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# **On the Effects of the BRICS on World Economic Growth**

## **Abstract**

The purpose of this empirical study is to examine the potential effects of the BRICS on other economies' 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 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

## Introduction

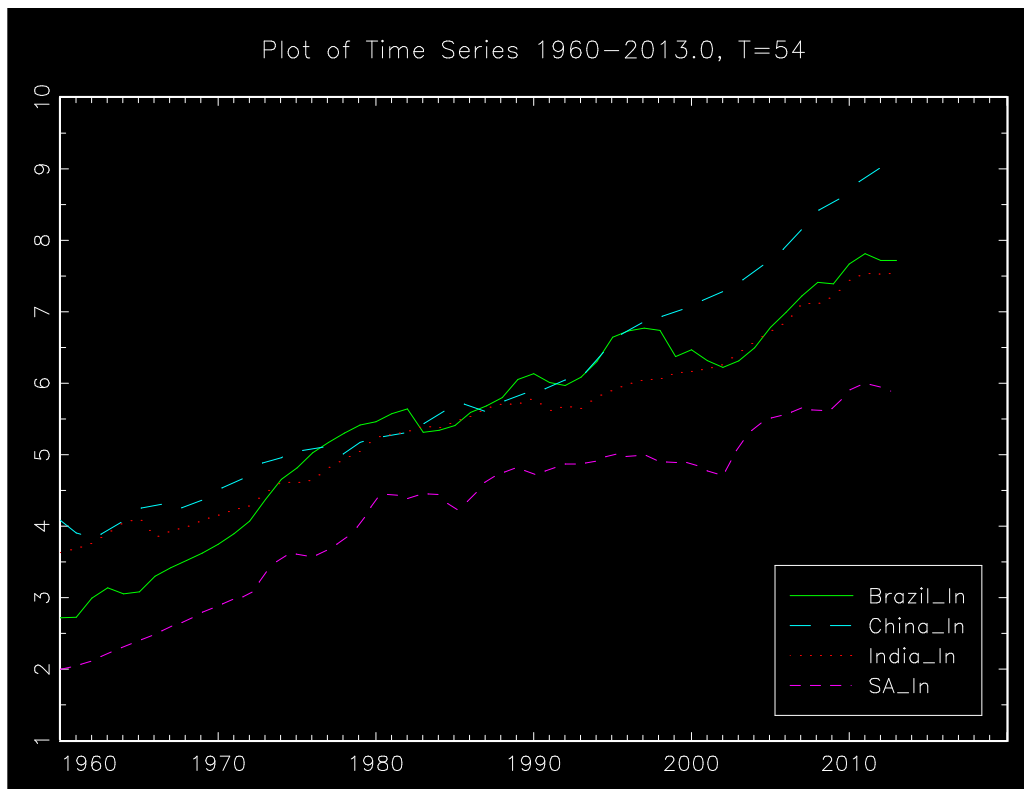
The acronym BRICS refers to a set of fast developing nations namely: Brazil, Russia, India, China and South Africa. Economic growth exhibited by these economies has been quite impressive in the last decades particularly for China and India. China's economic growth has been exponential over the years. Today China is the second largest economy in the world. Additionally China's influence has been robust in matters 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 spillovers 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 has multiplied. 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 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 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 (see figure 1). Note that Russia has not been included in this study due to data availability challenges.

**Figure 1: Progress of Economic Growth (1960-2013)**



*Note:* The data has been converted to natural logarithms so that it is easy to monitor the volatility of the variables over the material period. Due to data unavailability Russia was not included in this analysis. Source: JMulti (4) statistical package.

## 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 results of the study revealed that exports with higher energy content and globalization induce economic growth. Amador (2012) highlighted that the BRICS members Brazil, India and China possess high energy content in manufacturing exports. The authors noted that economic growth is dependent on other factors such as political and social integration. The results of this study are conceivable because political turmoil tends to disrupt economic growth in many economics especially in Africa. The problem with high energy content exports is the production of emissions in the manufacturing process. Carbon dioxide is not the only gas we should be concerned about. Sulphur dioxide is also a challenge and has detrimental effects on the environment and people. Chang et al (2013) argued that energy exports and globalisation are important determinants of economic prosperity in the South Caucasus region.

Sharma (2003) contributed by investigating the determinants of India's export performance in a simultaneous equation framework. The study examined data over the period 1970-1998 and

the results revealed that the real appreciation of the Rupee adversely affects 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. Tekin (2012) examined causation between real GDP, real exports and Foreign Domestic Investment (FDI) in least developed countries over the period 1970 to 2009. The results demonstrated that exports induce economic growth in Haiti, Rwanda and Sierra Leone. Such countries can be termed as export-led growth economies. Export led growth economies have to consider how they can reduce emissions without hampering economic growth. Economic growth was found to accelerate exports growth of the following economies: Angola, Chad and Zambia. FDI was found to Granger cause GDP in Benin and Togo.

A summary of the reviewed literature shows that economic growth is affected by several factors such as exchange rates, political and social integration. The BRICS are associated with high energy exports following (Amador, 2012). This study intends to determine the influence of the BRICS on other economies' economic growth over the period 1960 to 2013. The investigation applies the recent cointegration method proposed by Saikkonen and Lütkepohl (2000). The examination further uses the Toda and Yamamoto (1995) approach to determine the direction of causation between economic growths among the BRICS.

## Materials and Methods

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 (US\$). 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:

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

The model applied in this study is:

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

The definition of terms is as follows. The regression constant is  $\alpha$  and  $\beta$  is the coefficient of the time trend. Following Asemota and Bala (2011)  $\varepsilon_t$  was defined as the white noise error term. Eviews 7 was used to test the stationarity of the series. Table 1 shows the results of the Augmented Dickey Fuller test. Note that only Bangladesh series was stationary.

**Table 1: Augmented Dickey Fuller (ADF) Test Results**

Country	ADF Test Statistics		
	1% level	5% level	10% level
Brazil	-2.402113 <sup>1</sup> (-4.140858)	-2.402113 <sup>2</sup> (-3.496960)	-2.402113 <sup>3</sup> (-3.177579)
Belize	-1.808152 <sup>1</sup> (-4.140858)	-1.808152 <sup>2</sup> (-3.496960)	-1.808152 <sup>3</sup> (-3.177579)
Bolivia	-2.511779 <sup>1</sup> (-4.140858)	-2.511779 <sup>2</sup> (-3.496960)	-2.511779 <sup>3</sup> (-3.177579)
Canada	-0.978457 <sup>1</sup> (-4.140858)	-0.978457 <sup>2</sup> (-3.496960)	-0.978457 <sup>3</sup> (-3.177579)
Chile	-3.673869 <sup>1</sup> (-4.140858)	-3.673869 <sup>2</sup> (-3.496960)	-3.673869 <sup>3</sup> (-3.177579)
Colombia	-2.428655 <sup>1</sup> (-4.140858)	-2.428655 <sup>2</sup> (-3.496960)	-2.428655 <sup>3</sup> (-3.177579)
Costa Rica	-2.528498 <sup>1</sup> (-4.140858)	-2.528498 <sup>2</sup> (-3.496960)	-2.528498 <sup>3</sup> (-3.177579)
Dominica	-2.316012 <sup>1</sup> (-4.140858)	-2.316012 <sup>2</sup> (-3.496960)	-2.316012 <sup>3</sup> (-3.177579)
Ecuador	-2.290930 <sup>1</sup> (-4.140858)	-2.290930 <sup>2</sup> (-3.496960)	-2.290930 <sup>3</sup> (-3.177579)
Guatemala	-3.553112 <sup>1</sup> (-4.140858)	-3.553112 <sup>2</sup> (-3.496960)	-3.553112 <sup>3</sup> (-3.177579)
Guyana	-0.796204 <sup>1</sup> (-4.140858)	-0.796204 <sup>2</sup> (-3.496960)	-0.796204 <sup>3</sup> (-3.177579)
Honduras	0.158081 <sup>1</sup> (-4.140858)	0.158081 <sup>2</sup> (-3.496960)	0.158081 <sup>3</sup> (-3.177579)
Jamaica	-3.165784 <sup>1</sup> (-4.140858)	-3.165784 <sup>2</sup> (-3.496960)	-3.165784 <sup>3</sup> (-3.177579)
Mexico	-2.741484 <sup>1</sup> (-4.140858)	-2.741484 <sup>2</sup> (-3.496960)	-2.741484 <sup>3</sup> (-3.177579)
Nicaragua	-3.140482 <sup>1</sup> (-4.140858)	-3.140482 <sup>2</sup> (-3.496960)	-3.140482 <sup>3</sup> (-3.177579)
Panama	-2.084095 <sup>1</sup> (-4.140858)	-2.084095 <sup>2</sup> (-3.496960)	-2.084095 <sup>3</sup> (-3.177579)
Peru	-2.389856 <sup>1</sup> (-4.140858)	-2.389856 <sup>2</sup> (-3.496960)	-2.389856 <sup>3</sup> (-3.177579)
Puerto Rico	1.861587 <sup>1</sup> (-4.140858)	1.861587 <sup>2</sup> (-3.496960)	1.861587 <sup>3</sup> (-3.177579)
Saint Vincent	-1.559270 <sup>1</sup> (-4.140858)	-1.559270 <sup>2</sup> (-3.496960)	-1.559270 <sup>3</sup> (-3.177579)
Suriname	-1.292000 <sup>1</sup> (-4.140858)	-1.292000 <sup>2</sup> (-3.496960)	-1.292000 <sup>3</sup> (-3.177579)
Trinidad & Tobago	-1.317052 <sup>1</sup> (-4.140858)	-1.317052 <sup>2</sup> (-3.496960)	-1.317052 <sup>3</sup> (-3.177579)
USA	1.773539 <sup>1</sup> (-4.140858)	1.773539 <sup>2</sup> (-3.496960)	1.773539 <sup>3</sup> (-3.177579)
Uruguay	-3.131048 <sup>1</sup> (-4.140858)	-3.131048 <sup>2</sup> (-3.496960)	-3.131048 <sup>3</sup> (-3.177579)
Venezuela	-1.498755 <sup>1</sup> (-4.140858)	-1.498755 <sup>2</sup> (-3.496960)	-1.498755 <sup>3</sup> (-3.177579)
Algeria	-0.989750 <sup>1</sup> (-4.140858)	-0.989750 <sup>2</sup> (-3.496960)	-0.989750 <sup>3</sup> (-3.177579)
Benin	-2.530252 <sup>1</sup> (-4.140858)	-2.530252 <sup>2</sup> (-3.496960)	-2.530252 <sup>3</sup> (-3.177579)
Botswana	-0.423076 <sup>1</sup> (-4.140858)	-0.423076 <sup>2</sup> (-3.496960)	-0.423076 <sup>3</sup> (-3.177579)
Burkina Faso	-1.629912 <sup>1</sup> (-4.140858)	-1.629912 <sup>2</sup> (-3.496960)	-1.629912 <sup>3</sup> (-3.177579)
Cameroon	-1.061231 <sup>1</sup> (-4.140858)	-1.061231 <sup>2</sup> (-3.496960)	-1.061231 <sup>3</sup> (-3.177579)
Chad	-1.534980 <sup>1</sup> (-4.140858)	-1.534980 <sup>2</sup> (-3.496960)	-1.534980 <sup>3</sup> (-3.177579)
Ghana	-0.700408 <sup>1</sup> (-4.140858)	-0.700408 <sup>2</sup> (-3.496960)	-0.700408 <sup>3</sup> (-3.177579)
Ivory Coast	-1.836463 <sup>1</sup> (-4.140858)	-1.836463 <sup>2</sup> (-3.496960)	-1.836463 <sup>3</sup> (-3.177579)
Lesotho	-2.334822 <sup>1</sup> (-4.140858)	-2.334822 <sup>2</sup> (-3.496960)	-2.334822 <sup>3</sup> (-3.177579)
Liberia	-1.903387 <sup>1</sup> (-4.140858)	-1.903387 <sup>2</sup> (-3.496960)	-1.903387 <sup>3</sup> (-3.177579)
Malawi	-2.139807 <sup>1</sup> (-4.140858)	-2.139807 <sup>2</sup> (-3.496960)	-2.139807 <sup>3</sup> (-3.177579)
Madagascar	-1.774836 <sup>1</sup> (-4.140858)	-1.774836 <sup>2</sup> (-3.496960)	-1.774836 <sup>3</sup> (-3.177579)
Mauritania	-2.015906 <sup>1</sup> (-4.140858)	-2.015906 <sup>2</sup> (-3.496960)	-2.015906 <sup>3</sup> (-3.177579)
Morocco	-1.526097 <sup>1</sup> (-4.140858)	-1.526097 <sup>2</sup> (-3.496960)	-1.526097 <sup>3</sup> (-3.177579)
Niger	-2.234723 <sup>1</sup> (-4.140858)	-2.234723 <sup>2</sup> (-3.496960)	-2.234723 <sup>3</sup> (-3.177579)
Nigeria	-1.007071 <sup>1</sup> (-4.140858)	-1.007071 <sup>2</sup> (-3.496960)	-1.007071 <sup>3</sup> (-3.177579)
Congo	-1.616850 <sup>1</sup> (-4.140858)	-1.616850 <sup>2</sup> (-3.496960)	-1.616850 <sup>3</sup> (-3.177579)
Seychelles	-1.380275 <sup>1</sup> (-4.140858)	-1.380275 <sup>2</sup> (-3.496960)	-1.380275 <sup>3</sup> (-3.177579)
Sierra Leone	-1.571073 <sup>1</sup> (-4.140858)	-1.571073 <sup>2</sup> (-3.496960)	-1.571073 <sup>3</sup> (-3.177579)
South Africa	-2.134646 <sup>1</sup> (-4.140858)	-2.134646 <sup>2</sup> (-3.496960)	-2.134646 <sup>3</sup> (-3.177579)
Sudan	-1.542140 <sup>1</sup> (-4.140858)	-1.542140 <sup>2</sup> (-3.496960)	-1.542140 <sup>3</sup> (-3.177579)
Swaziland	-1.881155 <sup>1</sup> (-4.140858)	-1.881155 <sup>2</sup> (-3.496960)	-1.881155 <sup>3</sup> (-3.177579)
Togo	-1.193167 <sup>1</sup> (-4.140858)	-1.193167 <sup>2</sup> (-3.496960)	-1.193167 <sup>3</sup> (-3.177579)
Uganda	-3.420546 <sup>1</sup> (-4.140858)	-3.420546 <sup>2</sup> (-3.496960)	-3.420546 <sup>3</sup> (-3.177579)
Zambia	-1.032484 <sup>1</sup> (-4.140858)	-1.032484 <sup>2</sup> (-3.496960)	-1.032484 <sup>3</sup> (-3.177579)
Zimbabwe	-1.829366 <sup>1</sup> (-4.140858)	-1.829366 <sup>2</sup> (-3.496960)	-1.829366 <sup>3</sup> (-3.177579)
Bangladesh	-5.177530 <sup>1</sup> (-4.140858)	-5.177530 <sup>2</sup> (-3.496960)	-5.177530 <sup>3</sup> (-3.177579)
China	-0.804449 <sup>1</sup> (-4.140858)	-0.804449 <sup>2</sup> (-3.496960)	-0.804449 <sup>3</sup> (-3.177579)

Hong Kong	-0.593099 <sup>1</sup> (-4.140858)	-0.593099 <sup>2</sup> (-3.496960)	-0.593099 <sup>3</sup> (-3.177579)
India	-1.686225 <sup>1</sup> (-4.140858)	-1.686225 <sup>2</sup> (-3.496960)	-1.686225 <sup>3</sup> (-3.177579)
Israel	-1.830077 <sup>1</sup> (-4.140858)	-1.830077 <sup>2</sup> (-3.496960)	-1.830077 <sup>3</sup> (-3.177579)
Japan	-0.125997 <sup>1</sup> (-4.140858)	-0.125997 <sup>2</sup> (-3.496960)	-0.125997 <sup>3</sup> (-3.177579)
Malaysia	-1.651926 <sup>1</sup> (-4.140858)	-1.651926 <sup>2</sup> (-3.496960)	-1.651926 <sup>3</sup> (-3.177579)
Nepal	-2.366434 <sup>1</sup> (-4.140858)	-2.366434 <sup>2</sup> (-3.496960)	-2.366434 <sup>3</sup> (-3.177579)
Oman	-1.219531 <sup>1</sup> (-4.140858)	-1.219531 <sup>2</sup> (-3.496960)	-1.219531 <sup>3</sup> (-3.177579)
Pakistan	-2.469553 <sup>1</sup> (-4.140858)	-2.469553 <sup>2</sup> (-3.496960)	-2.469553 <sup>3</sup> (-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”.

### *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:

$$y_t = v + A_1 y_{t-1} + \dots + A_p y_{t-p} + \varepsilon_t \quad t = p + 1, p + 2, \dots,$$

Following Saikkonen and Lütkepohl (2000) allow  $A_j$  to be  $n \times n$  coefficient matrices while  $\varepsilon_t$  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  $E(\varepsilon_t \varepsilon_t' | \varepsilon_s, s < t) = \Omega$ . The resulting final error correction model formed by subtracting  $y_{t-1}$  on both sides of the  $VAR(p)$  above is

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

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



*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 Granger causality test (see Granger, 1969) was not selected because not all data in this study is non-stationary (Bangladesh income series was stationary). The Toda and Yamamoto (1995) technique can apply even if the series does not have unit roots. Granger causality also 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 Ouliaris (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:

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

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

## Empirical Results

The Saikkonen and Lütkepohl test was carried out at 90%, 95% and 99% critical levels using JMulti (4) statistical package. 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  $\rho$ -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%	$\rho$ -value	$r_0$	LR	90%	95%	99%	$\rho$ -value
Belize	0	6.4300	13.880	15.760	19.710	0.72400 <sup>1,2,3</sup>	1	1.0200	5.470	6.790	9.730	0.78630 <sup>1,2,3</sup>
Bolivia	0	5.7100	13.880	15.760	19.710	0.80480 <sup>1,2,3</sup>	1	2.4600	5.470	6.790	9.730	0.43960 <sup>1,2,3</sup>
Canada	0	9.5800	13.880	15.760	19.710	0.37820 <sup>1,2,3</sup>	1	1.1600	5.470	6.790	9.730	0.74950 <sup>1,2,3</sup>
Chile	0	13.7900	13.880	15.760	19.710	0.10320 <sup>1,2,3</sup>	1	1.7400	5.470	6.790	9.730	0.59920 <sup>1,2,3</sup>
Colombia	0	9.6900	13.880	15.760	19.710	0.36730 <sup>1,2,3</sup>	1	2.1800	5.470	6.790	9.730	0.49880 <sup>1,2,3</sup>
Costa Rica	0	12.5200	13.880	15.760	19.710	0.15880 <sup>1,2,3</sup>	1	2.4500	5.470	6.790	9.730	0.44130 <sup>1,2,3</sup>
Dominica	0	12.5300	13.880	15.760	19.710	0.15810 <sup>1,2,3</sup>	1	1.9300	5.470	6.790	9.730	0.55330 <sup>1,2,3</sup>
Ecuador	0	11.7100	13.880	15.760	19.710	0.20560 <sup>1,2,3</sup>	1	2.1100	5.470	6.790	9.730	0.51280 <sup>1,2,3</sup>
Guatemala	0	9.6700	13.880	15.760	19.710	0.36960 <sup>1,2,3</sup>	1	1.9300	5.470	6.790	9.730	0.55370 <sup>1,2,3</sup>
Guyana	0	7.2800	13.880	15.760	19.710	0.63000 <sup>1,2,3</sup>	1	0.5600	5.470	6.790	9.730	0.90580 <sup>2,3</sup>
Honduras	0	11.0400	13.880	15.760	19.710	0.25240 <sup>1,2,3</sup>	1	1.6400	5.470	6.790	9.730	0.62440 <sup>1,2,3</sup>
Jamaica	0	8.8800	13.880	15.760	19.710	0.44970 <sup>1,2,3</sup>	1	2.1100	5.470	6.790	9.730	0.51210 <sup>1,2,3</sup>
Mexico	0	14.7400	13.880	15.760	19.710	0.07330 <sup>1,2,3</sup>	1	2.6500	5.470	6.790	9.730	0.40310 <sup>1,2,3</sup>
Nicaragua	0	11.4900	13.880	15.760	19.710	0.22050 <sup>1,2,3</sup>	1	2.3100	5.470	6.790	9.730	0.46940 <sup>1,2,3</sup>
Panama	0	7.0600	13.880	15.760	19.710	0.6560 <sup>1,2,3</sup>	1	2.2500	5.470	6.790	9.730	0.48350 <sup>1,2,3</sup>
Peru	0	7.9600	13.880	15.760	19.710	0.55130 <sup>1,2,3</sup>	1	1.3900	5.470	6.790	9.730	0.68920 <sup>1,2,3</sup>
Puerto Rico	0	7.8200	13.880	15.760	19.710	0.56830 <sup>1,2,3</sup>	1	0.1400	5.470	6.790	9.730	0.98890 <sup>3</sup>
Saint Lucia	0	8.5400	13.880	15.760	19.710	0.48620 <sup>1,2,3</sup>	1	0.9300	5.470	6.790	9.730	0.81230 <sup>1,2,3</sup>
Suriname	0	6.0700	13.880	15.760	19.710	0.76730 <sup>1,2,3</sup>	1	1.9000	5.470	6.790	9.730	0.56040 <sup>1,2,3</sup>
T & Tobago	0	7.3500	13.880	15.760	19.710	0.62200 <sup>1,2,3</sup>	1	2.1000	5.470	6.790	9.730	0.51630 <sup>1,2,3</sup>
USA	0	17.0800	13.880	15.760	19.710	0.02980 <sup>1,2,3</sup>	1	1.7800	5.470	6.790	9.730	0.59080 <sup>1,2,3</sup>
Uruguay	0	13.8200	13.880	15.760	19.710	0.10210 <sup>1,2,3</sup>	1	2.6200	5.470	6.790	9.730	0.40970 <sup>1,2,3</sup>
Venezuela	0	5.0400	13.880	15.760	19.710	0.86730 <sup>1,2,3</sup>	1	2.6200	5.470	6.790	9.730	0.40940 <sup>1,2,3</sup>
Algeria	0	6.9300	13.880	15.760	19.710	0.67160 <sup>1,2,3</sup>	1	1.4800	5.470	6.790	9.730	0.66570 <sup>1,2,3</sup>
Benin	0	7.7200	13.880	15.760	19.710	0.57920 <sup>1,2,3</sup>	1	3.7300	5.470	6.790	9.730	0.24260 <sup>1,2,3</sup>
Botswana	0	9.0800	13.880	15.760	19.710	0.42830 <sup>1,2,3</sup>	1	0.7100	5.470	6.790	9.730	0.87010 <sup>1,2,3</sup>
Burkina Faso	0	7.5000	13.880	15.760	19.710	0.60500 <sup>1,2,3</sup>	1	2.8300	5.470	6.790	9.730	0.37240 <sup>1,2,3</sup>
Burundi	0	4.3300	13.880	15.760	19.710	0.92090 <sup>2,3</sup>	1	1.8200	5.470	6.790	9.730	0.57940 <sup>1,2,3</sup>
Cameroon	0	9.5800	13.880	15.760	19.710	0.37820 <sup>1,2,3</sup>	1	1.1600	5.470	6.790	9.730	0.74950 <sup>1,2,3</sup>
Chad	0	14.9600	13.880	15.760	19.710	0.06760 <sup>1,2,3</sup>	1	1.6600	5.470	6.790	9.730	0.61850 <sup>1,2,3</sup>
Ghana	0	8.8400	13.880	15.760	19.710	0.45370 <sup>1,2,3</sup>	1	0.8300	5.470	6.790	9.730	0.83750 <sup>1,2,3</sup>
Ivory Coast	0	15.7600	13.880	15.760	19.710	0.04990 <sup>1,2,3</sup>	1	1.1900	5.470	6.790	9.730	0.74250 <sup>1,2,3</sup>
Lesotho	0	16.5100	13.880	15.760	19.710	0.03740 <sup>1,2,3</sup>	1	2.7300	5.470	6.790	9.730	0.39000 <sup>1,2,3</sup>
Liberia	0	5.8100	13.880	15.760	19.710	0.79480 <sup>1,2,3</sup>	1	2.1800	5.470	6.790	9.730	0.49750 <sup>1,2,3</sup>
Malawi	0	12.0000	13.880	15.760	19.710	0.18810 <sup>1,2,3</sup>	1	1.9500	5.470	6.790	9.730	0.54910 <sup>1,2,3</sup>
Madagascar	0	6.4600	13.880	15.760	19.710	0.72400 <sup>1,2,3</sup>	1	2.0000	5.470	6.790	9.730	0.53830 <sup>1,2,3</sup>
Mauritania	0	16.4700	13.880	15.760	19.710	0.03800 <sup>1,2,3</sup>	1	2.9500	5.470	6.790	9.730	0.35140 <sup>1,2,3</sup>
Morocco	0	12.9200	13.880	15.760	19.710	0.13890 <sup>1,2,3</sup>	1	2.4600	5.470	6.790	9.730	0.43920 <sup>1,2,3</sup>
Niger	0	7.8400	13.880	15.760	19.710	0.56590 <sup>1,2,3</sup>	1	2.4900	5.470	6.790	9.730	0.43460 <sup>1,2,3</sup>
Nigeria	0	5.3400	13.880	15.760	19.710	0.84060 <sup>1,2,3</sup>	1	0.9500	5.470	6.790	9.730	0.80640 <sup>1,2,3</sup>
Congo	0	7.0500	13.880	15.760	19.710	0.65760 <sup>1,2,3</sup>	1	2.3900	5.470	6.790	9.730	0.45340 <sup>1,2,3</sup>
Seychelles	0	10.8500	13.880	15.760	19.710	0.26670 <sup>1,2,3</sup>	1	1.3300	5.470	6.790	9.730	0.70330 <sup>1,2,3</sup>
Sierra Leone	0	6.6200	13.880	15.760	19.710	0.70690 <sup>1,2,3</sup>	1	1.9400	5.470	6.790	9.730	0.55260 <sup>1,2,3</sup>

South Africa	0	13.1100	13.880	15.760	19.710	0.13030 <sup>1,2,3</sup>	1	1.7300	5.470	6.790	9.730	0.60280 <sup>1,2,3</sup>
Sudan	0	6.0600	13.880	15.760	19.710	0.76770 <sup>1,2,3</sup>	1	2.5200	5.470	6.790	9.730	0.42890 <sup>1,2,3</sup>
Swaziland	0	10.8900	13.880	15.760	19.710	0.26340 <sup>1,2,3</sup>	1	1.8400	5.470	6.790	9.730	0.57600 <sup>1,2,3</sup>
Togo	0	16.2100	13.880	15.760	19.710	0.04210 <sup>1,2,3</sup>	1	2.7100	5.470	6.790	9.730	0.39380 <sup>1,2,3</sup>
Uganda	0	13.5300	13.880	15.760	19.710	0.11300 <sup>1,2,3</sup>	1	2.4000	5.470	6.790	9.730	0.45230 <sup>1,2,3</sup>
Zambia	0	8.5800	13.880	15.760	19.710	0.48160 <sup>1,2,3</sup>	1	0.9600	5.470	6.790	9.730	0.80180 <sup>1,2,3</sup>
Zimbabwe	0	10.3600	13.880	15.760	19.710	0.30650 <sup>1,2,3</sup>	1	2.4400	5.470	6.790	9.730	0.44440 <sup>1,2,3</sup>
Bangladesh	0	15.0900	13.880	15.760	19.710	0.06430 <sup>1,2,3</sup>	1	2.3200	5.470	6.790	9.730	0.46850 <sup>1,2,3</sup>
China	0	8.7100	13.880	15.760	19.710	0.46820 <sup>1,2,3</sup>	1	0.0800	5.470	6.790	9.730	0.99540
Hong Kong	0	13.6300	13.880	15.760	19.710	0.10920 <sup>1,2,3</sup>	1	1.1700	5.470	6.790	9.730	0.74560 <sup>1,2,3</sup>
India	0	7.3600	13.880	15.760	19.710	0.62130 <sup>1,2,3</sup>	1	1.2300	5.470	6.790	9.730	0.73040 <sup>1,2,3</sup>
Israel	0	8.3500	13.880	15.760	19.710	0.50790 <sup>1,2,3</sup>	1	1.1300	5.470	6.790	9.730	0.75690 <sup>1,2,3</sup>
Japan	0	8.1500	13.880	15.760	19.710	0.52960 <sup>1,2,3</sup>	1	0.3400	5.470	6.790	9.730	0.95630 <sup>3</sup>
Malaysia	0	11.3400	13.880	15.760	19.710	0.23080 <sup>1,2,3</sup>	1	1.3200	5.470	6.790	9.730	0.70730 <sup>1,2,3</sup>
Nepal	0	7.6500	13.880	15.760	19.710	0.58720 <sup>1,2,3</sup>	1	2.3100	5.470	6.790	9.730	0.47130 <sup>1,2,3</sup>
Oman	0	12.7800	13.880	15.760	19.710	0.14570 <sup>1,2,3</sup>	1	0.7700	5.470	6.790	9.730	0.85270 <sup>1,2,3</sup>
Pakistan	0	13.2300	13.880	15.760	19.710	0.12500 <sup>1,2,3</sup>	1	2.6600	5.470	6.790	9.730	0.40140 <sup>1,2,3</sup>

Note: <sup>1</sup> shows statistical significance at 90% critical level; <sup>2</sup> shows statistical significance at 95% critical level; <sup>3</sup> shows statistical significance at 99% critical level. Note that  $\rho$ -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%	$\rho$ -value	$r_0$	LR	90%	95%	99%	$\rho$ -value
Brazil	0	8.7100	13.880	15.760	19.710	0.46820 <sup>1,2,3</sup>	1	0.0800	5.470	6.790	9.730	0.99540
Belize	0	8.7500	13.880	15.760	19.710	0.46310 <sup>1,2,3</sup>	1	0.2700	5.470	6.790	9.730	0.96830 <sup>3</sup>
Bolivia	0	10.0500	13.880	15.760	19.710	0.33340 <sup>1,2,3</sup>	1	0.8700	5.470	6.790	9.730	0.82600 <sup>1,2,3</sup>
Canada	0	6.0400	13.880	15.760	19.710	0.77030 <sup>1,2,3</sup>	1	0.3300	5.470	6.790	9.730	0.95720 <sup>3</sup>
Chile	0	17.4500	13.880	15.760	19.710	0.02560 <sup>1,2,3</sup>	1	0.6600	5.470	6.790	9.730	0.88270 <sup>1,2,3</sup>
Colombia	0	6.6400	13.880	15.760	19.710	0.70390 <sup>1,2,3</sup>	1	0.2200	5.470	6.790	9.730	0.97680 <sup>3</sup>
Costa Rica	0	9.1900	13.880	15.760	19.710	0.41730 <sup>1,2,3</sup>	1	0.2300	5.470	6.790	9.730	0.97500 <sup>3</sup>
Dominica	0	5.6700	13.880	15.760	19.710	0.80870 <sup>1,2,3</sup>	1	0.4900	5.470	6.790	9.730	0.92270 <sup>2,3</sup>
Ecuador	0	7.9100	13.880	15.760	19.710	0.55740 <sup>1,2,3</sup>	1	1.3400	5.470	6.790	9.730	0.70160 <sup>1,2,3</sup>
Guatemala	0	5.7300	13.880	15.760	19.710	0.80270 <sup>1,2,3</sup>	1	0.0100	5.470	6.790	9.730	0.99980
Guyana	0	5.7100	13.880	15.760	19.710	0.80490 <sup>1,2,3</sup>	1	1.1300	5.470	6.790	9.730	0.75670 <sup>1,2,3</sup>
Honduras	0	6.2600	13.880	15.760	19.710	0.74630 <sup>1,2,3</sup>	1	0.0100	5.470	6.790	9.730	0.99990
Jamaica	0	9.0100	13.880	15.760	19.710	0.43570 <sup>1,2,3</sup>	1	0.6300	5.470	6.790	9.730	0.88800 <sup>1,2,3</sup>
Mexico	0	12.9700	13.880	15.760	19.710	0.13690 <sup>1,2,3</sup>	1	0.5300	5.470	6.790	9.730	0.91320 <sup>2,3</sup>
Nicaragua	0	9.9600	13.880	15.760	19.710	0.34190 <sup>1,2,3</sup>	1	0.4500	5.470	6.790	9.730	0.93210 <sup>2,3</sup>
Panama	0	7.8900	13.880	15.760	19.710	0.55960 <sup>1,2,3</sup>	1	0.2600	5.470	6.790	9.730	0.97120 <sup>3</sup>
Peru	0	5.9400	13.880	15.760	19.710	0.78110 <sup>1,2,3</sup>	1	0.1500	5.470	6.790	9.730	0.98810 <sup>3</sup>
Puerto Rico	0	9.1900	13.880	15.760	19.710	0.41640 <sup>1,2,3</sup>	1	0.4200	5.470	6.790	9.730	0.93930 <sup>2,3</sup>
Saint Lucia	0	12.4400	13.880	15.760	19.710	0.16310 <sup>1,2,3</sup>	1	0.3600	5.470	6.790	9.730	0.95130 <sup>3</sup>
Suriname	0	6.8900	13.880	15.760	19.710	0.67530 <sup>1,2,3</sup>	1	1.1300	5.470	6.790	9.730	0.75760 <sup>1,2,3</sup>
T & Tobago	0	4.5800	13.880	15.760	19.710	0.90360 <sup>2,3</sup>	1	0.1800	5.470	6.790	9.730	0.98280 <sup>3</sup>
USA	0	5.9400	13.880	15.760	19.710	0.78100 <sup>1,2,3</sup>	1	3.3600	5.470	6.790	9.730	0.28940 <sup>1,2,3</sup>
Uruguay	0	10.4600	13.880	15.760	19.710	0.29810 <sup>1,2,3</sup>	1	0.6100	5.470	6.790	9.730	0.89350 <sup>1,2,3</sup>
Venezuela	0	5.8600	13.880	15.760	19.710	0.78930 <sup>1,2,3</sup>	1	1.4000	5.470	6.790	9.730	0.68490 <sup>1,2,3</sup>
Algeria	0	4.5000	13.880	15.760	19.710	0.75270 <sup>1,2,3</sup>	1	0.3400	5.470	6.790	9.730	0.95630 <sup>3</sup>
Benin	0	6.2000	13.880	15.760	19.710	0.84030 <sup>1,2,3</sup>	1	0.5300	5.470	6.790	9.730	0.91330 <sup>1,2,3</sup>
Botswana	0	5.3400	13.880	15.760	19.710	0.57380 <sup>1,2,3</sup>	1	0.9300	5.470	6.790	9.730	0.81080 <sup>1,2,3</sup>
Burkina Faso	0	7.7700	13.880	15.760	19.710	0.87700 <sup>1,2,3</sup>	1	1.0600	5.470	6.790	9.730	0.77670 <sup>1,2,3</sup>
Burundi	0	5.3400	13.880	15.760	19.710	0.69800 <sup>1,2,3</sup>	1	1.9100	5.470	6.790	9.730	0.55780 <sup>1,2,3</sup>

Cameroon	0	4.9200	13.880	15.760	19.710	0.74050 <sup>1,2,3</sup>	1	0.5900	5.470	6.790	9.730	0.89980 <sup>1,2,3</sup>
Chad	0	6.6900	13.880	15.760	19.710	0.69270 <sup>1,2,3</sup>	1	0.5700	5.470	6.790	9.730	0.90390 <sup>2,3</sup>
Ghana	0	6.3200	13.880	15.760	19.710	0.74050 <sup>1,2,3</sup>	1	0.6500	5.470	6.790	9.730	0.88340 <sup>1,2,3</sup>
Ivory Coast	0	6.7400	13.880	15.760	19.710	0.69270 <sup>1,2,3</sup>	1	1.8400	5.470	6.790	9.730	0.57630 <sup>1,2,3</sup>
Lesotho	0	7.5400	13.880	15.760	19.710	0.60070 <sup>1,2,3</sup>	1	0.5600	5.470	6.790	9.730	0.90740 <sup>2,3</sup>
Liberia	0	11.0600	13.880	15.760	19.710	0.25040 <sup>1,2,3</sup>	1	0.7000	5.470	6.790	9.730	0.87090 <sup>1,2,3</sup>
Malawi	0	9.0400	13.880	15.760	19.710	0.43250 <sup>1,2,3</sup>	1	0.4100	5.470	6.790	9.730	0.94000 <sup>2,3</sup>
Madagascar	0	5.0100	13.880	15.760	19.710	0.86940 <sup>1,2,3</sup>	1	2.0600	5.470	6.790	9.730	0.52490 <sup>1,2,3</sup>
Mauritania	0	6.2500	13.880	15.760	19.710	0.74770 <sup>1,2,3</sup>	1	1.1000	5.470	6.790	9.730	0.76630 <sup>1,2,3</sup>
Morocco	0	6.7800	13.880	15.760	19.710	0.68870 <sup>1,2,3</sup>	1	0.0600	5.470	6.790	9.730	0.99710
Niger	0	7.9200	13.880	15.760	19.710	0.55670 <sup>1,2,3</sup>	1	0.6300	5.470	6.790	9.730	0.88870 <sup>1,2,3</sup>
Nigeria	0	6.4900	13.880	15.760	19.710	0.72170 <sup>1,2,3</sup>	1	1.5800	5.470	6.790	9.730	0.64020 <sup>1,2,3</sup>
Congo	0	8.2200	13.880	15.760	19.710	0.52150 <sup>1,2,3</sup>	1	2.4200	5.470	6.790	9.730	0.44840 <sup>1,2,3</sup>
Seychelles	0	8.1700	13.880	15.760	19.710	0.52740 <sup>1,2,3</sup>	1	0.6100	5.470	6.790	9.730	0.89520 <sup>1,2,3</sup>
Sierra Leone	0	8.5500	13.880	15.760	19.710	0.48560 <sup>1,2,3</sup>	1	1.6100	5.470	6.790	9.730	0.63200 <sup>1,2,3</sup>
South Africa	0	7.9700	13.880	15.760	19.710	0.55080 <sup>1,2,3</sup>	1	0.4700	5.470	6.790	9.730	0.92660 <sup>2,3</sup>
Sudan	0	6.3500	13.880	15.760	19.710	0.73700 <sup>1,2,3</sup>	1	0.2800	5.470	6.790	9.730	0.96690 <sup>3</sup>
Swaziland	0	8.8100	13.880	15.760	19.710	0.45690 <sup>1,2,3</sup>	1	0.5900	5.470	6.790	9.730	0.89900 <sup>1,2,3</sup>
Togo	0	8.0500	13.880	15.760	19.710	0.54180 <sup>1,2,3</sup>	1	0.5100	5.470	6.790	9.730	0.91750 <sup>2,3</sup>
Uganda	0	14.9200	13.880	15.760	19.710	0.06860 <sup>1,2,3</sup>	1	0.6000	5.470	6.790	9.730	0.89650 <sup>1,2,3</sup>
Zambia	0	7.0000	13.880	15.760	19.710	0.66270 <sup>1,2,3</sup>	1	0.6900	5.470	6.790	9.730	0.87340 <sup>1,2,3</sup>
Zimbabwe	0	9.9500	13.880	15.760	19.710	0.34300 <sup>1,2,3</sup>	1	0.1300	5.470	6.790	9.730	0.98990 <sup>3</sup>
Bangladesh	0	19.9800	13.880	15.760	19.710	0.00890 <sup>1,2,3</sup>	1	0.5400	5.470	6.790	9.730	0.91110 <sup>2,3</sup>
Hong Kong	0	7.2300	13.880	15.760	19.710	0.63670 <sup>1,2,3</sup>	1	1.7200	5.470	6.790	9.730	0.60530 <sup>1,2,3</sup>
India	0	6.0100	13.880	15.760	19.710	0.77370 <sup>1,2,3</sup>	1	0.4900	5.470	6.790	9.730	0.92320 <sup>2,3</sup>
Israel	0	6.5400	13.880	15.760	19.710	0.71520 <sup>1,2,3</sup>	1	0.4300	5.470	6.790	9.730	0.93640 <sup>2,3</sup>
Japan	0	8.5700	13.880	15.760	19.710	0.48340 <sup>1,2,3</sup>	1	0.4600	5.470	6.790	9.730	0.92920 <sup>2,3</sup>
Malaysia	0	5.3800	13.880	15.760	19.710	0.83610 <sup>1,2,3</sup>	1	0.6600	5.470	6.790	9.730	0.88220 <sup>1,2,3</sup>
Nepal	0	13.3600	13.880	15.760	19.710	0.11990 <sup>1,2,3</sup>	1	0.8800	5.470	6.790	9.730	0.82530 <sup>1,2,3</sup>
Oman	0	6.5800	13.880	15.760	19.710	0.71050 <sup>1,2,3</sup>	1	0.0300	5.470	6.790	9.730	0.99890 <sup>3</sup>
Pakistan	0	9.9100	13.880	15.760	19.710	0.34630 <sup>1,2,3</sup>	1	0.5500	5.470	6.790	9.730	0.90890 <sup>2,3</sup>

Note: <sup>1</sup> shows statistical significance at 90% critical level; <sup>2</sup> shows statistical significance at 95% critical level; <sup>3</sup> shows statistical significance at 99% critical level. Note that  $\rho$ -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  $D_t = u_0 + u_{1t}$ . Superscripts 1, 2, 3 show statistical significance at 90%, 95%, and 99% critical levels. LR = Likelihood Ratio.

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 countries registered  $\rho$ -values less than the 5% critical level suggesting that we have to reject the null hypothesis of non-causality. Table 4 is a presentation of the VAR estimates before the causality test. Table 5 presents the results of the Toda and Yamamoto (1995) causality test.

**Table 4: Vector Autoregression (VAR) Estimates**

	BRAZIL	INDIA	CHINA	SOUTH AFRICA
BRAZIL_LN(-1)	0.893856 (0.14585) [6.12849]	0.159168 (0.10593) [1.50255]	-0.053817 (0.10323) [-0.52131]	0.09826 (0.14993) [0.65779]
BRAZIL_LN(-2)	-0.251374 (0.13123) [-1.91556]	-0.139890 (0.09531) [-1.46774]	-0.058306 (0.09288) [-0.62774]	0.020327 (0.13490) [0.15068]
INDIA_LN(-1)	0.146953 (0.234970) [0.625420]	0.857351 (0.170650) [5.02391]	0.257046 (0.166310) [1.545600]	0.262708 (0.241540) [1.087630]
INDIA_LN(-2)	-0.555782 (0.244730) [-2.270990]	-0.050748 (0.177750) [-0.285500]	0.283923 (0.173220) [-1.639080]	-0.126563 (0.251580) [-0.503070]
CHINA_LN(-1)	0.155202 (0.199810) [0.776750]	-0.077558 (0.145120) [-0.534440]	1.090469 (0.141430) [7.710570]	-0.073913 (0.205400) [-0.359840]
CHINA_LN(-2)	0.0838210 (0.2085500) [0.401920]	0.1885270 0.151470 [1.244660]	-0.0493370 0.147610 [-0.334230]	0.030952 0.214390 [0.144370]
SA_LN(-1)	0.4900440 (0.174350) [2.810750]	0.093754 (0.126630) [0.740400]	0.0298370 (0.123400) [0.241780]	1.066611 (0.179230) [5.951210]
SA_LN(-2)	0.030164 (0.183150) [0.164700]	-0.055641 (0.133020) [-0.418300]	0.1072180 (0.129630) [0.827100]	-0.313102 (0.188270) [-1.663030]
C	0.602748 (0.211400) [2.851220]	0.1964430 (0.153540) [1.279440]	0.0129480 (0.149630) [0.086530]	-0.049159 (0.217320) [-0.226210]

**Table 5: Toda and Yamamoto Causality Test Results**

Dependent: Brazil				
Country	Chi-square	df	p-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	p-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	p-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	p-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 p-values less than the 5% critical level ( $p < 0.05$ ) represent causality in a given direction. The null hypothesis is therefore rejected for p-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.

## Discussion and Conclusion

This study aimed to determine the influence the BRICS have on other economies 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 1980 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 for future world economic growth. All economies under investigation revealed long term relations with China and Brazil's economic growth. To a reasonable extent, this shows a state of dependency between the BRICS and such nations. China and Brazil need to export their goods and services to developing nations. Developing economies also require such goods and services for their own economic development and industrialisation attempts. Brazil's economic growth is induced by other BRICS members namely South Africa, China and India. This suggests that economic and financial integration is required among the BRICS. If these economies heighten economic and financial cooperation, other developing economies will also benefit from this collaboration. Even though the BRICS are competing in terms of exports sales, economic and financial is still a necessity for high economic growth. In conclusion of this study, the BRICS are influential in world economic growth. However, their economic prosperity is also dependent on integration.

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