Asian Journal of Economic Modelling
ISSN(e): 2312-3656
ISSN(p): 2313-2884
DOI: 10.18488/journal.8/2016.4.1/8.1.1.17
Vol. 4, No. 1, 1-17

URL: www.aessweb.com

INFLATION AND ECONOMIC GROWTH NEXUS IN BRICS: EVIDENCE FROM ARDL BOUND TESTING APPROACH

Jaganath Behera[1+]
Alok Kumar Mishra[2]

[1]*Ph.D. Research Scholar, School of Economics, University of Hyderabad, Prof. C. R. Rao Road, Central University, Hyderabad, India*
[2]*Assistatnt Professor, School of Economics, University of Hyderabad, Central University, Hyderabad, India*

(+ Corresponding author)

Article History
Received: 6 June 2015
Revised: 6 July 2015
Accepted: 26 August 2015
Published: 26 September 2015

Keywords
Inflation
Economic growth
Cointegration
Causality
ARDL
BRICS
Unit root.

JEL Classification:
E_{00}, E_3 & E_6.

ABSTRACT

The present study investigated the inflation growth nexus in the context of BRICS countries. The study used time series data covering from the period 1980 to 2012. The data sources are cumulated from the World Bank, World Economic Outlook (WEO). The empirical findings of the study indicate that a long run positive relationship between inflation and economic growth only for China and South Africa at the 5 percent level of significance. The study also found that there is a unidirectional causality between economic growth and inflation in the context of India whereas; bidirectional causality takes place in the case of China. The VAR analysis could not find a consistent short run relationship between inflation and economic growth over ten years ahead for BRICS countries. From the policy implication point of view the study suggests that policy makers in BRICS should consider the short run relationship between inflation and economic growth while, the China and South Africa policy makers should pay attention to both short run and long run relationship.

Contribution/ Originality: The present study is one of very few studies which have examined the relationship between inflation and economic growth in the context of BRICS. To examine the long run equilibrium relationship between inflation and economic growth this study employed the advance ARDL bound testing approach of cointegration which is the solitary contribution to the existing literature. The empirical findings of the study suggest that the policy makers in BRICS should consider the short run relationship between inflation and economic growth in their policy making while the China and the South Africa policy makers should pay attention to both the short run and long run relationship.

1. INTRODUCTION

To attain high and sustainable output growth with low and stable rates of inflation is the main objective of macroeconomic policies (Kan and Omay, 2010). For a sustained economic

growth a certain magnitude of inflation is necessary to "Grease the Wheels" (Temple, 2000). Therefore, policy makers find it important to understand the inflation growth relationship in order to ensure sound policy making if inflation is detrimental to economic growth.

The common objective of macroeconomic policy is to keep inflation rate low, which creates a conducive environment for higher economic growth. Low inflation leads to economic growth by encouraging capital accumulation and increasing price flexibility. However, in order to attain macroeconomic stability low inflation rate is necessary, but not sufficient condition for sustained economic growth. This is evidenced by the fact that most countries have gone slowly despite low inflation, for instance, this transpired in the France zone during the 1980's (Fischer, 1983). Many cross county studies suggest the existence of a negative relationship between inflation and economic growth. Furthermore, the magnitude of this relationship is envisaged to vary from region to region depending on the level of development and other factors. Although the significant body of research investigating the inflation growth relationship exists in developed and developing countries, but very few studies have dealt with BRICS countries. For instance, Ghosh and Phillips (1998) by employing a large data set covering all IMF member countries and found a negative and statistically significant relationship between inflation and economic growth. Moshiri and Sepehri (2004) compared the data set for 54 countries 26 lower middle income countries and 28 low-income countries and also found a negative relationship between inflation and economic growth. In the light of the above, this study examined the inflation growth relationship in the BRICS countries. The importance of investigating the linkage between inflation and economic growth in this region stems from the notion that the member countries are determined towards common goals and therefore are likely to pursue similar macroeconomic policies. The motivation for the analysis emanates not only due to lack of studies analyzing inflation and economic growth in the BRICS region, but more generally, because of the fact that this relationship may differ from the one that exists in developed countries due to the level of economic development and prudent macroeconomic policies that are being practiced in the region (Sarel, 1996). Moreover, inflation is considered to be one of the major indicator of macroeconomic stability, and can therefore, be regarded as an indicator of the ability of the government to manage the economy. The high level of inflation may be indicative of lack of sound governance by the monitoring authority of a country or even a sign that the government has lost control of his finances (Fischer, 1993). The contribution of the study to the literature is twofold. This study looks into the inflation growth nexus in the context of BRICS countries. The sample restricted to only include countries in the BRICS region since these countries exhibit similar characteristics. This paper is organised as follows, review of literature is given in the section II, background of the BRICS countries are presented in the section III, data and methodology has been dealt with section IV. The empirical results are discussed in section V and the section VI considered conclusion and policy implications.

2. REVIEW OF LITERATURE

There have been extensive theoretical and empirical research in the relationship between inflation and economic growth, but still the issue is remaining controversial for the policy makers.

The present study gives a brief review about different inflation and economic growth in various contexts. Barro (1995) examined the inflation growth relationship covering a large sample more than 100 countries. He found that there is statistically negative relationship exist between inflation and economic growth. In other words, the study suggests the relationship is negative when some reasonable instruments are considered in the statistical process. Bruno and Easterly (1995) found that inconsistent and inconclusive relationship between inflation and economic growth below the threshold level that is 40 percent. Sarel (1996) explored that inflation rates were modest in most countries before the 1970's after that rates started to be high. Therefore, most empirical studied found that the relationship is positive before that period, but the relationship is negative after this period. Malla (1997) examined the inflation growth relationship using a small sample of Asian countries and OECD countries separately. He found that a statistically significant negative relationship between inflation and economic growth. The important analysis of the study basically says that the cross country relationship between inflation and long term growth experiences some fundamental problems like adjustment in the country sample and time period. Shitundu and Luvarda (2000) studied the inflation growth relationship in the context of Tanzania by employing the Least Trimmed Squares (LTS) method. The study suggests that inflation has been harmful and negatively affect the economic growth in Tanzania. Faria and Carneiro (2001) investigated the inflation growth relationship in the context of Brazil. The study found that there is negative relationship between inflation and economic growth in Brazil in the short run but inflation does not affect economic growth in the long run.

Gylfason (2001) investigated the cross country link between inflation and economic growth for 170 developing and developed countries. The empirical findings of the study suggest that the cross country relation between inflation and economic growth are economically and statistically significant and robust. Sweidan (2004) analysed the inflation and economic growth relationship from the period 1970 to 2003. He concluded that the inflation growth relationship tends to be positive and significant below an inflation rate 2 percent beyond this point economic growth will be jeopardised. Gokul and Hanif (2004) examined the relationship between inflation and economic growth in the context of Fiji covering the period from 1970 to 2003.

The study found that there is exists weak and negative correlation between inflation and economic growth. Mubarik (2005) examined the threshold level of inflation in the context of Pakistan. He found that an inflation rate beyond 9 percent is detrimental for the economic growth of Pakistan. Saaed (2007) examined the inflation and economic growth relationship in the context of Kuwail covering the sample from 1985 to 2005. The empirical findings suggest that there a long run and strong inverse relationship exist between inflation and economic growth. Eaboyka and Okuyan (2008) explored the relationship between inflation and economic growth in Turkey. The study found that no statistically significant long term relationship was found with formed of ARDL models, but a negative statistical significant short run relationship has been found. The study also suggests that no causality was found from economic growth to inflation, but there is unidirectional causality revealed from inflation to economic growth.

Mallick and Chowdhury (2007) examined the short run and long run dynamics of the relationship between inflation and economic growth in four South Asian countries. The study

found that there is a positive and statistical relationship exists for all four countries. Behera (2014a) examined the inflation and economic growth relationship in the context of six South Asian countries. The empirical findings of the study suggest that there is a high positive correlation exists between inflation and economic growth for all countries. Moreover, the study also suggests that there is no long run relationship between inflation and economic growth for all the countries except Malaysia. Behera (2014b) investigated the inflation growth relationship in the context of seven South Asian countries by employing advanced Pedronic panel cointegration technique. The study found that there is a negative relationship exists between inflation and economic growth for all the countries. The findings also pointed out that there is a long run relationship exist between inflation and economic growth for all the countries and there is a unidirectional causality runs for inflation to economic growth for all the countries.

3. BACKGROUND OF THE BRICS COUNTRIES

The "BRIC" country level selected a group of four large, developing countries (Brazil, Russia, India, and China). The four "BRIC" countries are distinguished from a host of other primary emerging markets by their demographic and economic potential to rank among the world's largest and most influenced economies in the 21 century (and by having a reasonable chance of realizing that potential) together, the four original BRIC countries more than 2.8 billion people or 40% of the world's population, cover more than a quarter of the world's land area over three continents and account for more than 25% of the global GDP.

The "BRIC" designation was first coined by Jim O Neill chief economist of Goldman Sachs in 2001paper titled. The world needs better economic BRICS. The BRIC countries since gone into meet and seek out opportunities for cooperation in trade, investment, infrastructure development and other areas. In December, 2010 China invited South Africa to join the group of BRIC nations and hosted the third annual "BRICS" summit in April, 2011.

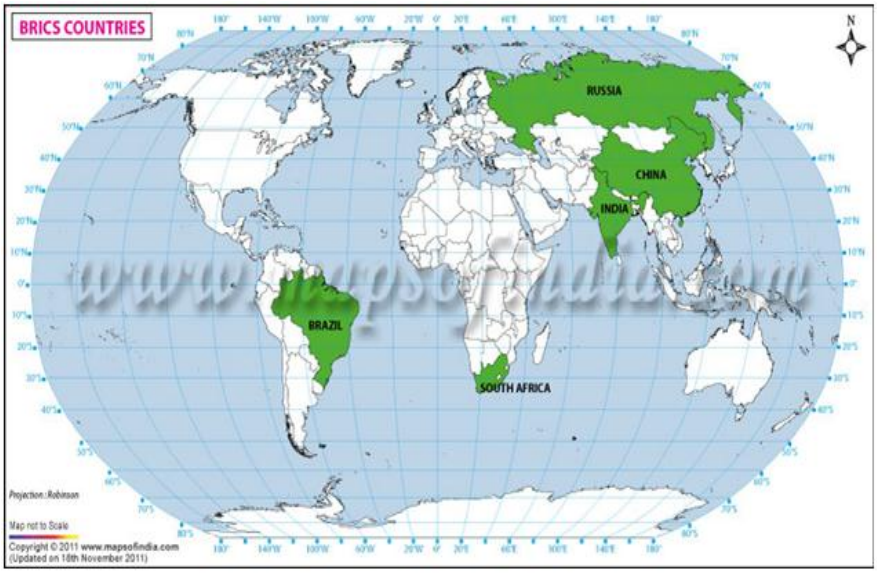

Figure-1. BRICS Countries

Source: http://www.mapsofindia.com

3.1. Contribution of the Study

The study contributes to the body of knowledge in the field of economics by enhancing the understanding of the inflation growth relationship in the "BRICS" countries. The study gives a comprehensive idea regarding inflation growth relationship in the context of "BRICS".

3.2. The Long Term Economic Growth Experience in Today's Longest Developing Countries

Some of the longest developing countries have put their economies a track to catch up with developed countries, yet many have not after the Second World War, countries such as Japan and the republic of Korea caught up with the income levels of many industrial economics to also become developed countries. A World Bank report published in 2008 on the growth report strategies for sustained growth and inclusive development rates that only 6 developing countries have grown faster than 3 percent in per capital terms, with the10 having growth rate below 2 percent since the 1960's.

For economic growth to be sustainable and to catch up with the industrialized economics, many developing countries needed to grow at a higher rate. Hence, in the mid 1980's and early1990's several developing countries including "BRICS" and five of the fastest growing SSA countries (Sub Saharan African), embarked upon several different economic and financial reforms which focused mainly on integration into the global economy. The purpose of this study is to examine the growth experiences of these countries. The analysis sheds light on the strengths and weaknesses of the growth in these countries by identifying similarities and differences with other countries and also assesses their economic performance on that comparative basis.

Brazil

The economic history of Brazil covers different events outlining changes in the economy. Through the 1980's and 1990's, the Brazilian economy suffered low and volatile growth where the economy suffered from ramped inflation, high real interest rates and balance of payment problems between 1980 and 2007, the average growth of GDP was 2.7% compared to the 8.7% obtained between 1970 and 1979. During this period, Brazil introduced a series of economic reforms, including Import Substitution Industrialisation (ISI).

Between 1981 and 1992, Brazils GDP increased at an average annual rate at 1.9 percent and the per capital income declined 6.1percent. Physical capital that is gross fixed capital formation as a ratio of GDP, fall from 22.1 percent to 18 percent, partly due to the fiscal crisis and the loss of public sector investment capacity. According to economist the 1980's the reformed as the last decade' for Latin American countries in Brazil for example, the 1980's was played by chronic inflation problems as a result of expansion of the money supply which government used in financing investment. Inflation was as high as 1430 percent in 1989 and remained a problem in the 1990's with the average rate of 1667 percent between 1990 and 1994. In the beginning of the 1990's the Washington consensus recommendations were spread out across all developing countries, including Brazil. Following this Brazil developed and implemented several different strategies and economic policies, including trade and capital Liberalization, Privatization, flexible exchange rates and the shock stabilization program referred to as the 'plan real' in mid-1994.

These plans aimed at removing restrictions on free enterprise, increasing competition and privatizing public enterprises. The plan brought stability and enabled the country to sustain economic growth through the economic decade. In the present decade, Brazil has steadily improved its macroeconomic stability, building of foreign reserve and reducing its debt profile by shifting debt burden towards real dominated and domestically held instruments.

Russia

Since the fall of the Union of Soviet Socialist Republics (USSR) in 1991, Russia has gone through a series of economic reforms in order to promote economic development. Russia's long-term development prospects are characterised by their dependence on the extraction of natural resources. Russia's recent rapid expansion has contributed to improved living standards and a narrowing of the income gap, in comparison to other emerging markets and the Euro area.

Russia entered the 1990s with a huge production structure inherited from the Soviet Union. After its collapse, the Russian economy underwent tremendous strain as it liberalised both its trade and production systems in 1992. This was to accommodate raising government revenues and the government's dependence on short-term borrowing to finance budget deficits. Although Russia reached a high level of economic openness, the reforms did not produce the expected results and the economy witnessed a negative growth in the first half of the 1990s (Aghion and Blanchard, 1998) leading to a major financial crisis in 1998. During this period, the government devalued the Ruble and inflation reached approximately 85 percent. But, following implementation of several economic reforms and tight fiscal policy, both inflation and the exchange rate stabilised. Household consumption and fixed capital investments both grew by approximately 10 percent per year, replacing the role of exports as the main drivers of demand. World oil prices rapidly rose during 1999 and 2000, further contributing to the recovery of the Russian economy. In addition, during the period between 1998 and 2007, GDP grew at an average of 6.7 percent approximately.

Investment also played an important role in Russia's take off in growth. Foreign direct investment (FDI) contributed approximately 4.2 percent to GDP in 2007, up from approximately 0.3 % in 1992. In absolute terms, it grew at an annual average of 25.7 percent over fifteen years, from US $1.2 billion in 1980 to over US $55 billion in 2007. Although international trade played a remarkable role in the growth of the Russian economy during the 1990s, it has, however, suffered a reduction in the current decade, reaching 52 percent in 2007.

In terms of population, the size, age and literacy rate seem to work as an advantage in promoting sustained growth. However, the distribution of employment in the different sectors of the economy seems to be typical of developing economies. For example, in 1990, the agriculture and industry sectors employed 54 percent of the work force and the services sector employed 41 percent. By contrast, in a more industrialised county like the United States, for example, 29.3 percent of the labour force is in the agriculture and industry sectors, and 70.7 percent is in the services sector. However, in the present day (2007), a series of changes have occurred in the composition of employment in the various sectors of the economy, reflecting a configuration of modern industrialised economies, partly due to the transition of the Russian economy as among

one of the fastest growth economies in the world. The service sector now employs approximately 62 percent of the labour force and the agriculture and industry sectors now employs approximately 38 percent of the labour force.

India

The Indian economy has faced many different economic reform packages to become one of the fastest growing economies in recent years. The process of economic growth in India has been mainly caused by improvements in labour productivity (Alessandrini and Buccellato, 2008). Following the implementation of an import substitution strategy, which focused on the restriction of all goods and services coming into the country, economic growth in India improved in the 1980s, after the liberalisation era. The Indian economy grew at an average annual rate of 4.6 percent in the period 1980 to 1989. Both the agriculture and industry sectors contributed an average of 58 percent to GDP compared with 42 percent in the services sector.

The loss of India's major trading partner (the USSR) in the 1990s, led to a series of political and social instabilities, and India faced a severe balance of payments crisis. Thus, India turned to the International Monetary Fund IMF for assistance. Following the recommendation from the Washington Consensus in 1994, India embarked upon various economic reform programs including a plan to move the economy to a more market-oriented one, through reducing the regulations and public sector share in the economy. India's growth rate averaged 7.5 percent during the period 1994 to 1996. Unfortunately, the high growth was short lived as a result of the 1997 East Asian financial crisis' effect on India's exchange rate.

In the second half of the 1990s, the services sector began to contribute more to GDP resulting in the rise in telecommunication and information technology. Recent liberalisation programs, in particular the policy of import substitution led to the development of a broad industrial base with the state owned enterprises playing a major role in heavy industry. Throughout the 1990s, the share of industry of India's GDP remained almost constant at 26 percent. By 2007, the share of services in GDP had risen to 53 percent from an average of 46 percent in the 1990s. India benefits from its large population, making it a potential consumer market and relevant players in the world economy.

China

China has sustained an impressively high GDP per capita growth spanning more than three decades, which is supported by a decline in population growth rate. The Chinese economic take off started with economic reforms in the early 1980s. The first part of these Chinese economic reforms involved implementing an export-led growth pattern that involves labour shifts from agriculture to industry and services. As a result, the share of agriculture in China's GDP decreased from 28 percent in 1985 to 20 percent in 1995, while industry and services increased from 43 and 29 percent in 1985 to 47 and 33 percent in 1995, respectively. In 1995China's trade and investment reforms and incentives have led to a surge in FDI since the beginning of the 1990s. The data obtained from the World Bank (2011) show that both trade and FDI have contributed a lot to the development of the Chinese economy. For example, China's growth in

foreign trade averaged 14 percent during the 1990s, and by 2007, the country exported nearly US $1.2 trillion in goods, resulting in a trade surplus of US $340 billion. In the same year, China recorded a surplus in current account balances of US $354 billion, as opposed to the deficit of US $11 billion recorded in 1993. The Chinese government implemented several economic reforms in the 1990s, in order to tackle inflation, reform the state owned enterprises and integrate with the international economy. During this period, China went through a slow and progressive internationalisation of the economy by selectively introducing elements of the market economy. According to the World Bank (2011) China's FDI in absolute terms increased more than threefold from US $42 billion in 1997 to US $143 billion in 2007, making china one of the world's largest destinations of FDI. The large population in China makes it a consumer market for the global economy. However, there are various problems associated with having such a large population size. China suffered severe food supply problems and starvation in the late 1995os and with the increasing decline in the contribution of the agricultural sector to GDP since the mid-1990s, the government introduced the 'one child policy' so as to control population growth. The implementation of this policy has led to the reduction of population growth from 1.3 % in 1980 to 0.5 % in 2007. The Chinese government has strongly promoted literacy and education of the whole population because improving the education and skill levels of Chinese workers could make the economy more productive. Focus on these basic goals has resulted in an increase in the number of literate persons in China, from 66 percent in 1982 to approximately 93 percent in 2007.

South Africa

South Africa's economy has been shaped by an abundance of natural resources. South Africa is the world's largest producer of platinum, gold, chromium and coal, and their mineral wealth surpasses that of almost any other country in the world, except the Soviet Union. The mining industry has, therefore, provided the foundation for the growth of the economy. However, by the early 1980s, South Africa encountered a series of negative economic annual growths (1982, 1983 and 1985) due to a distortion by government policies, which excluded some selected South African's from any significant participation in the nation's wealth. Inflation reached its highest at 18.7 percent in 1986, forcing the depreciation of the Rand. During the second half of the 1980s, South Africa's GDP grew by 2 percent, while per capita GDP increased by 0.5 percent from US $4100 in 1986, to US $4165 in 1989. According to the University of Pretoria Report the recent growth performance of the economy has proven that even though South Africa has achieved a period of political stability, it does not necessarily follow that the long-term growth rate will rise to a level that will permit a steady improvement in per capita income. By the early 1990s, South Africa experienced slow and constant growth, and despite the vast mineral wealth, the weaknesses in the economy were becoming increasingly apparent. Some segments of the population were poorer, with approximately 41 percent of the population living on $2 a day. The recovery of the economy strengthened in 1994 when GDP grew by 2.2 percent to US $158 billion from US $151 billion in 1992. GDP per capita also increased to US $3798, placing South Africa among the World Banks upper middle income developing countries. Unemployment contributed to the weak economic performance experienced in South Africa. The level of unemployment was

high and averaged 29 percent between 2000 and 2004, as industries concentrated on capital intensive investments to reduce labour costs. Growth in GDP declined from 3.6 % in 2002, to 2.8 % in 2003, due to this high rate of unemployment. In 2004, the appreciation of the low inflation rate fostered high domestic demand and low interest rates, leading to a GDP growth of approximately 3.8 percent. Between 2006 and 2007, strong demand and favourable external environments increased the GDP growth to 4 percent. South Africa remains one of the strongest nations in Southern Africa despite its slow economic growth in the past few years. Its largest trading partner is Europe and in 2004, trade with Europe accounted for 35 percent of total exports, China accounted for only 2.5 percent and Africa, 13 percent. South Africa witnessed a trade deficit in 2004, due to a slight increase in the demand for imported goods, even though there was also an increase in exports. While FDI inflow to South Africa is declining, the country is the main source of outward FDI in Africa. The nations' bilateral agreements are mostly between the Southern African Customs Union (SACU) members, Southern African Development Community (SADC) and the US. In order to build a competitive environment and reduce unemployment and poverty, South Africa needs to promote the diversification of exports, and encourage domestic and foreign investments.

4. DATA AND METHODOLOGY

This study uses the CPI data as a proxy for inflation and GDP as an indicator of economic growth for the period of 1980 to 2012. The data were obtained from the World Economic Outlook (WEO) and they were converted into their natural log values. First the stationarity of the each series was checked using the Augmented Dickey Fuller (ADF) test and the Phillips Perron (PP) Unit Root Tests. If both the variables are stationary at I (1), then the long run relationship was tested using Johansen's cointegration test (Johansen and Hansen, 1999). If the two variables are stationary at different levels, then the ARDL bound test is used as it is independent of order of integration (Pesaran *et al.*, 2001). The number of lags for the cointegration was identified through a VAR lag setup. Further, the direction of causality between inflation and economic growth was verified by Granger causality test (Granger, 1988).

5. EMPIRICAL RESULTS

5.1. Descriptive Statistics

Table-1. Descriptive statistics

COUNTRIES	BRAZIL		RUSSIA		INDIA		CHINA		SOUTH AFRICA	
VARIABLES	LCPI	LGDP	LCPI	LGDP	LCPI	LGDP	LCPI	LGDP	LCPI	LGDP
Mean	1.62	2.86	1.35	4.48	0.88	4.33	0.55	3.78	0.92	3.10
Median	1.18	2.86	1.14	4.46	0.94	4.31	0.52	3.79	0.94	3.07
Max	3.46	3.07	2.94	4.64	1.14	4.78	1.38	4.25	1.27	3.30
Min	0.50	2.68	0.70	4.32	0.57	3.93	-0.39	3.28	0.14	2.97
Std.Dev	0.97	0.11	0.59	0.11	0.17	0.25	0.44	0.31	0.24	0.10
Skewness	0.50	0.23	1.38	0.07	-0.50	0.20	-0.14	-0.02	-0.91	0.55
Kurtosis	1.79	2.01	3.99	1.46	2.05	1.86	2.88	1.71	4.13	1.88
J-B	3.49	1.70	7.61	2.07	2.70	2.04	0.08	1.37	6.53	3.48
Prob	0.17	0.42	0.02	0.35	0.25	0.36	0.95	0.50	0.03	0.17
Sum	55.12	97.46	28.53	94.13	30.22	147.26	11.13	75.64	31.50	105.59
Sumsq.Dev	31.15	0.43	6.97	0.24	1.01	2.19	3.71	1.87	1.97	0.36
Obs	34	34	21	21	34	34	20	20	34	34

An unrestricted VAR is used to understand the short run relationship between two variables. It is important to mention over here that all these above time series methods are available in the literature and in the standard textbook on time series Econometrics. Hence, we are not making an effort to discuss these here in this chapter. The summary of the statistical movements of all the variables is presented in the table-1, from the table it can be seen that, the coefficient of skewness, an indicator used in the distribution analysis as a sign of asymmetry for all the variables are greater than zero. This is further suggested that all the variables are positively skewed in case of Brazil and Russia and CPI for India and South Africa are negatively skewed distribution. The kurtosis coefficient, a measure of thickness of the tail of the distribution is quite high in the case of CPI in Russia and CPI in case of South Africa. A Gaussian (normally) distribution has kurtosis equal to three, and hence, this implies that the assumption of Gaussianity cannot be made for distribution of the concerned variables. This finding further strengthens by Jarque –Bera test for normality which in our case yields very high values for CPI in the context of both for Brazil and Russia and for CPI and GDP in the case of South Africa. Therefore, for these variables we can reject the null hypothesis of normality of any conventional confidence level.

Table-2. Correlation Statistics

COUNTRIES	BRAZIL		RUSSIA		INDIA		CHINA		SOUTH AFRICA	
VARIABLES	LCPI	LGDP	LCPI	LGDP	LCPI	LGDP	LCPI	LGDP	LCPI	LGDP
LCPI	1		1		1		1		1	
LGDP	-0.72	1	-0.63	1	-0.21	1	-0.27	1	-0.68	1

5.2. Unit Root Result

According to the ADF results in Table-3, it is evident that all the variables are stationary at I (1) at 5% level of significance for all the countries. The PP test, which even tests for series staionarity under the presence of structural breaks, shows that GDP and INF at stationary at 1(0) for Russia at 5% significance level, Also, INF is stationary at I (0) for China when the equation is specified with a constant. However, all variables are stationary at I (1) at a 5% significance level.

Table-3. Unit Root Test

		ADF Test				PP Test			
Country	**Variable**	**Level**		**First Difference**		**Level**		**First difference**	
		c	**c &t**	**c**	**c &t**	**c**	**c &t**	**c**	**c &t**
Brazil	Lngdp	3.42	-2.56	-4.96*	-4.87*	0.75	-2.70	-5.00*	-4.83*
	Lncpi	-0.90	-1.86	-4.33*	-4.27*	-0.90	-1.86	-4.28*	-4.22*
Russia	Lngdp	0.45	-2.39	-3.64*	-3.30*	0.10	-3.94*	-3.81*	-3.32
	Lncpi	-2.00	-3.25	-3.16*	-5.46*	-4.63*	-6.55*	-4.65*	-6.81*
India	Lngdp	2.39	-1.38	-3.62* -	-4.22*	3.16	-0.73	3.69*	-3.78*
	Lncpi	-2.78	-2.73	7.36*	-7.37*	-2.68	-2.64	-7.72*	-7.95*
China	Lngdp	-2.75	-2.69	-3.98*	-3.89*	-2.54	-2.44	-4.46*	-4.26*
	Lncpi	-2.68	-2.24	-3.43*	-3.33	-3.13*	-1.95	-2.71	-3.26
SA	Lngdp	1.58	-1.85	-4.16*	-4.97*	1.51	-1.08	-4.21*	-5.03*
	Lncpi	-2.07	-3.25	-5.28*	-5.18*	-1.91	-3.05	-11.16*	-11.30*

Note: The * represents significance at 5% level and c-represents constant and t-represents trend.

Johansen's cointegration approach requires variables should be non-stationary at their respective levels, but their linear combination must be stationary and they should be integrated at the same order (Johansen, 1991). However, the ARDL bound test is independent of the order of integration of the variables. According to Table-4 both the trace and Eigen value statistics in the

Johansen cointegration test indicate a cointegrating (long run equilibrium) relationship between inflation and economic growth for China and South Africa. However the rest of the BRICS did not indicate a long run relationship between two variables.

Table-4. Cointegration Test

Country	H_0	Trace Statistics	Critical Value at 5% (p –value)	Eigen Value	Max Eigen value	Critical Value at 5% (p-value)
Brazil	None(r=0) Atmost(r=1)	5.43 0.03	15.49(0.76) 3.84(0.86)	0.1600 0.000	5.4086 0.0306	14.26(0.68) 3.8414(0.86)
Russia	None(r=0) Atmost(r=1)	13.56 0.64	15.49(0.09) 3.84(0.42)	0.5123 0.0349	12.9268 0.6408	14.26(0.08) 3.84(0.42)
India	None(r=0) Atmost(r=1)	8.67 0.92	15.49(0.39) 3.84(0.33)	0.2212 0.0294	7.7551 0.9272	14.26(0.40) 3.84(0.33)
China	None(r=0) Atmost(r=1)	43.27 7.01	15.49(0.00) 3.84(0.00)	0.7655 0.2448	36.2597 7.0797	14.26*(0.00) 3.84*(0.00)
South Africa	None(r=0) Atmost(r=1)	18.55 1.76	15.49(0.00) 3.84(0.18)	0.4182 0.0552	16.7943 1.7616	14.26(0.01) 3.84(0.18)

Note: * indicates the level of significance at 1%.

5.3. Auto Regressive Distributed Lag Model (ARDL)

In the time series analysis before we are going to estimate the long run relationship among the variables we have to check the order of integration among the variables. Generally, in the long run analysis the variables should be integrated of order one i.e. I (1). Then only the long run analysis can be estimated.

Whereas the Autoregressive distributed Lag Model has independent of order of integration. That means it can be applied in both cases when the variables are both I (0) and I (1). The ARDL Model has several advantages (i) It can be applied irrespective of whether the underlying variables are I (0), I (1) or a combination of both. (ii) The ARDL model takes a sufficient number of lags to capture the data generating process in general to specific framework. (iii) This model helps to derive the error correction model through a simple liner transformation, which integrates short run adjustments with long run equilibrium without losing long run information. (iv)The small sample properties of ARDL approach are far superior to those of Johansen and Juselius cointegration technique. (v) The model is free from endogeneity because it is free of residual correlation. As Pesaran and Shin (1999) demonstrates, the appropriate lags in the ARDL Model are correlated for both serial correlation and endogeneity problems. (vi) This model helps to distinguish between dependent and explanatory variables.

From the table 3 we observe that all the variables are attained staionarity in both level and difference. Therefore, the study employ the Autoregressive distributed Lag Model for the cointegration analysis in the context of BRICS countries.

The study presents the results of the ARDL bound test in Table-5. The ARDL test indicates no long run relationship between inflation and economic growth for BRICS countries. As the F-statistics for the BRICS countries are lower than the lower bound 5 percent critical value of 6.606, we concluded that the BRICS countries do not indicate a long run relationship between inflation and economic growth.

5.4. Model Specification

$$\Delta GDP_t = \alpha_1 + \alpha_t GDP_{t-1} + \alpha_{CPI}\, CPI_{t-1} + \sum_{i=1}^{p} \alpha_i\, \Delta GDP_{t-i} + \sum_{j=0}^{q} \alpha_j\, \Delta CPI_{t-j} + \mu_t \ldots (1)$$

$$\Delta CPI_t = \beta_1 + \beta_t GDP_{t-1} + \beta_{CPI}\, CPI_{t-1} + \sum_{i=1}^{p} \beta_i\, \Delta CPI_{t-i} + \sum_{j=0}^{q} \beta_j\, \Delta GDP_{t-j} + \mu_t \ldots (2)$$

Table-5. ARDL Bound Test

Country	F Statistics
Brazil	4.97
Russia	1.71
India	1.06
China	5.71
South Africa	4.27

The Granger causality test is used to understand the causality between the two variables under study. Essentially, the Granger causality test determines whether inflation causes economic growth or vice versa.

Table-6 reports the Granger's causality test between inflation and growth for BRICS countries. The table surmised the result that there is a unidirectional causality between GDP and Inflation in the context of India and the causality runs from GDP to Inflation. However, we found a bidirectional causality between growth and inflation in the context of China.

Table-6. Granger Causality Result

Country	Hypothesis	F-Statistics	Probability
Brazil	DLNGDP – DLNCPI DLNINF – DLNGDP	0.21 1.06	0.806 0.361
Russia	DLNGDP – DLNCPI DLNINF –DLNGDP	1.93 1.25	0.186 0.319
India	DLNGDP →DLNCPI DLNINF – DLNGDP	4.57 2.22	0.020 0.129
China	DLNGDP →DLNCPI DLNINF – DLNGDP	3.45 3.34	0.052 0.057
South Africa	DLNGDP →DLNCPI DLNINF – DLNGDP	1.56 0.86	0.229 0.432

Note: '→' indicates unidirectional causality and '–'shows no causality

Table-7. Lag Order Selection Criterion

Country	Lags
Brazil	1
Russia	1
India	3
China	2
South Africa	1

Note: The lag length criteria are based on AIC (Akaike Information Criterion), SC (Schwarz Information Criterian), and HQ (Hannan Quinn Information).

A unidirectional VAR analysis is used to analyze the short run dynamic relationship between inflation and economic growth. Impulse response function shows the possible dynamic response of all the variables in the system to shock or innovation in each variable.

The standard Cholesky Decomposition method is used to obtain impulse responses to shocks from either variable over a 10 year period ahead. For Brazil a one standard deviation shock to inflation does not affect economic growth in the short run and one standard deviation shock to economic growth reduces inflation. However, in the long run both variables decay towards zero.

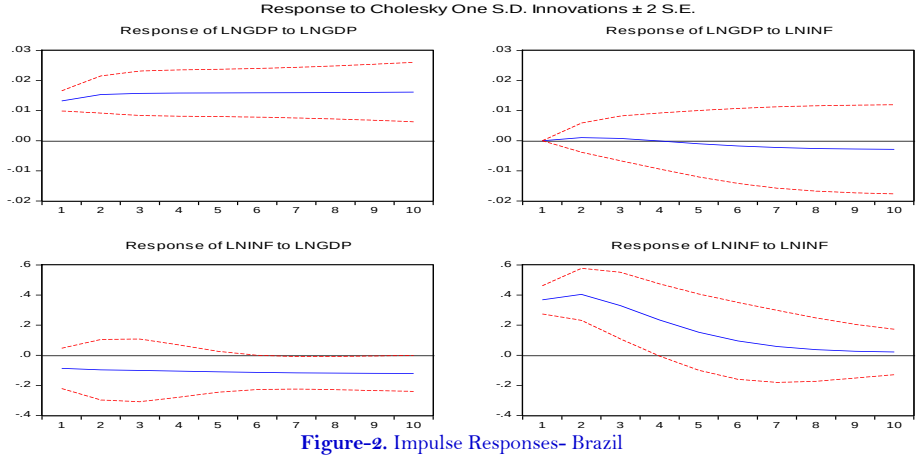

Figure-2. Impulse Responses- Brazil

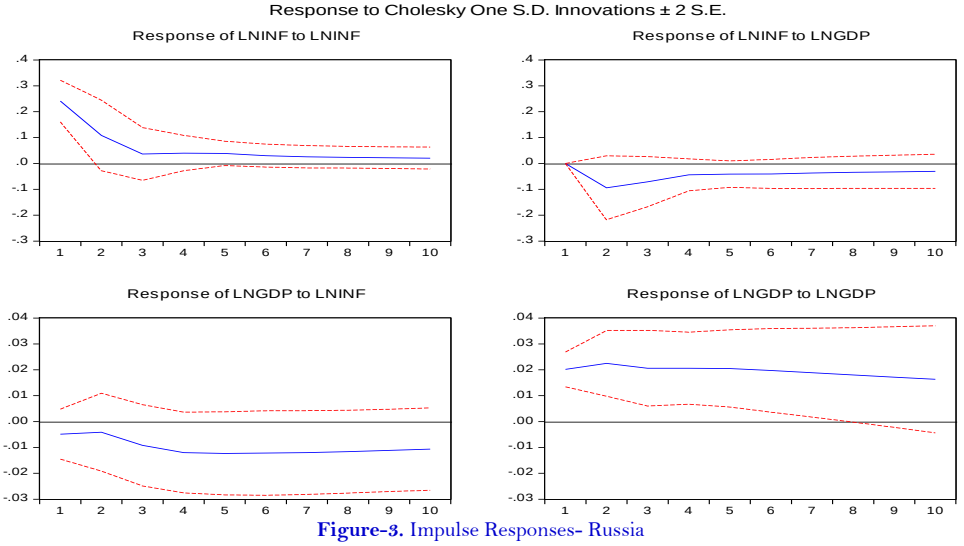

Figure-3. Impulse Responses- Russia

For Russia, a shock to inflation increases the economic growth in the short run. The same to the economic growth reduces inflation in the short run. The effects of both shock, however returns to zero in the long run.

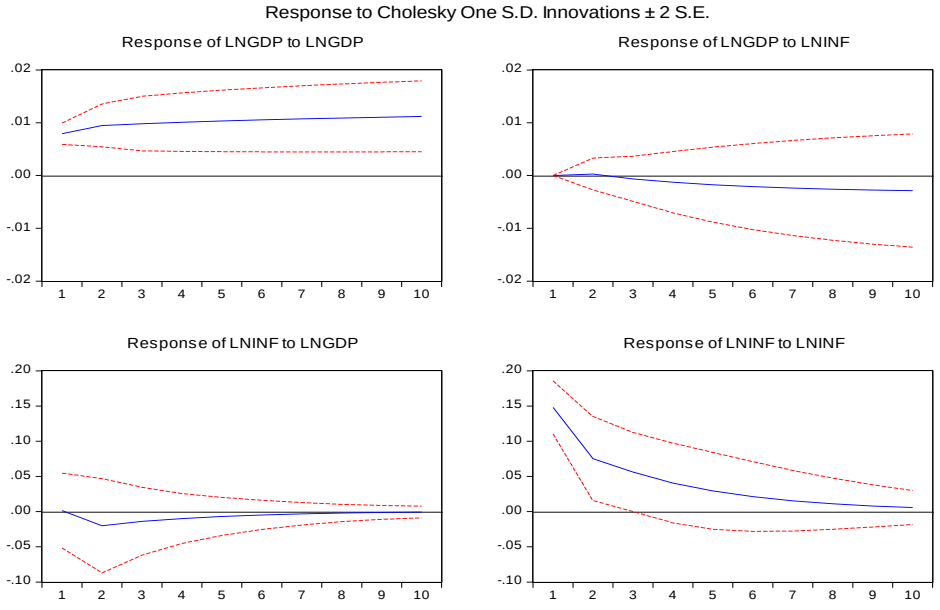

Figure-4. Impulse Responses- India

In India, one standard deviation shock to inflation increases the economic growth in the short run, where in the long run the effect reduces. A shock to economic growth reduces the inflation.

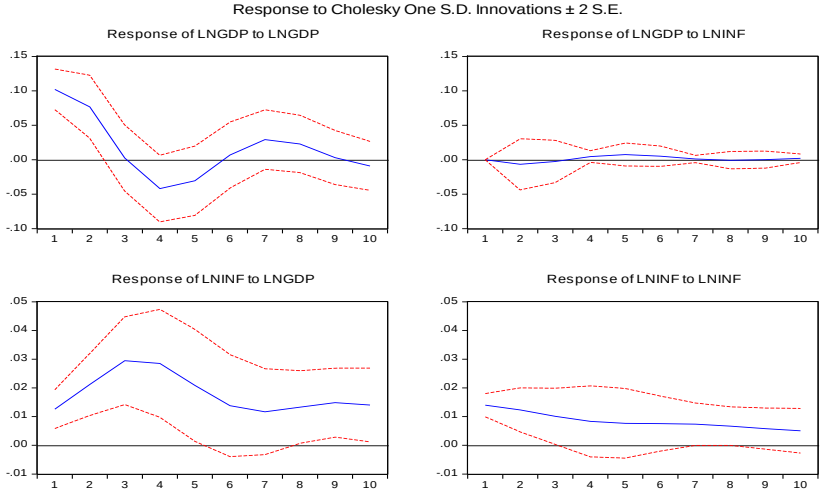

Figure-5. Impulse Responses- China

For China, a shock to inflation increase economic growth in the short run, similarly a shock to economic growth increases inflation, but in the long run the shock becomes ineffective for the china.

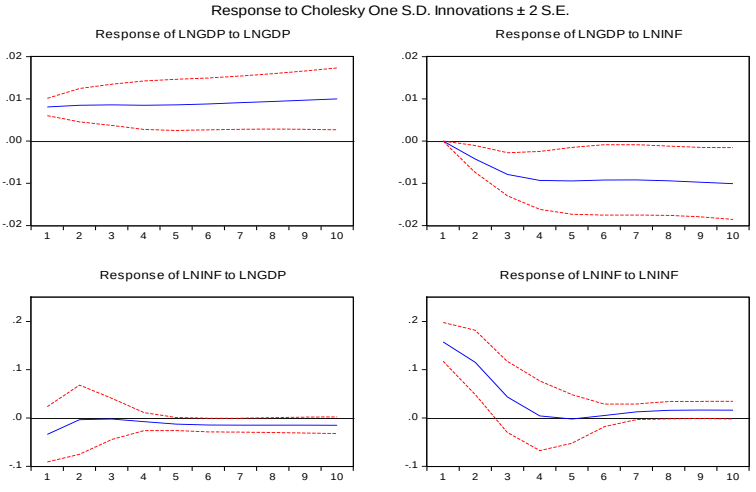

Figure-6. Impulse Responses- South Africa

For South Africa, a shock to inflation increases the economic growth in the short run but in the long run economic growth reduces. Similarly, one standard deviation shock in economic growth reduces inflation in the short run as well as in the long run.

6. CONCLUDING REMARKS AND POLICY SUGGESTIONS

This study investigated the inflation growth nexus in the context of BRICS countries. The result indicates a long run positive relationship between inflation and economic growth only for China and South Africa at the 5% significance level. The causality test revealed a unidirectional causality between economic growth and inflation in the context of India. However, we found bidirectional causality between economic growth and inflation in case of China. The VAR analysis could not find a consistent short run relationship between inflation and economic growth over the ten years period ahead for BRICS countries. The results of this study have significant policy implications for BRICS countries. In general the policy makers in BRICS should consider the short run relationship between inflation and economic growth in their policy making while the China and South Africa policy makers should pay attention to both the long run and short run relationship.

Funding: This study received no specific financial support.

Competing Interests: The authors declare that they have no competing interests.

Contributors/Acknowledgement: All authors contributed equally to the conception and design of the study.

REFERENCES

Aghion, P. and O.L. Blanchard, 1998. On privatisation methods in Eastern Europe and their implications. Economics of Transition, 6(1): 87-99.

Alessandrini, M. and T. Buccellato, 2008. China, India and Russia: Economis reforms structutral change and regional disparities. Economics Working Paper No. 97.

Barro, R.J., 1995. Inflation and economic growth, national bureau of economic research (NBER). Working Paper No. 5326.

Behera, J., 2014a. Inflation and its impact on economic growth: Evidence from six South Asian countries. Journal of Economics and Sustainable Development, 5(7): 145-154.

Behera, J., 2014b. Inflation and economic growth in seven South Asian countries: Evidence from panel data analysis. EPRA International Journal of Economics and Business Review, 2(6): 15-20.

Bruno, M. and W. Easterly, 1995. Inflation crises and long run growth, world bnak policy research. Working Paper No.1517.

Eaboyka, E. and H.A. Okuyan, 2008. Does inflation depress economic growth? Evidence from Turkey. International Research Journal of Finance and Economics, 17(1450-2887): 40-48.

Faria, J.R. and F.G. Carneiro, 2001. Does high inflation affect growth in the long and short run. Journal of Applied Economics, 4(1): 89-105.

Fischer, S., 1983. Inflation and growth, 267-278, NEBR Working Paper No. 1235.

Fischer, S., 1993. The role of macroeconomic factors in growth. Journal of Monetary Economics, Working Paper No. 4565.

Ghosh and S. Phillips, 1998. Warning: Inflation may be harmful to your growth. IMF Staff Paper, 45(4): 672-710.

Gokul, V. and S. Hanif, 2004. Relationship between inflation and economic growth. Working Paper No. 2004/04, Economics Department, Reserve Bank of Fiji.

Granger, C.W.J., 1988. Causality, cointegration, and control. Journal of Economic Dynamics and Control, 12(2.3): 551-559.

Gylfason, 2001. Does inflation matter for growth? University of Ice Land, center for business and policy studies. Stockholm, Sweden: CEPR, Institute of Economic Studies.

Johansen, S., 1991. Estimation and hypothesis testing of cointegration vectors in gaussian vector autoregressive models. Econometrica, 59(6): 1551–1580.

Johansen, S. and H. Hansen, 1999. Some tests for parameter constancy in cointegrated VAR-model. Econometrics Journal, 2(2): 306-333.

Kan, E. and T. Omay, 2010. Re-examination the threshold effects in the inflation growth nexus with cross section ally dependent non-liner period: Evidence from six industrialised economics. Economic Modelling, 27(5): 996-1005.

Malla, S., 1997. Inflation and economic growth: Evidence from a growth equation. Hanolula: Mimi co, Department of Economics, University of Hawai, I at Manoa. Available from www.ii.edu/~malla.

Mallick, G. and A. Chowdhury, 2007. Inflation and economic growth: Evidence from South Asian countries. Asian Pacific Development Journal, 8(1): 123-135.

Moshiri, S. and A. Sepehri, 2004. Inflation growth profiles across countries: Evidence from developing and developed countries. International Review of Applied Economics, 18(2): 191-207.

Mubarik, Y.A., 2005. Inflation and growth: An estimate of threshold level of inflation in Pakistan. State Bank Publication-Research Bulletin, 1(1-2): 35-44.

Pesaran, H., Y. Shin and R. Smith, 2001. Bound testing approach to the analysis of level relationship. Journal of Applied Econometrics, 16(3): 289-326.

Pesaran, M.H. and Y. Shin, 1999. An autoregressive distributed lag modelling approach to cointegration analysis, centennial volume of Ragner Frisch, Eds. S. Strom, A. Holly and P. Diamond. Cambridge: Cambridge University Press.

Saaed, A., 2007. Inflation and economic growth in Kuwait 1985-2008 evidence from cointegration and error correction model. Applied Econometrics and International Development, 7(1): 143-155.

Sarel, M., 1996. Non-liner effects of inflation on economic growth. IMF WP/98/56, Washington.

Sarel, M., 1996. Nonlinear effects of inflation on economic growth, IMF staff paper. International Monetary Fund, 43(March): 199-215.

Shitundu, J.L. and E.G. Luvarda, 2000. The effects of inflation and economic growth in Tanzania. African Journal of Finance and Management, 9(1): 70-77.

Sweidan, O.D., 2004. Does inflation harm in economic growth in Jordan? An econometric analysis for the period 1970-2000. International Journal of Applied Econometrics and Quantitative Studies, 1(2): 41-66.

Temple, J., 2000. Inflation and growth, short stories and tall. Journal of Economic Survey, 14(4): 395-426.

World Bnak, 2011. World development report: Conflict, security and development, 0163-5058. Washington D.C: World Bank.