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Exploring Causality Between Domestic Savings and Economic Growth: Fresh Panel Evidence from BRICS Countries

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Abstract

The paper analyses the direction of causality between domestic savings and economic growth for BRICS countries with the help of secondary data. It also examines the functional interrelationship between savings and economic growth to answer one of the key questions if the rapid economic growth of these emerging countries can be explained by their extent of savings. The Dynamic panel estimation method has been applied to examine both the short-run and the long-run relationship between savings and economic growth. Both Granger and Dumitrescu-Hurlin panel granger causality tests have been used to explore the direction of causality. Results of panel autoregressive distributed lag (ARDL) model show that both in the short-run and in the long-run, gross domestic savings significantly explains economic growth. Both the causality tests argue in favour of bi-directional causality between savings and economic growth for BRICS countries. Country-specific results show mixed causality where India, China and South Africa experienced bi-directional causality. For Brazil the causality is only from savings to economic growth while there is no causality for Russia. The study will help the policymakers to formulate monetary and fiscal policies that will be either saving-friendly or income-friendly.

Keywords: Domestic Savings, Economic Growth, Causality, Cross-Sectional Dependence, Dynamic Panel.

JEL: C23, E21, F43

1. Introduction

Savings play a vital role in an economy that wishes to move on a sustained growth path. In fact, it will not be imperative to say that the size of domestic savings, in many cases, determines the fate of the economic growth of a country. A study by the World Bank (1993) reveals that countries with higher savings rates have experienced higher economic growth. In his seminal paper Solow (1956) has justifiably pointed out the pivotal role of savings in determining economic growth. In the Solow model, savings results in investment, which in turn propels economic growth. Though the Solow model advocates that savings increase economic growth, the model believes the impact is temporary. However, endogenous growth theory moves further to ascertain that savings can have a long run positive impact on growth (Romer,

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1986; Lucas, 1988). Whatever the process be, there is very little disagreement over the fact that there is a significant interlinkage between savings and the economic growth of a country. Apart from intervening in this interrelationship, examining the direction of causality between economic growth and savings is an essential aspect for policy makers (Deaton, 1995), as the origin of this causality helps them to formulate effective strategies. Though there are many studies on this issue, there is still much debate on the direction of causality between savings and economic growth on the empirical ground. Few studies followed Solow's concept and have pointed out that savings lead to economic growth (Jappelli and Pagano, 1994; Gutierrez and Solimano, 2007). There are alternative beliefs that point out that the causal relationship stems from economic growth and ends at savings (Carroll and Weil, 1994). Apart from this, various empirical findings suggest a bi-directional causal relationship between these two macroeconomic components (Singh, 2010; Tang and Chua, 2012). Again, while there are differences in views in the context of developing and developed countries (Agrawal et al., 2010; Aghion et al., 2016; Andrei and Huidumac-Petrescu, 2013), there are conflicting findings for the same country in both the short run and long run (Patra et al., 2017). Hence there is scope for further studies regarding the nature of causality existing between economic growth and savings.

The present study carries this task with special emphasis on BRICS countries which is comprised of four developing countries, Brazil, India, China, and South Africa, along with a developed country like Russia. There are several reasons which call for a separate study of this nexus for the BRICS nations. Despite having discouraging status of unemployment and inflation, these countries are experiencing economic growth which not only separate them from most of the developing countries but also put them at the forefront among the emerging market economies. In addition, this small group holds all the heterogeneity in various economic fronts like growth of the informal sector, the degree of urbanization, the trend of foreign direct investment (FDI), the extent of foreign trade, the level of domestic savings etc. All these have resulted into a varied degree of economic growth within this group itself in the last decade or so. For example, the gross domestic product (GDP) of China has grown almost two and half times since 2009 with an increasing trend, while within the same period the GDP of Brazil grew roughly 1.4 times and that too with a fluctuating trend. To understand this diverse growth dynamics of the BRICS countries, one needs to address the pattern of causal relationship specifically involving savings and economic growth of these economies for some valid reasons mentioned above. For the sake of convenience, the study has been arranged into the following sub-sections. After a brief introduction in the first section, the second section deals with the review of part of the existing literature. The third section discusses the interlinkages between savings and economic growth with a special focus on BRICS. The fourth section provides the data sources and details of the variables that the study used. The fifth section deals with the methodology part adopted in the study. Section six discusses the results, while the seventh and the last section discusses the relevant conclusions and policy recommendations.

2. Literature Review

There is enough controversy regarding the direction of causality between economic growth and savings in the theoretical and empirical field. The reasons behind this may be attributed to various factors like choice of the time period, the status of the country under consideration (i.e., whether developing or developed), the existence of any structural break, etc. The debate also gained its momentum as various researchers used the diverse theoretical background to support their views. There are mainly two theoretical models, Keynes (1936) and Solow (1956), which are considered to be the backbone of the interrelationship between economic growth and savings. According to Keynes (1936), it is the growth of the national income (widely considered as a proxy of economic growth) that gives rise to domestic savings. According to this theory, there is unidirectional causality from income to savings, and any change in the level of national income brings variation in the level of savings, but the reverse is not true. On the other hand, Solow (1956) propounded a model that argues that domestic savings are the determinant of national income. According to this model, the increase in domestic savings increases investment, which in turn raises income. The criticism of this model has to do with the fact that this relationship holds only in the short run, and for long-run economic growth, there should be technological innovations. Whatever be the path, this model advocates for a unidirectional causal relation that runs from savings to economic growth, which is in flagrant contradiction with the Keynesian model.

Most of the empirical studies that have discussed the causal relationship between savings and economic growth support of either of these two theoretical models. Studying 17 euro-area countries having annual data series for 1960-2011, Andrei and Huidumac-Petrescu (2013) found unidirectional causal relationships from savings to economic growth. Similar findings have been seen by Tang and Tan (2014) while working on Pakistan with annual data from 1970-2011. They also came up with a unidirectional causality that runs from savings to economic growth. While studying Nepal, Bist and Bista (2018) found a significant but negative impact of savings on economic growth. The study by Oladipo (2010) on Nigeria with data from 1970-2006 also reveals a unidirectional causal relationship where saving was found to be the source of economic growth. Joshi et al. (2019), using annual data of Nepal for the period 1975-2016, also found a unidirectional causality from savings to economic growth and hence the findings suggest support of the hypothesis of the Solow model. Bankole and Fatai (2013), while working on the Nigerian economy, found a unidirectional causality that runs from savings to economic growth and hence rejects the Keynesian hypothesis. While analysing the Chinese growth story for last four decades, Song et al. (2019) argued that initially China could maintain a high growth rate only due to its high household savings rate. But in the later years, the savings rate in China declined from 2011 to 2017 which reduced domestic investment and this in turn resulted into sluggish economic growth. All these empirical studies validate the Solow model and negate the Keynesian theory. There are other empirical findings which, in turn, confirm the Keynesian view. Agarwal et al. (2010) found unidirectional causal relationships from economic growth to savings and hence seem to support the Keynesian view. Using Nigerian annual data for the period 1970-2007 and employing Johansen co-integration and Granger causality test, Abu (2010) rejected the Solow hypothesis and concluded in the line of the Keynesian theory that causality runs from economic growth to savings.

Apart from these two groups of empirical studies, certain studies have encountered either bi-directional causality or the existence of no causal relationship whatsoever between economic growth and savings. Bayar (2014) has empirically validated a bi-directional hypothesis while working with time-series data from 1982-2012 for emerging Asian countries. Tang and Chua (2012), while re-investigating the nexus between saving and growth for the Malaysian economy, found a bi-directional causality between the two variables. Adeleke (2014) found bi-directional causality for the Nigerian economy while working on annual data for the period 1970-2013. Sothan (2014), using Cambodian data for the time period 1989-2012, found no causal relationship between these two components. A similar finding can be seen by Budha (2012), who used annual data of Nepal and applied VECM Granger causality only to find the absence causality between savings and economic growth. A multi-country study by Alomar (2013) on selected middle-east countries, namely, Bahrain, Kuwait, Qatar, and Saudi Arabia, shows mixed results. While bilateral causality can be seen only in Bahrain's case, in all other countries, a unidirectional causality has been observed. Another multi-country study on chosen African countries by Bolarinwa and Obembe (2017) also found mixed results. While Liberia, Niger, and Sierra could observe unidirectional causality from savings to economic growth, Ghana and Burkina Faso experienced unidirectional causality from growth to domestic savings. The study found no causality for a country like Nigeria, which contrasts with other studies like Abu (2010) and Adeleke (2014).

3. Savings-Growth Interlinkages: BRICS Experience

Savings, whether private or public, have a profound impact on capital formation. This, in the form of investment accelerates the economic growth of a country. Many developing countries rely heavily on domestic savings (specifically household savings) as an alternative to public savings to maintain the sustainable growth objective. These countries lack capital inflows from developed countries and hence there is intensive dependency of investment on domestic savings to enable them to converge towards developed countries (Lucas, 1990). Savings are also seen as a future source of capital accumulation for developing countries. In addition, higher saving implies less dependency on developed countries (through foreign capital flows) and less trade deficit which in turn, propels growth (Mankiw, 2006).

According to the life-cycle theory (Modigliani & Ando, 1957), saving motive changes for individuals when they grow older. A younger person saves when he/she is in the labour force and after retirement spending more than what they receive. Thus, the saving potential of a country is highly related with the number of people in the labour force and hence is very much influential over economic growth. One of the main reasons why few BRICS countries experienced almost double-digit growth for a considerable period, is their ever-increasing share of population under labour force. This is specifically true for countries like India and China. This increases the saving potential of the country which overtime has been channelled to growth process and in turn promotes future savings. This becomes clear if we look into the panel line-plots of BRICS countries (Fig 1).

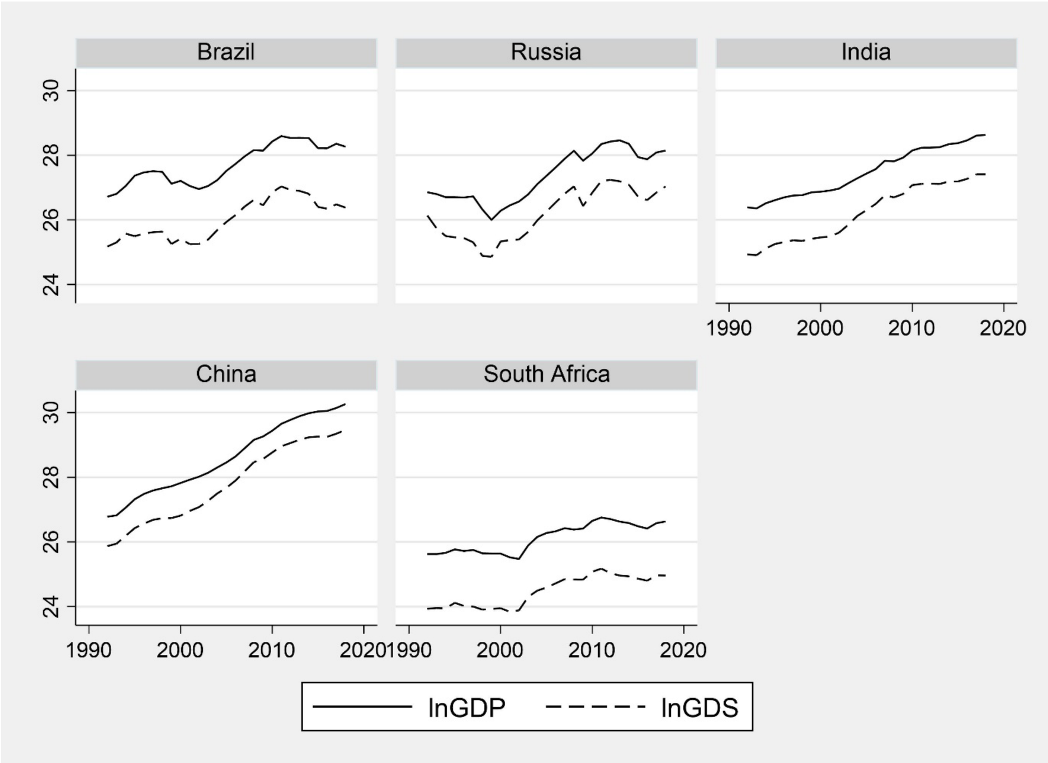

Figure 1. Panel Line Plot of Domestic Savings and the Gross Domestic Product of BRICS Countries

Figure 1 depicts the trend of gross domestic savings and gross domestic product of BRICS countries for the period 1992-2018. It shows a similar trend of these two variables for all the countries, though there are inter-country differences. Countries like India and China have a more or less smooth trend over these years while other three BRICS countries have experienced a fluctuating trend vis-à-vis these two key factors. As the figure suggests, countries like Brazil, Russia and South Africa have encountered major deepening in 2002, 1999 and 2002 respectively in both savings and economic growth. On the contrary, India and China have maintained an increasing trend in terms of both these macroeconomic variables during this span which may be one of the reasons how they are the two leading emerging economies in the world. To analyse this heterogeneous growth pattern of these five countries one needs to look into the causal relationship between domestic savings and economic growth and find out which factor is the resultant of the other.

4. Data Sources and Variables Used

The study is based on five emerging nations, the member countries of BRICS, namely, Brazil, Russia, India, China, and South Africa. It has tried to capture data on relevant variables for the period 1992-2018. The variables under examination are gross domestic product (GDP), gross domestic savings (GDS); both measured in current US dollar, and the volume of trade (TRADE) as a percentage of GDP. The study has used data from World Development Indicators (WDI) published by the World Bank. For analytical ease, the study has utilised the natural logarithmic transformation of each of these variables.

Table 1. Description of Variables

Variables	Unit	Abbreviation used in the Study	Source
Gross Domestic Product	Current US Dollar	LNGDP	
Gross Domestic Savings	Current US Dollar	LNGDS	WDI
Trade	As Percentage of GDP	LNTRADE	

5. Methodology and Model Specification

There are two major frameworks that intervene into the causal relationship between economic growth and savings. One is the most famous Keynesian model (1936), which assumes that economic growth is the determinant of savings. The second one is the advanced model by Solow (1956), which hypothesizes that economic growth is the function of savings. The present study is based on the Solow hypothesis, where savings is the determinant of economic growth. The broad functional form can be written as

$$Y = f(S) \tag{1}$$

Where,
Y = economic growth
S = savings

The implicit form can be written as,

$$Y_i = \alpha + \beta S_i + u_i \tag{2}$$

Where,
α and β are two parameters and u are the random disturbance term. Eqn. (2) constructs the basic framework of the study.

5.1 Panel ARDL Model

The study has applied a panel ARDL (Autoregressive Distributed Lag) framework following Pesaran et al. (1999). There are various advantages of applying an ARDL model. According to Westerlund (2007), the ARDL model gives efficient panel data modelling results if time-dimension is greater than the cross-section dimension, as in our present case. Another advantage is that the explanatory variables can either be purely I (0) or purely I (1) or a mix. But one cannot apply ARDL if the stationarity is of order I (2). Similarly, if there is cross-sectional dependence, ARDL provides consistent estimates of parameters neutral to the regressors' information being exogenous and endogenous (Pesaran et al., 1999).

Suppose our ARDL model is of the following form where i= 1,2,…, N represents cross-country specification and time period is given by t=1,2,…, T.

$$y_{it} = \sum_{j=1}^{m} \alpha_{ij} y_{it-j} + \sum_{j=0}^{n} \beta'_{ij} X_{it-j} + \partial_i + \varepsilon_{it} \tag{3}$$

Where, y_{it} is the dependent variable, X_{it-j} is the set of explanatory variables. ∂_i stands for fixed effects, α_{ij} is the coefficients of the lagged dependent variable, and β_{ij} is a vector of coefficients of regressors. M and n are the optimal order of lag and ε_{it} is the error term. Equation (3) can be re-parameterized to have ARDL Error Correction Model as

$$\Delta y_{it} = \delta_i(y_{it-1} - \theta_i' X_{it-1}) + \sum_{j=1}^{m-1} \alpha_{ij}^* \Delta y_{it-j} + \sum_{j=0}^{n-1} \beta_{ij}^{*\prime} \Delta X_{it-j} + \partial_i + \varepsilon_{it} \quad (4)$$

Where, $(y_{it-1} - \beta_i' X_{it-1})$ is the Error Correction Term (ECT), δ_i depicts the long-run speed of convergence and for the stability of the model the condition is that δ_i should be negative. θi's stand for long-run cross-section parameters which are heterogeneous. Hence eqn. (4) can again be written as

$$\Delta y_{it} = \delta_i(ECT_{t-1}) + \sum_{j=1}^{m-1} \alpha_{ij}^* \Delta y_{it-j} + \sum_{j=0}^{n-1} \beta_{ij}^{*\prime} \Delta X_{it-j} + \partial_i + \varepsilon_{it} \quad (5)$$

Internalising the economic growth-saving causal relationship of eqn. (2) in the above panel, the ARDL model eqn. (5) can be re-written as

$$\Delta GDP_{it} = \delta_i(ECT_{t-1}) + \sum_{j=1}^{m-1} \alpha_{ij}^* \Delta GDP_{it-j} + \sum_{j=0}^{n-1} \beta_{ij}^{*\prime} \Delta X_{it-j} + \partial_i + \varepsilon_{it} \quad (6)$$

Here, X is the set of regressors comprising GDS and Trade. This eqn. (6) can be solved by applying either Mean Group (MG) or Pooled Mean Group (PMG) estimators. The present study chooses the MG estimator as the Hausman test favours for it. There are certain other advantages of MG techniques as well. The main difference between the MG and PMG estimator is, while the PMG estimator assumes homogeneity among the cross-section unit, the MG estimator is more practical allowing heterogeneity among the countries.

5.1.1 Mean Group (MG) Estimator

The Mean group estimator actually takes into account the long-run relationship between the dependent variable and the set of independent variables by averaging both the long-run convergence coefficient and the long-run cross-section coefficients. This implies

$$\delta_{MG} = \frac{1}{N}\sum_{i=1}^{N} \widehat{\delta_i} \text{ and } \theta_{MG} = \frac{1}{N}\sum_{i=1}^{N} \widehat{\theta_i} \quad (7)$$

Where, $\widehat{\delta_i}$ and $\widehat{\theta_i}$ denote the estimated value of δ and θ respectively. One of the pivotal points of the MG estimator is that it allows slopes and intercepts (both short-run and long-run intercepts) to vary across countries. This implies there exists both short-run and long-run heterogeneity for MG estimators which makes it an efficient one. Though according to Nair-Reichert and Weinhold (2001) MG estimators are largely influenced by outliers as they are unweighted averages, Pesaran et al. (1999) have shown that these estimators give highly consistent values of long-run coefficients irrespective of the fact whether the independent variables are integrated or not, which is most important for a causal study.

5.1.2 Pooled Mean Group (PMG) Estimator

This method was proposed by Pesaran et al. (1999). Contrary to the MG estimator, the PMG estimator allows long-run homogeneity and short-run heterogeneity. As Pesaran et al. (1999) have shown, under the homogeneity assumption of long-run cross-section coefficients, PMG yields more efficient estimates than the MG estimator. Hence, keeping all other factors intact, the difference in model specification in the case of the PMG estimator compared to the MG estimator boils down to the form of the error correction term (ECT).

$$ECT_{MG} = y_{it-1} - \theta_i' X_{it-1} \text{ and } ECT_{PMG} = y_{it-1} - \theta' X_{it-1} \quad (8)$$

Where, θ_i' and θ' take into account the long-run heterogeneity of the MG estimator and long-run homogeneity of the PMG estimator respectively. In the case of the PMG, θ is the same for all countries. One of the similarities of both the MG and the PMG estimator is that both the models follow maximum likelihood estimation procedure. Estimates from both techniques can be used to predict the existence of any causality, e.g. coefficients of lagged regressors (β's) can be tested for the short-run causality whereas the coefficient of ECT (δ) can be tested for any possible long-run causality.

5.2. Panel Causality

There is a number of tests that are available for examining the existence of causality, but two tests that are widely used in analysing this are the Granger (1969) test and the Dumitrescu and Hurlin (2012) panel Granger Causality test. Granger causality is a classical time-series test for pairwise causality, which assumes homogeneity among the panels and ignores dependency among the cross-section units. On the other hand, Dumitrescu and Hurlin takes into consideration both the heterogeneous panel and cross-sectional dependence. In that sense, the Dumitrescu and Hurlin causality test is more extensive compared to the Granger pairwise causality test.

5.2.1 Granger (1969) Test

Granger causality is primarily a pairwise causality where a bivariate regression model is formulated and causality between these two sets of variables is being tested based on proper test statistic. If there are two variables x_t and y_t then we can make the statement that x_t Granger causes y_t if the present value of y_t can be estimated uniquely from the lagged values of x_t. Alternatively speaking, x_t Granger causes y_t if it is not possible to efficiently predict the present value of y_t with only having the information of lagged values of y_t and without knowing the lagged values of x_t. Mathematically this statement can be represented as

$$y_t = a + \sum_{j=1}^{p} \alpha_j y_{t-j} + \sum_{j=1}^{p} \beta_j x_{t-j} + \mu_t$$

where, t=1, 2, 3,…,T (9)

The basic hypotheses of the model are, μ_t is the random disturbance term which is independently identically distributed; x_t and y_t both are stationery series. The null hypothesis of this test is

$\beta_j = 0 \quad \forall j$ i.e. x_t does not Granger causes y_t

Against the alternative that

$\beta_j \neq 0 \quad \forall j$ i.e. x_t Granger causes y_t

The above null hypothesis is then tested using the F-statistic.

5.2.2 The Dumitrescu-Hurlin (DH) (2012) panel Granger Causality Test

The DH test is an improvement of the earlier Granger causality test as it considers both the cases of heterogeneous panels and cross-sectional dependence. Along with this, one of the major advantages of this test is that it is applicable irrespective of the fact whether the panel is balanced or unbalanced. The mathematical panel data form of this test is basically an extension of eq. (9) to include cross-section units.

$$y_{it} = a_i + \sum_{j=1}^{p} \alpha_{ij} y_{it-j} + \sum_{j=1}^{p} \beta_{ij} x_{it-j} + \mu_{it} \quad (10)$$

Where, t=1, 2, 3,…,T and i=1, 2, 3,…,N.

The assumptions regarding the variables involved and the disturbance term remains the same. The DH test is a non-causality test in the sense that its null hypothesis assumes there is no homogeneous causality among any of the cross-sectional units i.e. to say,

$$\beta_{ij} = 0 \quad \forall\, i$$

The alternative is a combination of two hypotheses and emphasizes on existence of at least one causal relationship among the cross-sectional units implying,

$$\beta_{ij} = 0 \quad \forall\ i = 1, 2, 3,\ldots, N_1$$

$$\beta_{ij} \neq 0 \quad \forall i = N_1+1, N_1+2, N_1+3,\ldots, N$$

The above hypothesis is tested by applying the average Wald statistic having the form

$$W_{N,T}^{HNC} = \frac{1}{N}\sum_{i=1}^{N} W_{i,T} \qquad (11)$$

Where, HNC stands for homogeneous non-causality and $W_{i,T}$ shows the individual Wald statistic for the i^{th} cross-sectional unit.

When the null hypothesis is rejected having N_1 = 0, then one concludes that for all the cross-sectional units x_t Granger causes y_t. On the other hand, if the null hypothesis is rejected having N_1 > 0 then one may conclude that for some of the cross-sectional units causality runs from x_t to y_t, but not for all.

In both tests if one constructs the reverse dependency equation of x_t on y_t (where the present value of x_t is dependent on not only its own lagged value but also on the lagged values of y_t as well), then causality can be tested to run from y_t to x_t. This is called bi-directional causality.

6. Results and Discussions

6.1. Cross-Sectional Dependence

Cross-sectional dependence implies interdependency among the cross-section units in panel data. In a panel data model, if any country experiences any shock, whichever form it may be, it will have effects on other countries involved. This cross-sectional dependence mainly arises due to reasons like interlinkages among units, omitted common efforts etc. and constitutes one of the key characteristics of the macro panel (Pesaran, 2015). Various studies have pointed out, while considering panel data one must take note of cross-sectional dependence whatsoever. According to Pesaran (2007) and Westerlund (2007), ignoring the presence of cross-sectional dependence when it is actually there can lead to an inefficient decision while conducting the panel unit root test and deploying the improper unit root technique can lead to spurious results as well. There are broadly four major cross-sectional dependence tests namely, Breusch and Pagan (1980) LM, the Pesaran (2004) scaled LM, Baltagi et al. (2012), the bias-corrected scaled LM and Pesaran (2004) CD. There are different conditions under which each of these tests behave efficiently. The Breusch-Pagan LM test is most suitable when the panel consists of a smaller cross-section unit. The Pesaran scaled LM test was explicitly useful to tackle large panel situations, i.e. this test is most appropriate for applying when cross-section and time dimension units are large. The Pesaran CD test gives the best result when the size of the time dimension is smaller than the cross-section units. The bias-corrected scaled LM test can be considered as an improvement of the Pesaran CD test as the former is specifically helpful for the homogeneous panel under fixed effects. The study has used all these four diagnostic tests of cross-sectional dependence.

Table 2. Cross-Sectional Dependence Test

Test	LNGDP	LNGDS	LNTRADE
Breusch-Pagan LM	231.6349*	230.4372*	103.1020*
Pesaran scaled LM	49.55907*	49.29125*	20.81824*
Bias-corrected scaled LM	49.46291*	49.19510*	20.72208*
Pesaran CD	15.21101*	15.16742*	4.345481*

N.B: One percent level of significance is denoted by*.

The null hypothesis of each of these test statistics is no cross-sectional dependency. As Table 2 highlights, there is a robust cross-sectional dependence among the variables as the null hypothesis for each of them is rejected at 1% level.

6.2. The Panel Unit Root

The existence (or non-existence) of a unit root in panel data is mostly done by applying three generations of tests. The First-generation test assumes that there exists cross-sectional independence. This set of unit root tests consists of Maddala and Wu (1999), Hadri (2000), Choi (2001), Levin, Lin and Chu (2002), and Im, Pesaran and Shin (2003). Each of these tests is based on a different test statistic. For example, Levin, Lin and Chu (2002) is based on t-statistic, Im, Pesaran and Shin (2003) on W-statistic. The Fisher $\chi 2$-statistic is applicable for both Maddala and Wu (1999), Choi (2001) and z-statistic specifically for Hadri (2000). There is heterogeneity regarding the application of these tests in terms of the types of panel data. While Levin, Lin and Chu (2002) is most suitable for a homogeneous panel, Maddala and Wu (1999), Choi (2001) and Im, Pesaran and Shin (2003) give efficient result in the presence of a heterogeneous panel. Similarly, these tests differ in terms of the null hypothesis based on which they are tested. The null hypothesis for Levin, Lin and Chu (2002), Im, Pesaran and Shin (2003), Maddala and Wu (1999) and Choi (2001) are the ‘existence of a unit root’, whereas, Hadri (2000) considers the ‘existence of stationarity’ as the null hypothesis. Again, while Levin, Lin and Chu (2002), Im, Pesaran and Shin (2003), Maddala and Wu (1999) and Choi (2001) are applicable for both balanced and unbalanced panel, Hadri (2000) is strictly for the balanced panel.

One of the serious flaws of all those aforementioned first-generation tests is that they ignored the presence of cross-sectional dependence in panel data, and as stated earlier, this can lead to serious consequences in the decision of stationarity and co-integration. This problem was overcome by the group of second-generation unit root tests like Chang (2002), Bai and Ng (2004), Bai and Ng (2005), Harris et al. (2005), Choi (2006), Pesaran (2007), Moon and Perron (2012). There is dissimilarity among these tests as well. Apart from Bai and Ng (2005) and Harris et al. (2005), the rest of the tests are based on the assumption of the ‘existence of unit root’, while the former two tests assume the ‘existence of stationarity’. However, these tests are useful to address both the issues of heterogeneity and cross-sectional dependence.

There is another set of panel unit root tests known as third-generation tests covering all the above issues of heterogeneity, cross-sectional dependence, additionally covering possible structural breaks in the panel. One such test is Bai and Carrion-I-Silvestre (2009), which is suitable for applying structural breaks in panel for various shocks or financial/ economic crises.

The study has tested the presence of stationarity by applying both the first and second-generation unit root tests (Table 3).

Table 3. Panel Unit Root Results (First Generation Tests)

Variables	LLC		IPS		ADF		PP	
	Level	1st Diff.	Level	1st Diff.	Level	1st Diff.	Level	1st Diff.
LNGDP	0.0750***	-4.39087*	1.03721	-3.74413*	3.98230	31.9738*	2.50861	42.8007*
LNGDS	-1.37169***	-3.93755*	1.06155	-3.63934*	3.50652	31.2451*	2.54999	45.8030*
LNTRADE	0.1375	-3.33290*	-0.78357	-4.70666*	11.9860	41.9321*	23.5088*	77.3385*

N.B: One percent, five percent and ten percent level of significance are denoted respectively by*, ** and ***.

The first-generation tests give mixed results (Table 3), as in the case of trade, it is seen to be stationary at level (for PP), whereas other variables are stationary at I (1). The study has also used Pesaran (2007), one of the widely used second-generation unit root tests, and its results are shown in Table 4. It shows that where GDP is stationary at the first difference, the rest of the variables are stationary at levels. So, the variables have mix stationarity.

Table 4. Pesaran (2007) Unit Root Test Results (Second Generation Test)

Variables	Level	1st Difference	Order
LNGDP	-2.193	-2.743*	I(I)
LNGDS	-2.637**	-3.424*	I(0)
LNTRADE	-3.043*	-2.544**	I(0)

Note: 1%, 5 % and 10 % level of significance are denoted respectively by*, ** and ***.

6.3. Panel Co-integration

Having done the tests for unit root and cross-sectional dependence and before moving towards test for panel co-integration, one must apply the test for slope homogeneity. Hence the study applies the Pesaran and Yamagata (2008) test, which is the standardised form of Swamy's test (1970) for slope homogeneity. The null hypothesis is the 'presence of slope homogeneity,' i.e., slope coefficients are homogeneous. The results favour the alternative hypothesis and conclude that there is slope heterogeneity in the model (cf. table A1 in the appendix). This result is significant since it guides to choose the correct estimator in the presence of heterogeneity (Bersvendsen and Ditzen, 2020).

In the panel co-integration test there also exist three groups of tests. The first group of co-integration tests consists of McCoskey and Kao (1998), Pedroni (1999), Kao et al. (1999), Larsson et al. (2001), which considers only the case of long-run convergence. But they fail to include the concept of cross-sectional dependence. For the large and heterogeneous panel Pedroni (1999) gives efficient results whereas, McCoskey and Kao (1998), Kao et al. (1999) are specifically useful for small panel (Tugcu, 2018). Among the second-generation tests, Groen and Kleibergen (2003) and Westerlund (2007) are improved versions compared to their predecessors. These tests not only take care of issues like long-run convergence and heterogeneity but also consider cross-sectional dependence. The difference lies, while Westerlund (2007) deals with single co-integration, multiple co-integration can be seen under Groen and Kleibergen (2003) test. The third-generation tests include Westerlund and Edgerton (2008), Banerjee and Carrion-i-Silvestre (2017). These tests address all the earlier tests' characteristics and in addition take care of structural breaks in panel data.

The study applies both the Pedroni (1999) and Kao et al. (1999) test from the first-generation co-integration tests. Finally, out of the second-generation tests, it has applied Westerlund (2007) to incorporate the cross-sectional dependence.

Table 5. Results of Pedroni (1999) Residual Panel Co-integration Test

Dimensions	Test Statistics	Statistic	p-Value
Within Dimension	Panel v-Statistic	2.277463**	0.0114
	Panel rho-Statistic	0.143799	0.5572
	Panel PP-Statistic	-1.996516**	0.0229
	Panel ADF-Statistic	-4.378724*	0.0000
Between Dimension	Group rho-Statistic	1.367389	0.9142
	Group PP-Statistic	-0.526245	0.2994
	Group ADF-Statistic	-3.272751*	0.0005

N.B: 1%, 5% level of significance are denoted respectively by* and **.

Table 6. Results of Kao et al. (1999) Residual Panel Co-integration Test

	t-Statistic	Probability
ADF	-5.569047*	0.0000

N.B: 1% level of significance are denoted by *.

Table 7. Results of Westerlund (2007) Panel Co-integration Test

Statistic	Constant	
	Value	Z-value
Gt	-6.181*	-11.035
Ga	-50.860*	-18.014
Pt	-8.243*	-4.883
Pa	-33.701*	-14.301

N.B: 1% level of significance are denoted by *.

Pedroni (1999) uses seven different test statistics out of which four are within dimension and the rest three statistics are between dimension. The results from Table 5 show that four of the seven statistics reject the null hypothesis of 'no co-integration' either at the 1 percent or at the 5 percent level. Kao et al. (1999) uses the augmented Dickey-Fuller (ADF) statistic to test the existence of any long-run relationship. The value of the test statistic significantly rejects the null hypothesis of 'no co-integration' at the 1 percent level (Table 6). Finally, the Westerlund (2007) panel co-integration test, which is basically error-correction based and comprises of four different test statistics, has also rejected the null hypothesis of 'no co-integration' and concluded in favour co-integration (Table 7).

6.4. The Hausman Test

Before identifying the proper estimator, selection of the optimal lag structure of the model has been done on the basis of Akaike Information Criteria (AIC) and it suggests the chosen ARDL model to be of the form ARDL (1 1 0). There are various estimators through which one can estimate a dynamic heterogeneous panel model. Two most important estimators out of them are the Mean Group (MG) estimator and the Pooled Mean Group (PMG) estimator suggested by Pesaran and Smith (1995) and Pesaran et al. (1999). One of the main concerns is, in between MG and PMG, which estimation technique is to be chosen. The best way to reply to this is to resort to the Hausman (1978) test proposed by Pesaran et al. (1999), which assumes a null hypothesis that there is no significant difference between PMG and MG. If the null hypothesis is accepted then, one selects the PMG estimation technique and the model is assumed to obey slope homogeneity. Conversely, if the test statistic rejects the null then the MG becomes the efficient estimator. The result of the Hausman test suggests in favour of the MG estimator as the null hypothesis is rejected (Table 8).

Table 8. Results of Hausman Test

	χ^2 -Statistic	Decision
MG vs. PMG	0.0075	MG

6.5. The Panel ARDL

Table 9 presents the short-run and long-run results of the panel ARDL model. For convenience the study has represented results of both the PMG and MG estimates. The error correction term of the model is negative and significant which means the estimated model is stable. The estimates show that both savings and trade are statistically significant in explaining GDP in the long-run. The finding regarding the interrelationship between GDP and GDS is consistent with other studies (Alper, 2018; Patra et al., 2017; Bayar, 2014; Misztal, 2011). Thus, the study contradicts the popular Keynesian economics which advocates that savings is detrimental for economic growth. Rather it supports the Solow model which considers savings as one of the main determinants of economic growth. An increase in domestic savings contributes significantly to an increase in domestic investment, which leads to a rise in the aggregate income and wealth. This means that countries should provide a more conducive environment to increase propensity to save at a higher rate than the propensity to consume. The results from the PMG and MG estimator show that under the ceteris paribus assumption, a 1% increase in gross domestic savings results in more or less equal increase in GDP. So, for the BRICS countries domestic savings has been one of the major propellants of economic growth. The short-run dynamics also predicts a significant and positive impact of domestic savings on the gross domestic product. The implication of finding a positive and significant impact of domestic savings at both short run and long run means the study also supports the endogenous growth theory, as it suggests that the rise in savings rate can have a permanent positive impact on growth (Romer, 1986; Lucas, 1988). Though trade has a negative impact on GDP, its impact is insignificant in the short-run. For a closer look into the interrelationship between GDP and GDS, the study has also reported the country-specific long-run and short-run dynamics for both MG and PMG estimates (Table A2 & Table A3 in appendix).

Table 9. Results of Panel ARDL Estimation (PMG and MG)

		PMG		MG	
		Coef.	P-value	Coef.	P-value
Long Run	LNGDS	1.001	0.000	0.996	0.000
	LNTRADE	-0.329	0.000	-0.462	0.000
Short Run	ECT	-0.408	0.000	-0.446	0.000
	DLNGDS	0.338	0.001	0.316	0.008
	DLNTRADE	-0.104	0.155	-0.072	0.398
	C	1.083	0.000	1.704	0.059

6.6. Panel Causality

One of the main aims of the study is to search for causality between domestic savings and economic growth for the BRICS countries. As our study has found long-run co-integration among variables hence, there is every chance that there exists at least one causal relationship among the variables. Therefore, the study has applied the panel causality test for the possible direction of causality. The existence of any causal relationship has been addressed here in two ways. One of them is the traditional Granger Causality (1969) test having the null hypothesis of non-causality. For an efficient result of this test, the condition is that there should be homogeneous panel and cross-sectional independence. But as stated earlier, for most of the panel data models, heterogeneity and cross-sectional dependence are two prevalent features as can be seen in our case. To internalise these two vital criteria and to have an efficient inference about the direction of causality in their presence, the study has also applied the Dumitrescu and Hurlin (2012) test of causality, one of the most recently developed tests which address both the issues of the heterogeneous panel and cross-sectional dependence. The test is based on the Vector Autoregression (VAR) technique and is applicable even if N and T are small (Lopez and Weber, 2017).

Table 10. Results of Pairwise Granger Causality Tests

Direction of Causality	F-Stat.	Prob.
LNGDS ⟶ LNGDP*	6.67984	0.0018
LNGDP ⟶ LNGDS**	4.21709	0.0170
LNTRADE ⟶ LNGDP	0.21592	0.8061
LNGDP ⟶ LNTRADE	0.92482	0.3994
LNTRADE ⟶ LNGDS	0.33536	0.7157
LNGDS ⟶ LNTRADE	1.02114	0.3633

N.B: 1%, 5% level of significance are denoted respectively by* and **.

Table 11. Results of Dumitrescu-Hurlin Panel Granger Causality Test

Direction of Causality	W-Stat.	Zbar-Stat.	Prob.
LNGDS → LNGDP*	9.25784	6.33206	2.E-10
LNGDP → LNGDS**	4.75206	2.27685	0.0228
LNTRADE → LNGDP	3.74134	1.36721	0.1716
LNGDP → LNTRADE*	9.36168	6.42551	1.E-10
LNTRADE → LNGDS***	4.19969	1.77972	0.0751
LNGDS → LNTRADE*	8.72681	5.85413	5.E-09

N.B.: 1%, 5 % and 10 % level of significance are denoted respectively by*, ** and ***.

A comparison of the results of both the Granger Causality test and the Dumitrescu-Hurlin test of causality shows what can happen if one ignores the existence of cross-sectional dependence and heterogeneity in the panel data model. As the table of Granger causality suggests, there is significant causality only between savings and GDP, while it gives insignificant results in all other causal relationships (Table 10). But while applying the Dumitrescu-Hurlin test, a significant causal relationship can be found from GDP to trade and from GDS to trade as well, which were absent in the case of the Granger test (Table 11). We should not forget that the Dumitrescu-Hurlin test has also shown significant bi-directional causality between GDP and GDS, the same as the Granger test. Hence it can be ascertained that while dealing with a heterogeneous panel with cross-sectional dependence the Dumitrescu-Hurlin test gives a better result than the Granger test.

Meanwhile, the study has also represented the country-specific causal relation and direction of causality among the variables (Table 12). The results show that three out of five countries, namely, India, China and South Africa, have shown a bi-directional causal relationship between gross domestic savings and GDP. This implies that while gross domestic savings is one important factor in achieving long run economic growth, the sustained growth also feeds back gross domestic savings. Hence, for these countries it would be pertinent to reinvest the gross domestic savings so that it propels GDP. Alternatively speaking, high savings implies low consumption which in turn raises capital investment resulting in higher economic growth. Thus, policy makers should provide conducive environment to increase domestic savings and channel those savings in productive investment to contribute to GDP. Mixed findings can be seen regarding the direction of causality in other studies as well (Hashmi and Sedai, 2016; Odhiambo, 2009; Verma, 2007; Agarwal, 2001). For Brazil, the causality shows a unidirectional trend, which runs from savings to economic growth. This is consistent with the finding of Greenidge and Miller (2010). This means steps should be taken to promote domestic savings to finance domestic investment so that higher growth rate can be achieved. Russia is the only country for which no such causal relationship could be seen between these two macroeconomic variables for the said period. The possible reason behind this can be that there may be other factors which control economic growth better for Russia.

Table 12. Results of Country-specific Pairwise Granger Causality Tests

Direction of Causality	Brazil	Russia	India	China	South Africa
LNGDS → LNGDP	3.59874**	1.35217	5.27662*	6.82254*	6.09453*
LNGDP → LNGDS	1.40710	0.50224	3.60165**	3.30766**	3.06151**
LNTRADE → LNGDP	2.16385	0.57793	0.85581	2.62547***	3.13030**
LNGDP → LNTRADE	0.56556	5.61646*	11.9412*	3.20860***	2.07239
LNTRADE → LNGDS	2.79853***	0.41775	0.87211	3.50165**	2.90917***
LNGDS → LNTRADE	0.01911	6.08449*	11.6226*	2.47592	1.61495

N.B.: 1%, 5 % and 10 % level of significance are denoted respectively by*, ** and ***.

7. Conclusion & Policy Recommendations

As per the Keynesian model, income is responsible for savings and not the other way round. This theoretical hypothesis has been rejected by Solow, who propounded that the income of a country is savings-driven. While discussing the saving-investment interrelationship and their direction of causality, various studies have been conducted in line with these two theoretical backgrounds. But as there exist differences in their theoretical backdrop, there are conflicting arguments in empirics as well regarding the functional relationship between domestic savings and economic growth. BRICS being one of the most influential economic groups, to the best of our knowledge no such studies have been conducted to address this issue for BRICS countries involving most recent data. Hence, the study re-examines this relationship and the direction of causality between these two vital macroeconomic variables for BRICS countries to answer one of the key questions if the rapid economic growth of these countries can be explained by their extent of savings. This has been done by the help of a panel ARDL model and causality tests. The results of the panel ARDL model show that both in short-run and long-run gross domestic savings significantly explain economic growth. The existence of causality has been addressed in the study by applying the Granger test and the Dumitrescu-Hurlin test. Both test results hint towards bi-directional causality between savings and economic growth for the BRICS countries. But due to the presence of heterogeneity and cross-sectional dependence in the panel, the Dumitrescu-Hurlin test gives better results than the classical Granger causality test. As in other empirical experiments, the present study has also come up with mixed causality while exploring the country-specific direction of causality between savings and economic growth. Out of five countries, India, China and South Africa experienced bi-directional causality. For Brazil the causality is unidirectional from savings to economic growth, while the study found no causality whatsoever for Russia.

Our findings suggest that for countries like Brazil, India, China and South Africa the task of the policymakers is to formulate a policy-mix of both monetary and fiscal policies (e.g., increasing interest rate, reducing tax rates, introducing attractive saving avenues, etc.) comprising both saving and income-friendly measures so that they can move on a sustained economic growth path. Adopting pro-saving policies for these countries are bound to help them not only to converge towards the growth path of some of the advanced countries in the world, but also will make them prepared to face any forthcoming financial crisis. An argument for country like Russia would be that there are different sets of attributes or structural parameters other than domestic savings that are responsible for their economic growth.

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Appendix

Table A1. Pesaran & Yamagata (2008) Test for Slope Heterogeneity

Test Statistic	Test Value	p-value
Delta	3.855	0.000
Adj. Delta	4.177	0.000

Table A2. Country-specific Results of Panel ARDL (MG)

			Coef.	P-value
Brazil	Long Run	LNGDS	1.016	0.000
		LNTRADE	-0.408	0.166
	Short Run	ECT	-0.275	0.009
		DLNGDS	0.380	0.004
		DLNTRADE	-0.378	0.017
		C	0.741	0.242
Russia	Long Run	LNGDS	0.931	0.000
		LNTRADE	-0.762	0.000
	Short Run	ECT	-0.873	0.000
		DLNGDS	-0.079	0.558
		DLNTRADE	0.145	0.281
		C	5.286	0.000
India	Long Run	LNGDS	1.034	0.000
		LNTRADE	-0.387	0.000
	Short Run	ECT	-0.322	0.000
		DLNGDS	0.366	0.000
		DLNTRADE	-0.056	0.277
		C	0.586	0.084
China	Long Run	LNGDS	0.962	0.000
		LNTRADE	-0.375	0.061
	Short Run	ECT	-0.197	0.022
		DLNGDS	0.654	0.000
		DLNTRADE	-0.045	0.425
		C	0.667	0.011

			Coef.	P-value
South Africa	Long Run	LNGDS	1.040	0.000
		LNTRADE	-0.380	0.025
	Short Run	ECT	-0.562	0.003
		DLNGDS	0.259	0.218
		DLNTRADE	-0.024	0.794
		C	1.240	0.106

Table A3. Country-specific Results of Panel ARDL (PMG)

			Coef.	P-value
Long Run		LNGDS	1.001	0.000
		LNTRADE	-0.329	0.000
Short Run	Brazil	ECT	-0.282	0.002
		DLNGDS	0.370	0.001
		DLNTRADE	-0.389	0.004
		C	0.800	0.002
	Russia	ECT	-0.685	0.000
		DLNGDS	0.049	0.739
		DLNTRADE	0.252	0.864
		C	1.710	0.000
	India	ECT	-0.338	0.000
		DLNGDS	0.351	0.000
		DLNTRADE	-0.754	0.072
		C	0.835	0.000
	China	ECT	-0.139	0.022
		DLNGDS	0.693	0.000
		DLNTRADE	-0.045	0.405
		C	0.303	0.026
	South Africa	ECT	-0.597	0.000
		DLNGDS	0.229	0.151
		DLNTRADE	-0.035	0.662
		C	1.764	0.000