300	13.880	15.760	19.710	0.92090^{2,3}	1	1.8200	5.470	6.790	9.730	0.57940^{1,2,3}
Cameroon	0	9.5800	13.880	15.760	19.710	0.37820^{1,2,3}	1	1.1600	5.470	6.790	9.730	0.74950^{1,2,3}
Chad	0	14.9600	13.880	15.760	19.710	0.06760^{1,2,3}	1	1.6600	5.470	6.790	9.730	0.61850^{1,2,3}
Ghana	0	8.8400	13.880	15.760	19.710	0.45370^{1,2,3}	1	0.8300	5.470	6.790	9.730	0.83750^{1,2,3}
Ivory Coast	0	15.7600	13.880	15.760	19.710	0.04990^{1,2,3}	1	1.1900	5.470	6.790	9.730	0.74250^{1,2,3}
Lesotho	0	16.5100	13.880	15.760	19.710	0.03740^{1,2,3}	1	2.7300	5.470	6.790	9.730	0.39000^{1,2,3}

Liberia	0	5.8100	13.880	15.760	19.710	0.79480[1,2,3]	1	2.1800	5.470	6.790	9.730	0.49750[1,2,3]
Malawi	0	12.0000	13.880	15.760	19.710	0.18810[1,2,3]	1	1.9500	5.470	6.790	9.730	0.54910[1,2,3]
Madagascar	0	6.4600	13.880	15.760	19.710	0.72400[1,2,3]	1	2.0000	5.470	6.790	9.730	0.53830[1,2,3]
Mauritania	0	16.4700	13.880	15.760	19.710	0.03800[1,2,3]	1	2.9500	5.470	6.790	9.730	0.35140[1,2,3]
Morocco	0	12.9200	13.880	15.760	19.710	0.13890[1,2,3]	1	2.4600	5.470	6.790	9.730	0.43920[1,2,3]
Niger	0	7.8400	13.880	15.760	19.710	0.56590[1,2,3]	1	2.4900	5.470	6.790	9.730	0.43460[1,2,3]
Nigeria	0	5.3400	13.880	15.760	19.710	0.84060[1,2,3]	1	0.9500	5.470	6.790	9.730	0.80640[1,2,3]
Congo	0	7.0500	13.880	15.760	19.710	0.65760[1,2,3]	1	2.3900	5.470	6.790	9.730	0.45340[1,2,3]
Seychelles	0	10.8500	13.880	15.760	19.710	0.26670[1,2,3]	1	1.3300	5.470	6.790	9.730	0.70330[1,2,3]
Sierra Leone	0	6.6200	13.880	15.760	19.710	0.70690[1,2,3]	1	1.9400	5.470	6.790	9.730	0.55260[1,2,3]
South Africa	0	13.1100	13.880	15.760	19.710	0.13030[1,2,3]	1	1.7300	5.470	6.790	9.730	0.60280[1,2,3]
Sudan	0	6.0600	13.880	15.760	19.710	0.76770[1,2,3]	1	2.5200	5.470	6.790	9.730	0.42890[1,2,3]
Swaziland	0	10.8900	13.880	15.760	19.710	0.26340[1,2,3]	1	1.8400	5.470	6.790	9.730	0.57600[1,2,3]
Togo	0	16.2100	13.880	15.760	19.710	0.04210[1,2,3]	1	2.7100	5.470	6.790	9.730	0.39380[1,2,3]
Uganda	0	13.5300	13.880	15.760	19.710	0.11300[1,2,3]	1	2.4000	5.470	6.790	9.730	0.45230[1,2,3]
Zambia	0	8.5800	13.880	15.760	19.710	0.48160[1,2,3]	1	0.9600	5.470	6.790	9.730	0.80180[1,2,3]
Zimbabwe	0	10.3600	13.880	15.760	19.710	0.30650[1,2,3]	1	2.4400	5.470	6.790	9.730	0.44440[1,2,3]
China	0	8.7100	13.880	15.760	19.710	0.46820[1,2,3]	1	0.0800	5.470	6.790	9.730	0.99540
Hong Kong	0	13.6300	13.880	15.760	19.710	0.10920[1,2,3]	1	1.1700	5.470	6.790	9.730	0.74560[1,2,3]
India	0	7.3600	13.880	15.760	19.710	0.62130[1,2,3]	1	1.2300	5.470	6.790	9.730	0.73040[1,2,3]
Israel	0	8.3500	13.880	15.760	19.710	0.50790[1,2,3]	1	1.1300	5.470	6.790	9.730	0.75690[1,2,3]
Japan	0	8.1500	13.880	15.760	19.710	0.52960[1,2,3]	1	0.3400	5.470	6.790	9.730	0.95630[3]
Malaysia	0	11.3400	13.880	15.760	19.710	0.23080[1,2,3]	1	1.3200	5.470	6.790	9.730	0.70730[1,2,3]
Nepal	0	7.6500	13.880	15.760	19.710	0.58720[1,2,3]	1	2.3100	5.470	6.790	9.730	0.47130[1,2,3]
Oman	0	12.7800	13.880	15.760	19.710	0.14570[1,2,3]	1	0.7700	5.470	6.790	9.730	0.85270[1,2,3]
Pakistan	0	13.2300	13.880	15.760	19.710	0.12500[1,2,3]	1	2.6600	5.470	6.790	9.730	0.40140[1,2,3]

Note: [1] shows statistical significance at 90% critical level; [2] shows statistical significance at 95% critical level; [3]shows statistical significance at 99% critical level. Note that ρ-values less than critical levels of 90%, 95% and 99% represent cointegration. The test was carried out using JMulti 4 statistical package. The deterministic term of the VECM was defined as $D_t = u_o + u_{1t}$. Superscripts 1, 2, 3 show statistical significance at 90%, 95%, and 99% critical levels. LR = Likelihood Ratio. Superscripts 1, 2, 3 show statistical significance at 90%, 95%, and 99% critical levels.

Table 3: Results of the Saikkonen and Lütkepohl Cointegration Test (China)

Country	r_0	**LR**	**90%**	**95%**	**99%**	**ρ-value**	r_0	**LR**	**90%**	**95%**	**99%**	**ρ-value**
Brazil	0	8.7100	13.880	15.760	19.710	0.46820[1,2,3]	1	0.0800	5.470	6.790	9.730	0.99540
Belize	0	8.7500	13.880	15.760	19.710	0.46310[1,2,3]	1	0.2700	5.470	6.790	9.730	0.96830[3]
Bolivia	0	10.0500	13.880	15.760	19.710	0.33340[1,2,3]	1	0.8700	5.470	6.790	9.730	0.82600[1,2,3]
Canada	0	6.0400	13.880	15.760	19.710	0.77030[1,2,3]	1	0.3300	5.470	6.790	9.730	0.95720[3]
Chile	0	17.4500	13.880	15.760	19.710	0.02560[1,2,3]	1	0.6600	5.470	6.790	9.730	0.88270[1,2,3]
Colombia	0	6.6400	13.880	15.760	19.710	0.70390[1,2,3]	1	0.2200	5.470	6.790	9.730	0.97680[3]
Costa Rica	0	9.1900	13.880	15.760	19.710	0.41730[1,2,3]	1	0.2300	5.470	6.790	9.730	0.97500[3]
Dominica	0	5.6700	13.880	15.760	19.710	0.80870[1,2,3]	1	0.4900	5.470	6.790	9.730	0.92270[2,3]
Ecuador	0	7.9100	13.880	15.760	19.710	0.55740[1,2,3]	1	1.3400	5.470	6.790	9.730	0.70160[1,2,3]
Guatemala	0	5.7300	13.880	15.760	19.710	0.80270[1,2,3]	1	0.0100	5.470	6.790	9.730	0.99980
Guyana	0	5.7100	13.880	15.760	19.710	0.80490[1,2,3]	1	1.1300	5.470	6.790	9.730	0.75670[1,2,3]
Honduras	0	6.2600	13.880	15.760	19.710	0.74630[1,2,3]	1	0.0100	5.470	6.790	9.730	0.99990
Jamaica	0	9.0100	13.880	15.760	19.710	0.43570[1,2,3]	1	0.6300	5.470	6.790	9.730	0.88800[1,2,3]
Mexico	0	12.9700	13.880	15.760	19.710	0.13690[1,2,3]	1	0.5300	5.470	6.790	9.730	0.91320[2,3]
Nicaragua	0	9.9600	13.880	15.760	19.710	0.34190[1,2,3]	1	0.4500	5.470	6.790	9.730	0.93210[2,3]
Panama	0	7.8900	13.880	15.760	19.710	0.55960[1,2,3]	1	0.2600	5.470	6.790	9.730	0.97120[3]
Peru	0	5.9400	13.880	15.760	19.710	0.78110[1,2,3]	1	0.1500	5.470	6.790	9.730	0.98810[3]
Puerto Rico	0	9.1900	13.880	15.760	19.710	0.41640[1,2,3]	1	0.4200	5.470	6.790	9.730	0.93930[2,3]
Saint Lucia	0	12.4400	13.880	15.760	19.710	0.16310[1,2,3]	1	0.3600	5.470	6.790	9.730	0.95130[3]
USA	0	5.9400	13.880	15.760	19.710	0.78100[1,2,3]	1	3.3600	5.470	6.790	9.730	0.28940[1,2,3]
Uruguay	0	10.4600	13.880	15.760	19.710	0.29810[1,2,3]	1	0.6100	5.470	6.790	9.730	0.89350[1,2,3]
Venezuela	0	5.8600	13.880	15.760	19.710	0.78930[1,2,3]	1	1.4000	5.470	6.790	9.730	0.68490[1,2,3]
Algeria	0	4.5000	13.880	15.760	19.710	0.75270[1,2,3]	1	0.3400	5.470	6.790	9.730	0.95630[3]
Benin	0	6.2000	13.880	15.760	19.710	0.84030[1,2,3]	1	0.5300	5.470	6.790	9.730	0.91330[1,2,3]
Botswana	0	5.3400	13.880	15.760	19.710	0.57380[1,2,3]	1	0.9300	5.470	6.790	9.730	0.81080[1,2,3]
Burkina Faso	0	7.7700	13.880	15.760	19.710	0.87700[1,2,3]	1	1.0600	5.470	6.790	9.730	0.77670[1,2,3]
Burundi	0	5.3400	13.880	15.760	19.710	0.69800[1,2,3]	1	1.9100	5.470	6.790	9.730	0.55780[1,2,3]
Cameroon	0	4.9200	13.880	15.760	19.710	0.74050[1,2,3]	1	0.5900	5.470	6.790	9.730	0.89980[1,2,3]
Chad	0	6.6900	13.880	15.760	19.710	0.69270[1,2,3]	1	0.5700	5.470	6.790	9.730	0.90390[2,3]
Ghana	0	6.3200	13.880	15.760	19.710	0.74050[1,2,3]	1	0.6500	5.470	6.790	9.730	0.88340[1,2,3]
Ivory Coast	0	6.7400	13.880	15.760	19.710	0.69270[1,2,3]	1	1.8400	5.470	6.790	9.730	0.57630[1,2,3]

Lesotho	0	7.5400	13.880	15.760	19.710	0.60070[1,2,3]	1	0.5600	5.470	6.790	9.730	0.90740[2,3]
Liberia	0	11.0600	13.880	15.760	19.710	0.25040[1,2,3]	1	0.7000	5.470	6.790	9.730	0.87090[1,2,3]
Malawi	0	9.0400	13.880	15.760	19.710	0.43250[1,2,3]	1	0.4100	5.470	6.790	9.730	0.94000[2,3]
Madagascar	0	5.0100	13.880	15.760	19.710	0.86940[1,2,3]	1	2.0600	5.470	6.790	9.730	0.52490[1,2,3]
Mauritania	0	6.2500	13.880	15.760	19.710	0.74770[1,2,3]	1	1.1000	5.470	6.790	9.730	0.76630[1,2,3]
Morocco	0	6.7800	13.880	15.760	19.710	0.68870[1,2,3]	1	0.0600	5.470	6.790	9.730	0.99710
Nigeria	0	6.4900	13.880	15.760	19.710	0.72170[1,2,3]	1	1.5800	5.470	6.790	9.730	0.64020[1,2,3]
Congo	0	8.2200	13.880	15.760	19.710	0.52150[1,2,3]	1	2.4200	5.470	6.790	9.730	0.44840[1,2,3]
Seychelles	0	8.1700	13.880	15.760	19.710	0.52740[1,2,3]	1	0.6100	5.470	6.790	9.730	0.89520[1,2,3]
Sierra Leone	0	8.5500	13.880	15.760	19.710	0.48560[1,2,3]	1	1.6100	5.470	6.790	9.730	0.63200[1,2,3]
Sudan	0	6.3500	13.880	15.760	19.710	0.73700[1,2,3]	1	0.2800	5.470	6.790	9.730	0.96690[3]
Swaziland	0	8.8100	13.880	15.760	19.710	0.45690[1,2,3]	1	0.5900	5.470	6.790	9.730	0.89900[1,2,3]
Togo	0	8.0500	13.880	15.760	19.710	0.54180[1,2,3]	1	0.5100	5.470	6.790	9.730	0.91750[2,3]
Uganda	0	14.9200	13.880	15.760	19.710	0.06860[1,2,3]	1	0.6000	5.470	6.790	9.730	0.89650[1,2,3]
Zambia	0	7.0000	13.880	15.760	19.710	0.66270[1,2,3]	1	0.6900	5.470	6.790	9.730	0.87340[1,2,3]
Zimbabwe	0	9.9500	13.880	15.760	19.710	0.34300[1,2,3]	1	0.1300	5.470	6.790	9.730	0.98990[3]
Hong Kong	0	7.2300	13.880	15.760	19.710	0.63670[1,2,3]	1	1.7200	5.470	6.790	9.730	0.60530[1,2,3]
Japan	0	8.5700	13.880	15.760	19.710	0.48340[1,2,3]	1	0.4600	5.470	6.790	9.730	0.92920[2,3]
Malaysia	0	5.3800	13.880	15.760	19.710	0.83610[1,2,3]	1	0.6600	5.470	6.790	9.730	0.88220[1,2,3]
Nepal	0	13.3600	13.880	15.760	19.710	0.11990[1,2,3]	1	0.8800	5.470	6.790	9.730	0.82530[1,2,3]
Oman	0	6.5800	13.880	15.760	19.710	0.71050[1,2,3]	1	0.0300	5.470	6.790	9.730	0.99890[3]
Pakistan	0	9.9100	13.880	15.760	19.710	0.34630[1,2,3]	1	0.5500	5.470	6.790	9.730	0.90890[2,3]

Note: [1] shows statistical significance at 90% critical level; [2] shows statistical significance at 95% critical level; [3]shows statistical significance at 99% critical level. Note that ρ-values less than critical levels of 90%, 95% and 99% represent cointegration. The test was carried out using JMulti 4 statistical package. The deterministic term of the VECM was defined as $D_t = u_o + u_{1t}$. Superscripts 1, 2, 3 show statistical significance at 90%, 95%, and 99% critical levels. LR = Likelihood Ratio. Superscripts 1, 2, 3 show statistical significance at 90%, 95%, and 99% critical levels.

Eviews 7 was used to carry out the Toda and Yamamoto (1995) approach to causality. The results show that Brazil's income is induced by China, South Africa and India's economic growth. The Toda and Yamamoto causality test was used to test for causal relations among the BRICS economic growth pattern. The VAR estimates of the series were carried out first and are presented in table 4. Following this, the next step was to carry out the Toda and Yamamoto test at the 5% critical level. The null hypothesis was that a given variable does not Granger cause the other. Note that for causality running from India to Brazil the **ρ**-value registered is 0.02550 suggesting we have to reject the null hypothesis of non-causality.This was the same with causality running from China and South Africa to Brazil. The **ρ**-values registered were 0.02100 and 0.00070 thus affirming causality. Note that further causality tests did not reveal any causal relations. The null hypothesis of non-causality had to be accepted in this case. Therefore, the only registered causality were from India, South Africa and China to Brazil's GDP. Table 5 presents the results of the Toda and Yamamoto causality test. Table 4 is a presentation of the VAR estimates before the causality test.

Table 4: Vector Autoregression (VAR) Estimates

	BRAZIL	INDIA	CHINA	SOUTH AFRICA
BRAZIL_ LN(-1)	0.893856	0.159168	-0.053817	0.09826
	(0.14585)	(0.10593)	(0.10323)	(0.14993)
	[6.12849]	[1.50255]	[-0.52131]	[0.65779]
BRAZIL_LN(-2)	-0.251374	-0.139890	-0.058306	0.020327
	(0.13123)	(0.09531)	(0.09288)	(0.13490)
	[-1.91556]	[-1.46774]	[-0.62774]	[0.15068]
INDIA_LN(-1)	0.146953	0.857351	0.257046	0.262708
	(0.234970)	(0.170650)	(0.166310)	(0.241540)
	[0.625420]	[5.02391]	[1.545600]	[1.087630]
INDIA_LN(-2)	-0.555782	-0.050748	0.283923	-0.126563
	(0.244730)	(0.177750)	(0.173220)	(0.251580)
	[-2.270990]	[-0.285500]	[-1.639080]	[-0.503070]
CHINA_LN(-1)	0.155202	-0.077558	1.090469	-0.073913
	(0.199810)	(0.145120)	(0.141430)	(0.205400)
	[0.776750]	[-0.534440]	[7.710570]	[-0.359840]
CHINA_LN(-2)	0.0838210	0.1885270	-0.0493370	0.030952

	(0.2085500)	0.151470	0.147610	0.214390
	[0.401920	[1.244660]	[-0.334230]	[0.144370]
SA_LN(-1)	0.4900440	0.093754	0.0298370	1.066611
	(0.174350)	(0.126630)	(0.123400)	(0.179230)
	[2.810750]	[0.740400]	[0.241780]	[5.951210]
SA_LN(-2)	0.030164	-0.055641	0.1072180	-0.313102
	(0.183150)	(0.133020)	(0.129630)	(0.188270)
	[0.164700]	[-0.418300]	[0.827100]	[-1.663030]
C	0.602748	0.1964430	0.0129480	-0.049159
	(0.211400)	(0.153540)	(0.149630)	(0.217320)
	[2.851220]	[1.279440]	[0.086530]	[-0.226210]

Table 5: Toda and Yamamoto Causality Test Results

	Dependent: Brazil			
Country	Chi-square	*df*	ρ-value	Causation
India	7.336837	2	0.02550*	India ⇒ Brazil
China	7.727293	2	0.02100*	China ⇒ Brazil
South Africa	14.40729	2	0.00070*	SA ⇒ Brazil
	Dependent: India			
Country	Chi-square	*df*	ρ-value	Causation
Brazil	2.520325	2	0.28360	Brazil ⇎ India
China	3.621016	2	0.16360	China ⇎ India
South Africa	0.553305	2	0.75830	SA ⇎ India
	Dependent: China			
Country	Chi-square	*df*	ρ-value	Causation
Brazil	2.665138	2	0.26380	Brazil ⇎ China
India	2.957489	2	0.22790	India ⇎ China
South Africa	1.688156	2	0.43000	SA ⇎ China
	Dependent: South Africa			
Country	Chi-square	*df*	ρ-value	Causation
Brazil	1.391189	2	0.49880	Brazil ⇎ SA
India	1.352688	2	0.50850	India ⇎ SA
China	0.323568	2	0.85060	China ⇎ SA

Note: The arrows signify the direction of causation. ⇒ implies causality in a given direction; ⇎ implies that there is no causality between the variables. The test was carried out at 5% significant level. The null hypothesis (H_0) is that a given variable does not Granger cause the other (non-causality). Note that ρ-values less than the 5% critical level $(\rho < 0.05)$ represent causality in a given direction. The null hypothesis is therefore rejected for ρ-values less than the significant level. Asterisks (*) represent a causal relationship at the 5% significant level. Eviews (7) was used to carry out the Toda-Yamamoto approach to Granger causality.

5 Discussion and Conclusion

This study aimed to determine the BRICS influence on other nation's economic growth. The other objective of this empirical investigation was to determine the causal relations between the BRICS's economic growth. Economic growth exhibited by the BRICS has been impressive in the last decade. China is currently the largest economy after the US but her economic growth has been attached with shortcomings. Economic growth is every country's major goal however there are environmental costs. The BRICS's economic growth has been attributed to exports variety and industrialisation. This paper aimed to find out if such rapid growth could potentially affect economic growth of other nations. In this investigation, the Saikkonen and Lütkepohl (2000) cointegration model has been applied to validate long term relationships between economic growth series. The Toda and Yamamoto (1995) approach to Granger causality was applied to investigate the influence the BRICS have on each other's economic growth over the period 1960 to 2013. The results of the empirical analysis show that all countries' depict long term relationships between China and Brazil's economic growth pattern. In addition, the causality test shows that South Africa, India and China induce Brazil's economic growth.

The results of this study carry implications. The study showed that all the economies under investigation trend positively with both China and Brazil's economic growth. This may be the result of spillovers that occur during trade. The results are explained by Falvey et al (2004). The authors argued that knowledge and skills can spill over through trade to other countries. Most developing economies rely on goods and services produced by large economies such as China and Brazil. This creates a state of dependency and escalates the demand for goods produced by the BRICS. It is probable that economic growth of the concerned economies will run parallel.

This is explained well by Swiston (2010). The author investigated the effect of the US economy on Central American economies. The results demonstrated that spillovers were largely transmitted through financial conditions and fluctuations in demand for Central American exports. Any shock to the U.S economy was found to affect the Central American nations (Swiston, 2010). The results of this study also showed that Brazil's growth is driven by other economies' GDP. The results may also be explained in terms of knowledge transfer during trade of goods and services (Falvey et al 2004; Douven and Peeters, 1998; Swiston, 2010). The results may also mean that Brazil is a big market for other BRICS member's goods and services. In conclusion, of this study, the BRICS play a major role in world economic growth. Skills transfer and knowledge have made many nations to depend on the BRICS especially China. Economic and financial integration of the BRICS could potentially produce very high economic growth but other factors will have to be considered in this endeavour such as balance of payments, and fiscal deficits.

References

[1] Achmad, D., and Hamzani, U. (2015). The role of regional superior sectors in creating GDP value added, employment opportunity, regional productivity and human development index. *Procedia Social and Behavioral Sciences,* Vol. 211, pp. 953-959.

[2] Amador, J. (2012). Energy content in manufacturing exports: A cross country analysis. *Energy Economics*, Vol. 34, pp. 1074:1081.

[3] Chang, Chun-Ping, Na Berdiev, A. and Lee, Chien-Chiang (2013). Energy exports, globalization and economic growth: The case of South Caucasus. *Economic Modelling,* Vol. 33, pp. 383-346.

[4] Sharma, K. (2003). Factors determining India's export performance. *Journal of Asian Economics*, Vol. 14, pp. 435-446.

[5] Asemota, O. M., and Bala, D. A. (2011). A Kalman Filter approach to Fisher effect: Evidence from Nigeria. *CBN Journal of Applied Statistics*, Vol. 2, No. 1, pp. 71-91.

[6] Caporale, G. M., and Pittis, N. (1999). Efficient estimation of cointegrating vectors and testing for causality in vector autoregressions. *Journal of Economic Issues,* Vol. 13, pp. 3-35.

[7] Dickey, D. A., and Fuller, W. A. (1979). Distribution of the estimators for autoregressive time series with a unit root. *Journal of the American Statistical Association*, Vol. 74, No. 366, pp. 427-431.

[8] Divya, K. M. and Devi, V.R. (2014). A study on predictors of GDP: early signs. *Procedia Economics and Finance,* Vol. 11, pp. 375-382.

[9] Douven, R., and Peeters M. (1998). GDP spillovers in multi-country models. *Economic Modelling,* Vol.15, pp. 163-195.

[10] Elliott, G. (1998). On the robustness of cointegration methods when regressors almost have a unit root. *Econometrica*, Vol. 66, No.1, pp. 149-158. doi:10.2307/2998544.

[11] Engle, R. F., and Granger, C. W. (1987). Cointegration and error correction: representation, estimation, and testing. *Econometrica*, Vol. 55, No. 2, pp. 251-276. doi:10.2307/1913236.

[12] Falvey, R., Foster, N., and Greenaway, D. (2004). Imports, exports, knowledge spillovers and growth. *Economics Letters,* Vol. 85, pp. 209-213.

[13] Granger, C. J. (1981). Some properties of time series data and their use in econometric model specification. *Journal of Econometrics*, Vol. 55, pp. 251-276. doi:10.1016/0304-4076(81)90079-8.

[14] Granger, C. W. J. and Engle, R. F. (1985). Dynamic model specification with equilibrium constraints. *University of California, San Diego.*

[15] Granger, C. W. J., and Weiss, A. A. (1983). Time series analysis of error correction models. In Karlim, S; Amemiya, T., and Goodman, L. A. *Studies in Economic Time Series and Multivariate Statistics*, (Academic Press: New York). doi:10.1016/b978-0-12-398750-1.50018-8.

[16] Granger, C. W. J. (1969). Investigating causal relations by econometric models: cross spectral methods. *Econometrica*, Vol. 37, No. 3, pp. 424- 438. doi:10.2307/1912791.

[17] http://www.theglobaleconomy.com/ (Retrieved 11 January 2016).

[18] Hovarth, W., and Watson, M. (1995). Testing for cointegration when some of the cointegrating vectors are prespecified.

Econometric Theory, Vol. 11, No.5, pp. 984-1014. doi:10.1017/s0266466600009944.

[19] Johansen, S. (1991a). Estimation and hypothesis testing of cointegration vectors in Gaussian Vector Autoregressive models. *Econometrica*, Vol. 59, No. 6, pp. 1551-1580. doi:10.2307/2938278.

[20] Johansen, S. (1988b). Statistical analysis of cointegration vectors. *Journal of Economic Dynamics and Control*, Vol. 12, pp. 231-254. doi:10.1016/0165-1889(88)90041-3.

[21] Johansen, S., and Juselius, K. (1990). Maximum likelihood estimation and inference on cointegration with applications to the demand for money. *Oxford Bulletin of Economics and Statistics*, Vol. 52, No. 2, pp. 169-210. doi:10.1111/j.1468-0084.1990.mp52002003.x.

[22] Mavrotas, G., and Kelly, R. (2001). Old wine in new bottle: testing causality between savings and growth. *The Manchester School Supplement,* pp. 97-105.

[23] Park, J. Y. (1992a). Canonical cointegration regression. *Econometrica*, Vol. 60, pp.119-144.

[24] Park, J. Y. (1990b). Testing for unit roots and cointegration by variable addition. *Advances in Econometrics*, Vol. 8, pp. 107-133.

[25] Phillips, P. C. B and Durlauf, S. N. (1986). Multiple time series regression with integrated processes. *Review of Economic Studies*, Vol. 53, pp. 473-495. doi:10.2307/2297602.

[26] Phillips, P. C. B., and Hansen, B. E (1990). Statistical inference in instrumental variable with I(1) processes. *Review of Economic Studies*, Vol. 57, pp. 99-125. doi:10.2307/2297545.

[27] Phillips, P. C. B., and Ouilaris, S. (1986). Testing for cointegration. *Cowles Foundation Discussion Paper*, No. 809.

[28] Phillips, P. C. B., and Park, J. Y. (1986). Asymptotic equivalence of OLS and GLS in regression with integrated regressors. *Cowles Foundation Discussion Paper*, No. 802.

[29] Phillips, P. C. B., and Perron, P. (1988). Testing for a unit root in time series regression. *Biometrika*, Vol. 75, No. 2, pp. 335-346. doi:10.2307/2336182.

[30] Rambaldi, A. N. (1997). Multiple time series models and testing for causality and exogeneity: a review. *Working Papers in Econometrics and Applied Statistics,* No. 96. Department of Econometrics, University of New England.

[31] Rambaldi, A. N., and Doran, H. E. (1996). Testing for Granger non-causality in cointegrated systems made easy. *Working Papers in Econometrics and Applied Statistics*, No.88. Department of Econometrics, University of New England.

[32] Saikkonen, P. (1992). Estimation and testing of cointegrated systems by an autoregressive approximation. *Econometric Theory,* Vol. 8 No. 1, pp. 1-27. doi:10.1017/s0266466600010720.

[33] Saikkonen, P., and Ltkepohl, H. (2000). Testing for the cointegrating rank of a VAR process with an intercept. *Economic Theory*, Vol. 16, pp. 373-406.

[34] Stock, J. H. (1987). Asymptotic properties of least squares estimates of cointegration vectors. *Econometrica*, Vol. 55, No. 5, pp. 1035-1056. doi:10.2307/1911260

[35] Stock, J. H., and Watson, M. W (1987). Testing for common trends. *Working Paper in Econometrics* (Hoover Institution, Stanford, CA).

[36] Swiston, A. (2010). Spillovers to Central America in light of the crisis: What a difference a year makes. *IMF Working Paper*, WP/10/.

[37] Toda., H. Y., and Yamamoto, T. (1995). Statistical inference in vector autoregressions with possibly integrated processes. *Journal of Econometrics,* Vol. 66, pp. 225-250.

[38] Wolde-Rufael, Y. (2005). Energy demand and economic growth: the African experience. *Journal of Policy Modeling,* Vol. 27, pp. 891-903. doi:10.1016/j.jpolmod.2005.06.003.

[39] Zapata, H, O., and Rambaldi, A. N. (1997). Monte Carlo evidence on cointegration and causation. *Oxford Bulletin of Economics and Statistics,* Vol. 59, pp. 285-298.

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