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BRICS: The 2008 financial crisis and economic performance

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Abstract

The 2008 global financial crisis (GFC) resulted in a deterioration of the economic condition in developing countries with lower growth of per capita GDP, a decline in the share of exports of goods and services in GDP, and a worsening of the external balance. After a limited initial impact, growth rates declined in all the economies and were substantially lower in all the BRICS countries in the period 2015–2019 than before the crisis. Two of them, Brazil and South Africa, experienced a drop in per capita GDP during 2015–1019. Export performance suffered and the external balance worsened for all BRICS countries. The BRICS share of world GDP increased mainly because of the rapid growth in China and to a lesser extent in India. The relative size of per capita GDP in Brazil, Russia and South Africa decreased between 2001–2007 and 2015–2019. Furthermore, the average per capita GDP in Brazil and South Africa decreased compared to that of the world. BRICS, however, fared better in trade. Both their share of world trade and the share of trade in their GDP increased. The BRICS countries have strong trade links with other developing countries and have become more stable after the GFC, thereby contributing to the performance of the global economy. There are strong growth linkages among the member countries. Trade relations are dominated by China. BRICS, however, failed to comply with G20 commitment made at the 2014 Brisbane summit to raise the rate of growth by 2% by 2018. The authors undertook a time series analysis to investigate the relationship between growth of per capita income, the share of gross fixed investment in GDP, the share of exports of goods and services in GDP, and the share of external balance in GDP. We found out that usually, but not for all BRICS countries, capital formation had a positive effect on growth, while the external deficit had a negative effect.

Keywords
BRICS, financial crisis, economic performance.

JEL: F43, F44, F47, F55.

Introduction

The BRICS countries are significant members of the world economy with four of them among the ten largest economies. BRICS countries account for 41% of the world's population and 23% of global GDP (Kumar, 2018). They were expected to play an increasingly important role in the world economy.[1] However, the original analysis that the importance of the BRICS countries in the world economy would increase was flawed. Expert analysis (Agarwal, 2008) showed that the rise in the share of BRICS in world GDP was mainly due to the rise of China and partly India. Each of the other three countries will continue to account for about one percent of the world economy. In this paper, we examine how the 2008 global financial crisis (GFC) affected the economic performance of the BRICS countries. In particular, we undertake a time series analysis to understand the growth process in the BRICS countries and whether it varies among them. The time series analysis seeks to find the relationship between growth of per capita GDP, the share of gross fixed capital formation in GDP(GFCF), a domestic factor, the share of exports of goods and services in GDP (XGS) and the share of external balance in GDP, the latter two being external factors. In section 1, we provide a survey of the role of external factors in growth. In section 2, we study how the GFC affected the performance of the world economy and, within this context, how it affected the BRICS economies. In section 3, we examine whether the BRICS countries have become more important to each other, namely, whether there is an economic logic for this group. We also examine whether their importance in the world economy has increased because one of the major objectives of BRICS – to influence international economic governance – can only be achieved if they become more important in the world economy. We do this by analyzing their share in world GDP and world trade. We also analyze whether per capita GDP has grown faster in the BRICS countries than in the world as a whole. As part of the analysis of their influence, in Section 4, we study whether the BRICS countries have achieved the goals enunciated at various G20 summits. In particular, whether they have achieved strong and sustained balanced growth, the goal proclaimed at the Philadelphia summit in 2009, and whether they have raised their growth by 2%, as proclaimed at the Brisbane summit in 2014. In section 5, we undertake a time series analysis to understand growth processes in the BRICS countries. Section 6 contains some concluding observations.

[1] The term BRIC was originally used in a report by Jim O'Neill of Goldman Sachs "Building better economic BRICs." Beginning with meetings in 2006 among the foreign ministers of the 4 BRIC countries on the sidelines of the UN General Assembly, it was formally established in 2009. South Africa officially became a member in December 2010.

1. Trade and development

The role of trade in economic development has been a controversial issue, with the dominant view changing over time. In the fifties and sixties, when many developing countries became independent and their governments sought to accelerate growth in order to improve the living conditions of their people, the general opinion of development economists was that these countries should adopt a strategy of import-substituting industrialization (ISI). Accelerating growth required increasing investment and more imports of capital goods as developing countries had limited capacity to produce them. The question was how to pay for imported capital goods. Rosenstein-Rodan (1943) argued for greater aid to finance such imports. Prebisch (1950) argued that developing countries exported mainly agricultural goods and earnings from such exports could not be readily increased because of declining terms of trade (TT).[2] Nurkse (1953) believed that a major constraint to raising the rate of growth was the lack of demand, which reduced the incentive to invest. Banning or limiting exports would generate demand for and investment in import competing industries (Nurkse, 1959). Neo-classical economists argued that since rates of return were higher in developing countries, opening the capital account would lead to capital flows to developing countries. But Myrdal (1956) argued that since markets in the advanced countries were more developed, capital would flow from developing countries. This has been happening over the last few decades as developing countries have been accumulating reserves, namely, lending to developed countries.

Experience has shown that growth has stalled after an initial spurt and balance of payments problems have re-emerged. Prebisch (1959) argued that goods from developing countries could not compete in international markets as their small markets prevented them from exploiting economies of scale. He, therefore, recommended formation of free trade areas.[3]

Now the consensus has shifted to the assertion that protection worsened performance and that countries should adopt freer trade policies. Scitovsky, Little and Scott (1970) and Bhagwati (1977) found that countries with more open policies grew faster and that countries' rates of growth picked up during liberalization episodes. Economies of developing countries were liberalized considerably in the 1980s and 1990s but economic growth did not pick up.[4]

One of the methods of estimating the effect of trade was to regress the rate of growth on trade performance, in which different variables were used to measure trade performance.[5] It was soon recognized that export performance could be affected by many factors not related to trade policy so what was needed was to regress growth on trade policy variables. A commonly used approach (for instance, Dollar (1992),

[2] After adjusting various shortcomings of his analysis, Prebisch (1959) found that his hypothesis was confirmed and terms of trade for agriculture declined by about 0.6% a year between 1870 and 1939. Serrano and Pinilla (2011) found that TOT declined between 1951 and 2000. For more recent data on declining TOT, see Lele et al. (2021).

Edwards (1998), and Sachs and Warner (1995)) was to form a composite index of openness by combining a number of indicators. As Rodriguez and Rodrik (2001) show, when they disaggregate the composite index, they find that trade policy variables are not significant.[6] Instead, variables such as the black-market premium on the exchange rate or subjective variables of trade policy are significant. The black market premium is more an indicator of macroeconomic or political instability, rather than trade policy. The effect of trade policy remains an open question, both theoretically and empirically (Rodriguez & Rodrik, 2001; Bhagwati & Srinivasan, 1978).

Empirical analyses of the relationship between GDP and trade openness for the BRICS countries show a variety of results. Srinivasan (2016) found evidence of bidirectional causality between exports and GDP in the long-run for all BRICS countries except China, where causality surprisingly runs from GDP to exports. Rani and Kumar (2018) found a similar result using dynamic panel OLS. They also found evidence of trade led growth via investment in India. However, Srinivasan (2016) did not find short-run causality for Brazil and Russia, bidirectional causality for India and unidirectional causality from GDP to exports and from exports to GDP for China. Burange et al. (2019) found evidence for growth led trade in services for India. Sat (2019) found export led growth in Russia, whereas Bakari et al. (2019) found the usual multiplier results, negative for imports and positive for exports. For India, the results are inconclusive again. Paul and Das (2012), Venkatraja (2015), and Biswas and Saha (2014) find export led growth, while Mishra (2011) finds no such evidence and Marjit and Santra (2016) find imports, particularly service imports, important.

Given the variety of results, we undertake a re-examination of the relationship between exports, imports and GDP growth for the BRICS countries.

2. Economic performance of BRICS and other developing countries

2.1. Economic performance in developing countries by region

The 2008 GFC had a long-term negative impact on performance in developing countries. Growth of per capita GDP was negative in the period 2015–2019 in Latin America and the Caribbean (LAC) and Sub-Saharan Africa (SSA) regions (Table 1).[3]

Growth of per capita GDP in Europe and Central Asia (ECA) was only one fourth of what it was before the crisis. The effect on Asia was much smaller. Growth in East Asia and the Pacific (EAP) fell by a third, whereas it actually increased in South Asia (SA) (see Table 1). The external balance deteriorated in all regions (Table 2), deteriorating by about 2% of GDP, except in SSA and the Middle East and North Africa (MNA) where it deteriorated much more – by 4 percent and 8 percent of GDP, respectively.

[3] These countries could not adjust their policies to counter the effects of the GFC.

Table 1. Average annual growth of per capita GDP

Region	2001-2007	2008-2010	2011-2014	2015-2019	2015-2019 as ratio of 2001-2007
EAP	8.4	7.9	6.7	5.7	0.68
ECA	6.5	0.8	3.4	1.6	0.25
LAC	2.1	1.5	1.6	-0.2*	
MNA	2.8	2.0	-0.4	0.4	0.15
SA	4.7	4.5	4.5	5.2	1.1
SSA	3.0	1.9	1.8	-0.2*	

Note: * a negative growth rate is a sufficient indicator of deteriorating performance. EAP is East Asia and Pacific, ECA is Europe and Central Asia, LAC is Latin America and the Caribbean, MNA is Middle East and North Africa, SA is South Asia, and SSA is Sub-Saharan Africa. Regions and income categories are indicated in accordance with the definition of the World Bank, World Development Indicators, World Bank.

Source: calculated by the authors based on data from the World Bank World Development Indicators, World Bank, Washington, DC.

Exports of goods and services (XGS) as a percentage of GDP fell in all regions and were lower in the period 2015–2019 compared to 2001–2007, except in LAC and SA (Appendix, Table A1). However, gross fixed capital formation (GFCF) was by and large maintained (Appendix, Table A2); it actually increased in EAP and ECA. Maintaining GFCF while growth of GDP is declining implies either that the structure of the economy is changing in the sense that more funds are invested in sectors with a higher capital output ratio or there is considerable excess capacity waiting to come into production

Table 2. External balance (% of GDP)

Region	2001-2007	2008-2010	2011-2014	2015-2019	Difference between 2015-2019 and 2001-2007
EAP	4.5	4.8	2.2	1.8	-2.8
ECA	4.9	3.1	2.0	2.9	-2.0
LAC	1.5	-0.4	-1.6	-1.3	-2.7
MNA	3.1	1.6	-1.1	-5.8	-8.9
SA	-2.5	-5.7	-5.4	-3.9	-1.4
SSA	1.1	0.0	-0.4	-2.9	-4.0

Source: calculated by the authors based on data from the World Bank World Development Indicators, World Bank, Washington, DC.

when conditions improve.[4] The capital intensive sector that has attracted investment is infrastructure, particularly large-scale projects.[5]

[4] We do not find any substantial shifts in the share of major sectors, such as agriculture or manufacturing, in GDP.

[5] Apart from infrastructure, investments are sought to be directed towards housing as this is expected to lead to higher employment. However, investments in construction rather than machinery and equipment can slow down production and growth (Agarwal et al., 2015).

In brief, the GFC resulted in a deterioration of the economic condition of developing countries with lower growth of per capita GDP, a decline in the share of XGS in GDP, and a worsening of external balance.

2.2. Economic performance of BRICS

Economic performance of the BRICS countries mirrors that of developing countries. The rate of growth of per capita GDP in 2015–2019 was negative for Brazil and South Africa and almost zero for Russia, but declined only marginally in China and India (Table 3).

Table 3. Annual average growth of per capita GDP in BRICS (%)

	2001-2007	2008-2010	2011-2014	2015-2019
Brazil	2.3	3.2	1.4	-1.2
China	10.2	9.4	7.6	6.2
India	5.2	5.0	4.8	5.6
Russia	7.2	4.2	2.1	0.9
South Africa	3.0	1.9	0.9	-0.6

Source: calculated by the authors based on data from the World Bank World Development Indicators, World Bank, Washington, DC.[6]

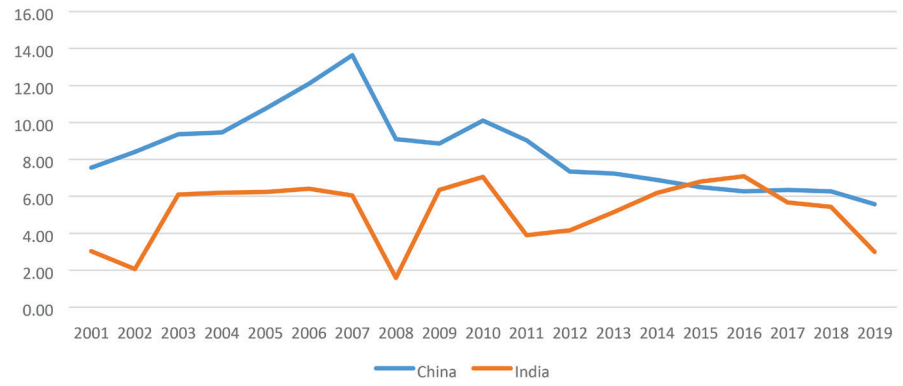

Figure 1. Annual growth rates of per capita GDP, 2001–2019. *Source:* calculated by the authors based on data from the World Bank World Development Indicators, World Bank, Washington, DC.

The relatively good growth performance of China and India is deceptive as the analysis of annual growth rates shows a considerable decline in growth rates in these two countries (Figure 1). Growth rates have been declining in China since 2007 and in India since 2016. This poor performance of the BRICS countries has not met expectations

[6] See Agarwal and Brahmo (2020a), and Agarwal and Brahmo (2020b).

that high growth in BRICS would help maintain economic activity in the world economy. The poor growth performance can be related to the deterioration in the

Table 4. External balance of BRICS (% of GDP)

	2001-2007	2008-2010	2011-2014	2015-2019
Brazil	1.2	-0.5	-1.8	0
China	4.4	5.2	2.4	1.8
India	-2.1	-5.0	-4.8	-2.7
Russia	11.9	8.2	6.6	7.2
South Africa	1.0	0	-1.1	0.3

Source: calculated by the authors based on data from the World Bank World Development Indicators, World Bank, Washington, DC.

external balance (EB). The EB in the last period 2015–2019 was worse compared to the first period of 2001–2007 for all the BRICS countries (Table 4).[7]

The BRICS countries have, however, maintained high levels of investment (Appendix, Table A3). The G20 at the London summit in 2009 recommended higher public expenditure and easy money to counter the recessionary effects of the financial crisis. Such expansionary monetary and fiscal policies in BRICS resulted in high levels of government investment,[8] as well as private investments due to lower interest rates. But such policies would also result in higher deficits in the EB, which is what we observe in BRICS.[9]

Despite the poor overall export performance (Appendix, Table A4), BRICS fared well in exports of information and computer technology (ICT) goods and services (Appendix, Tables A5, A6). BRICS's good performance in exporting ICT goods and services augurs well for the future as trade in such services is growing more rapidly than trade in goods. But such exports were too small and the correlation between exports of ICT and growth of GDP was not significant.[10] By and large, trade links of the BRICS economies with the world economy have weakened.

3. Economic relations among BRICS

There is a strong correlation between rates of growth in the BRICS countries. The correlation for most countries is significant at the 99% level of significance, with

[7] Deterioration of the EB usually leads to lower growth.

[8] The budget of President Obama in the US stressed the importance of shovel-ready projects that could be implemented quickly.

[9] For instance, see Kenen (2000).

[10] This is in contrast to the result of Marjit and Santra (2016) referred to in the literature survey

the exception of India, whose growth does not correlate with growth in any of the other BRICS countries (Table 5).

Table 5. Correlation of growth rates in BRICS

	China	India	Russia	South Africa
Brazil	0.64	-0.18.	0.63	0 .65
China		0.19	0.59	0.77
India			-0.19	-0.04
Russia				0.88

Source: calculated by the authors.

Table 6. Intra-BRICS exports and the share of their world exports

	Brazil		China		India		Russia		South Africa		BRICS Total	
	USD, billion	Share (%)	USD, billion	Share (%)	USD, billion	Share (%)	USD, billion	Share (%)	USD billion	Share (%)	USD billion	Share (%)
2001	3.7	6.4	7	2.6	2.3	5.3	6.9	6.9	1.1	4.4	21.1	4.3
2008	24.0	12.3	92.1	6,4	16.9	9.3	28.5	6.1	7.5	10.1	169.0	7.2
2014	50.4	22.8	158.5	6.8	28,5	9.0	44.4	8.9	13.5	14.7	295.4	8.5
2019	68.9	31.2	176.4	7.1	28.2	8.7	67.4	15.8	14.4	16.5	355.3	10.0

Source: calculated by the authors based on data from the World Bank World Development Indicators, World Bank, Washington, DC.

The share of intra-BRICS exports in their total exports increased from 4.3% in 2000 to 7.2% in 2008 and slightly more slowly to 10.0% in 2019 (Table 6). The country that is most dependent on exports to BRICS is Brazil, with 31.2% of its exports going to BRICS, which is almost quintupling between 2001 and 2019. The slowest was the growth of Indian exports, which increased by only 60%, the lowest among BRICS. China is the most important partner, whether as a recipient of other countries' exports or as a supplier of exports to them. While the growth of connections among BRICS is usually strong, trade relations are very asymmetric.

4. Importance of BRICS in the world economy

4.1. The share of BRICS countries in world GDP

BRICS were expected to play an increasingly important role in the world economy as their share of both world GDP and trade was increasing. In the immediate aftermath of the crisis of 2008–2010, the share of each of the BRICS countries in world GDP increased leading some analysts to expectations that BRICS might lift the world

economy out of the recession that accompanied the crisis (Table 7). But such hopes could not be fulfilled.

Table 7. Relative size of GDP in the BRICS countries (% of world GDP)

	2001-2007	2008-2010	2011-2014	2015-2019
Brazil	3.1	3.3	3.3	2.9
China	5.8	8.6	10.6	12.6
India	2.0	2.4	2.7	3.3
Russia	2.2	2.4	2.3	2.1
S. Africa	0.6	0.6	0.6	0.5
Total	13.6	17.1	19.5	21.4

Source: calculated by the authors based on data from the World Bank World Development Indicators, World Bank, Washington, DC.

Even though over the longer term, namely between 2001–2007 and 2015–2019, their share of world GDP increased by almost 60% (Table 7), most of this increase was due to rapid growth in China and, to a lesser extent, in India. The relative size of GDP in Brazil, Russia and South Africa decreased between 2001–2007 and 2015–2019 (Table 7). Furthermore, the average income of residents of two of these countries, Brazil and South Africa, decreased relative to the average per capita GDP of the world, being almost 20% lower in relation to world per capita GDP in 2015–2019 compared to the period 2001–2007.

4.2. Importance of BRICS in world trade

The BRICS countries, however, fared better in trade. Their share of world trade has increased and the share of trade in their GDP has also increased. BRICS substantially increased their share of world exports of goods and services in the periods 2001–2007 and 2015–2019; China's and India's share of world exports almost doubled (Appendix, Table A7). Brazil also increased its share of world trade in goods and services. The share of South Africa remained almost unchanged. The share of Russia, after an increase, substantially fell in the last period of 2015–2019, so that in the last period it was the same as in the initial period. (Appendix, Table A7).

The share of BRICS countries in world merchandise trade increased by almost 70%, more than their share of exports of goods and services (Appendix, Table A8). China more than doubled its share and it outperformed other BRICS countries. While India also increased its share substantially, the shares of Russia and South Africa remain almost unchanged. The share of BRICS countries in world service exports also increased (Appendix, Table A9), though the increase was less than for merchandise exports. While India had the largest share of world exports of services, China increased its share the most. Furthermore, the share of South Africa declined.

However, the share of exports of goods and services in GDP behaved differently for some of the BRICS countries than for the world in general. The share increased for the world, despite a dip in the period 2015–2019 (Appendix, Table A10). But among the BRICS countries, it increased only for India and South Africa, while for the other three countries, particularly China, it decreased.[11] In other words, only India and South Africa are becoming more export-oriented.

In the initial period of 2001–2007, the share of merchandise exports in GDP was higher for China, Russia, and South Africa than for the world (Appendix, Table A15). But this share decreased for the BRICS countries, with the exception of India and South Africa. By 2015–2019, only South Africa had a higher share of exports than the world on average. The share of service exports in GDP increased for the world and is much higher for the world than for the BRICS countries. The share of service exports in GDP increased for Brazil and India but remained unchanged for Russia and South Africa, and actually decreased for China.

4.3. Trade between BRICS and other developing countries

One of the objectives of BRICS is to foster South-South economic cooperation in addition to expanding economic cooperation among themselves.[12] A major feature of the exports of developing countries is the growing share of developing countries in world trade and the increasing importance of South-South trade (Agarwal, 2013). The BRICS's share in the total trade of the South increased from 28% in 2000 to 44% in 2017; the total trade of BRICS with South grew at a compounded annual growth rate of about 11% during 2000–2017 (Kumar, 2018).

Four of the BRICS countries send more of their exports to developing countries than the average for all G20 developing country members, and three of them send more of their exports to developing countries than the average for all developing countries (Appendix, Table A10).[13]

5. Have the BRICS countries achieved the G20 goals?

Here we analyze whether the BRICS economies have achieved the goals enunciated at various G20 summits. The Philadelphia summit of 2009 declared the goal

[11] For a discussion whether China was moving away from its investment and export dependent growth model, see Agarwal (2021).

[12] Partly for this purpose, the BRICS countries established the New Development Bank, open to membership of all countries, to provide development loans to developing countries. They also established the Contingent Reserve Arrangement to provide loans to countries with balance of payments deficits.

[13] For further details, see Agarwal, (2013), South-South Economic Cooperation: Emerging Trends and Challenges, Background Research Paper submitted to the High-Level Panel on the post-2015 Development Agenda, May 2013, UN, New York.

to achieve strong, stable and balanced global growth (SSBGG). The Brisbane summit of 2014 declared that G20 countries would raise growth of GDP by 2%. We measured the economic volatility of the BRICS member countries by calculating the standard deviation of their annual growth of per capita GDP from 2001 to 2007 and separately from 2011 to 2019 to examine whether economies have become more stable. The picture here is mixed; the standard deviation increased for Brazil and Russia and decreased substantially for China, while remaining almost constant for India and South Africa (Appendix, Table A11). The external sector deteriorated, with percentage of both XGS in GDP and EB in GDP worsening and both showing less volatility (Appendix, Tables A12, A13). This implies that a lower share of exports and a higher EB deficit may be long lasting. GFCF as a percentage of GDP was less volatile so this share is likely to remain high (Appendix, Table A14). This would make the task of macro management more difficult, as higher investment and lower growth, with its attendant lower domestic savings, would imply a continuing large external deficit. The BRICS countries, all members of the G20, were not able to increase the growth of their GDP by 2018 by two percent, as required by the Brisbane summit declaration.[14]

6. The growth process: Time series analysis

6.1. Research methodology and data

Annual data on macroeconomic variables are obtained from World Bank indicators for the sample period from 1992 to 2019. We investigate the relationship between growth of per capita GDP, the share of GFCF in GDP, and the share of external balance in GDP. In Model 1, we estimate the causal relationship between the variables of GDP per capita, external balance, and GFCF for each of the BRICS countries for the period from 1992 to 2019. Further, we also analyze this relationship by considering exports and imports separately in Model 2. These two models are specified as follows:

$$\text{Model 1: } PCI_{t-1} = \alpha_0 + \alpha_1 GFCF_{t-m} + \alpha_1 EB_{t-m} + \lambda_1 ECT_{t-1} + \varepsilon_t \quad (1),$$

$$\text{Model 2: } PCI_{t-1} = \beta_0 + \beta_1 GFCF_{t-m} + \beta_1 X_{t-m} + \beta_1 M_{t-m} + \lambda_2 ECT_{t-1} + \mu_t \quad (2),$$

where PCI – log of per capita GDP, GFCF – log of gross fixed capital formation, EB – log of (Imports/Exports), i.e. EB > 1 for current account deficit and EB < 1 for current account surplus, X – log of exports of goods and services, M = log of imports of goods and services, ECT = error correction term ε_t, μ_t = the stochastic error term

[14] Our data shows that growth of per capita GDP increased by less than 2%. Since growth of GDP would increase by less than the growth of per capita GDP unless the growth of population increased, which did not happen, we can infer that the Brisbane target was not met.

and α_0, β_0 = constant or intercept term (t-m) = (year t – lag order), where m is the order of lag length.

6.2. Unit root test

All variables must be stationary to avoid the problem of spurious regression. The Augmented Dickey Fuller (ADF) reveals that all the variables are non-stationary at levels and stationary after taking the first difference (Tables A16 and A17).

Since the variables are non-stationary at levels and stationary at the first differences, the variables can be co-integrated. The Johansen test of cointegration suggests the existence of cointegrating equations in both Model 1 and Model 2 for all BRICS countries (Appendix, Table A18). The lag length for cointegration test is selected using standard criteria (Appendix, Table A19).

Therefore, we use the Vector Error Correction Model (VECM) to estimate the short-run and long-run relationship between the variables, as defined above in equations (1) and (2).

6.3. Vector error correction model (VECM)

Short-run model looks like:

$$\text{Model 1: } \Delta PCI_{t-1} = \alpha_0 + \alpha_1 \Delta GFCF_{t-m} + \alpha_1 \Delta EB_{t-m} + \lambda_1 ECT_{t-1} + \varepsilon_t \quad (3),$$

$$\text{Model 2: } \Delta PCI_{t-1} = \beta_0 + \beta_1 \Delta GFCF_{t-m} + \beta_1 \Delta X_{t-m} + \beta_1 \Delta M_{t-m} + \lambda_2 ECT_{t-1} + \mu_t \quad (4).$$

The cointegrating equations (long-run model) when PCI is normalized to unity looks like:

$$\text{Model 1: } ECT_{t-1} = PCI_{t-1} - \varphi_1 GFCF_{t-1} - \varphi_2 EB_{t-1} + \varphi_0 \quad (5),$$

$$\text{Model 2: } ECT_{t-1} = PCI_{t-1} - \gamma_1 GFCF_{t-1} - \gamma_2 X_{t-1} - \gamma_3 M_{t-1} + \gamma_0 \quad (6),$$

where α_0, β_0, φ_0, γ_0 = constant or intercept term.

The VEC residual autocorrelation test confirms that there is no autocorrelation, i.e. the errors are not serially correlated (Table A21). The Jarque-Bera test of normality confirms that the errors are normally distributed (Table A22).

6.4. Granger causality (short-run dynamics)

The results of the short-run regression are presented in Appendix (Table A19). As far as the Granger causality test for short-run causality is concerned, we cannot reject the null hypothesis that there is no causal relationship between per capita GDP (PCI) and other variables in the short run-in Model 1 (Appendix, Tables A23). In Model 2, we find a significant short-run causality between per capita GDP and other variables for some BRICS countries (Appendix, Table A24).

Now we summarize the short-run causality (Table 8). China is a case of traditional growth dynamics; investment leads to growth. Neither domestic savings nor the external balance is constraints. Russia demonstrates an internal demand constraint, as investments lead to an increase in exports. South Africa demonstrates a bi-direction relationship between GFCF and growth of per capita income, a typical multiplier accelerator relation; investment-led and growth-led imports, which supports the conclusion on growth-led trade made by Rani and Kumar (2019). India shows a dominant external constraint; increased imports lead to growth, substantiating the conclusion of Maitra (2020). In India, imports positively affect exports, which is indicative of the share of import content in exports, as the exports and production of the industrial sector in India are heavily dependent on imports of petroleum, capital goods and other essential inputs (Maitra, 2020). Brazil has basically performed poorly since the 1982 debt crisis, despite different policy regimes, and this is reflected in the fact that there is no causality leading to growth, substantiating the result of Srinivasan (2016) and contrasting the results of Bakari et al. (2019).

Table 8. Summary of short-run causality

	Short-run causality	Direction of short-run causality
Brazil		
China	ΔGFCF --> ΔPCI	+
India	ΔM --> ΔPCI	+
	ΔM --> ΔX	+
Russia	ΔGFCF --> ΔX	+
South Africa	ΔGFCF <--> ΔPCI	+
	ΔPCI --> ΔM	+
	ΔGFCF --> ΔM	+

6.5. Cointegrating equations (long-run dynamics)

Since the coefficient of the error correction term is negative and significant for Brazil, India and China (Models 1 and 2), this indicates that there is a convergence towards the long-run dynamics compared to short-run. Thus, long-run relationship exists between per capita GDP and other variables in these countries. However, there are no long-run relationships in Russia and South Africa.[15] The cointegration equations for countries where long-run relationships between GDP and other macro variables exist are presented in Appendix (Tables A25 and A26) and a summary of the results is shown in Table 9.

[15] In Russia, the lack of a long-run relationship can be due to the high and rising dependence of the Russian economy on oil prices and negative oil price shocks (Beck et al., 2007).

Table 9. Summary of long-run relationships

	Brazil	China	India
Model 1	GFCF <--> PCI (+,+)	GFCF --> PCI (+)	GFCF --> PCI (+)
	EB --> PCI (-)	PCI --> EB (-)	
	EB --> GFCF (+)	GFCF --> EB (+)	
Model 2	GFCF <--> PCI (+,+)	GFCF --> PCI (+)	GFCF --> PCI (+)
	X <--> PCI (+,+)	X --> PCI (+)	X <--> PCI (+)
	M --> PCI (-)	M <--> PCI (-,-)	M --> PCI (-)
	X <--> GFCF (-,-)		GFCF --> X (-)
	M --> GFCF (+)	GFCF --> M (+)	
	M --> X (+)	X --> M (+)	M --> X (+)

Note: *The relationships in the above table are significant as per the Wald test.

In the long run, Brazil, China and India show a classical relationship between GFCF and growth. In addition, in Brazil, we find that the external balance adversely affects GDP but positively affects GFCF, as the government seeks to re-ignite growth when the external balance is favorable. While exports have a positive effect on per capita GDP as the external constraint is relaxed, imports have a negative effect on per capita GDP in Brazil; this supports the findings of Bakari et al. (2019). In China, investment has a positive effect both on growth and the external balance, reflecting its export-oriented development strategy. In India, investment has a positive effect on GDP. Exports have a positive effect on per capita GDP, but imports have a negative effect on per capita GDP, reflecting that for almost the entire period, the country has run an external deficit and has a long history of external crises in 1967, 1966–1968, 1973, 1981 and 1991. The negative impact of import on per capita GDP in the long run in India contradicts the findings of Maitra (2020) and Marjit and Santra (2016). Imports positively affect exports, which is indicative of the import content in exports and the dependence of Indian exports on imported inputs not only in the short run but also in the long run (Maitra, 2020).

To summarize, we find that GFCF has a positive effect on per capita GDP in Brazil, India and China in the long run. In all three countries, exports have a positive effect on per capita GDP but imports have a negative effect, a typical import multiplier effect. Per capita GDP, in turn, has a positive and significant effect on exports in Brazil. The external balance adversely affects GDP and positively affects GFCF in Brazil, while it has little effect on either GDP or GFCF in China and India. Imports trigger exports in Brazil and India, whereas in China, exports trigger imports. GFCF has a negative effect on exports in Brazil and India. Domestic output does not respond rapidly to GFCF demand, and output is diverted to meet investment demand. GFCF crowds out exports.

Conclusion

The GFC has had a deep and lasting effect on growth in the BRICS countries. In two of them, Brazil and South Africa, growth turned negative. Russia experienced a steadily declining growth rate, now approaching almost zero. Both China and India, after seemingly successfully weathering the crisis, faced a slowdown in growth. The growth experience of the BRICS countries means that only China and India increased their share of world GDP, in contrast to the original prediction in the Goldman Sachs study. The share of exports in GDP and their share in world exports tend to decrease. They are, however, a positive force for South-South trade as four BRICS countries export more to developing countries than the average G20 developing country and three BRICS countries – more than the average developing country. The volatility of GDP growth and GFCF ratio decreased for most of the BRICS countries; but this suggests that they are stuck at a low level on both these important indicators. Also, BRICS failed to achieve the goal of raising growth rate by 2% set at the Brisbane G20 summit.

In the VECM regression, we found that a long-run relationship existed between per capita GDP and other variables in Brazil, India and China. In Russia and South Africa, there is no long-run relationships. In the long run, the external balance has a negative effect on the growth of per capita GDP in Brazil, but the effect is insignificant for China and India. GFCF has a positive impact on per capita GDP in Brazil, India and China, as one would expect from traditional growth models. While this effect is unidirectional in China and India, it is bidirectional in Brazil. In all three countries (Brazil, China and India), exports have a positive effect, exports are growth inducing, as most analysts currently believe, and imports have a negative effect on GDP per capita in the long run. In Brazil and India, there is bidirectional causality between per capita GDP and exports (positive). In China, there is a bidirectional causality between per capita GDP and imports (negative). Imports trigger exports in Brazil and India, whereas in China, exports trigger imports. Based on Granger causality test, we fail to reject the null hypothesis that there is no causal relationship between variables in the short run in Brazil. In China, GFCF causes per capita GDP in the short run. In India, imports cause per capita GDP and exports in the short run. In Russia, GFCF causes exports, but does not cause per capita GDP in the short run. In South Africa, there is bidirectional causality between per capita GDP and GFCF, and both per capita GDP and GFCF cause imports in the short run. Some political implications of this research are to encourage an increase in domestic investment, which is found to be a key determinant of growth, to implement export-promotion strategies to control the current account deficit, as well as to enhance growth and stimulate imports of foreign inputs and capital goods, which, in turn, can boost exports and economic growth.

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Appendix

Table A1. Exports of goods and services by developing country regions (% of GDP)

	2001-2007	2008-2010	2011-2014	2015-2019	2015-2019 as ratio of 2001-2007
EAP	34.6	32.3	29.5	24.8	0.72
ECA	33.9	30.8	30.3	31.4	0.92
LAC	20.7	19.5	19.8	20.8	1.01
MNA	35.3	33.9	31.2	27.8	0.79
SA	17.2	21.0	22.8	18.1	1.05
SSA	30.2	31.3	30.0	24.1	0.80

Source: calculated by the authors based on data from the World Bank World Development Indicators, World Bank, Washington, DC.

Table A2. Gross fixed capital formation (% of GDP)

	2001-2007	2008-2010	2011-2014	2015-2019	2015-2019 as ratio of 2001-2007
EAP	34.3	38.7	40.5	39.1	1.14
ECA	21.3	23.4	23.5	23.2	1.09
LAC	18.5	20.4	20.5	18.0	0.97
MNA	23.5	26.9	24.9	22.9	0.98
SA	29.2	31.4	30.0	27.0	0.92
SSA	21.1	22.1	21.0	21.0	1.0

Source: calculated by the authors based on data from the World Bank World Development Indicators, World Bank, Washington, DC.

Table A3. Gross fixed capital formation of BRICS (% of GDP)

	2001-2007	2008-2010	2011-2014	2015-2019
Brazil	17.5	19.7	26.3	15.7
China	37.5	42.3	37.5	42.2
India	31.4	34	31.5	28.6
Russia	18.7	22.0	21.0	21.2
South Africa	17.1	21.4	21.9	18.9

Source: calculated by the authors based on data from the World Bank World Development Indicators, World Bank, Washington, DC.

Table A4. Exports of goods and services by BRICS (% of GDP)

	2001-2007	2008-2010	2011-2014	2015-2019
Brazil	14.5	11.8	11.6	13.3
China	29.5	28.2	25.0	19.6
India	17.3	22.5	24.4	19.2
Russia	34.4	29.5	27.0	28.0
South Africa	28.6	30.7	30.7	30.0

Source: calculated by the authors based on data from the World Bank World Development Indicators, World Bank, Washington, DC

Table A5. Exports of ICT goods by BRICS (% of goods exports)

	2001-2007	2008-2010	2011-2014	2015-2019
Brazil	2.9	1.4	0.5	0.4
China	27.5	28.8	26.8	26.8
India	1.4	2.1	1.7	1.2
Russia	0.2	0.2	0.4	0.6
South Africa	1.5	1.2	1.2	1.2

Source: calculated by the authors based on data from the World Bank World Development Indicators, World Bank, Washington, DC.

Table A6. Exports of ICT services by BRICS (% of service exports)

	2001-2007	2008-2010	2011-2014	2015-2019
Brazil	2.5	2.1	2.2	5.5
China	2.7	5.3	8.1	12.0
India	45.9	48.6	46.8	46.2
Russia	3.9	5.4	5.9	7.8
South Africa	2.6	2.0	3.4	4.0

Source: calculated by the authors based on data from the World Bank World Development Indicators, World Bank, Washington, DC.

Table A7. Exports of goods and services (% of world exports of goods and services)

	2001-2007	2008-2010	2011-2014	2015-2019
Brazil	1.0	1.2	1.2	1.1
China	5.4	8.1	9.7	10.6
India	1.1	1.7	2.0	2.1
Russia	1.8	2.4	2.5	1.8
South Africa	0.5	0.5	0.5	0.4
Total	9.8	13.9	15.9	16.1

Source: calculated by the authors based on data from the World Bank World Development Indicators, World Bank, Washington, DC.

Table A8. Merchandise exports (% of world merchandise exports)

	2001-2007	2008-2010	2011-2014	2015-2019
Brazil	1.0	1.2	1.3	1.2
China	6.4	9.5	11.3	13.0
India	0.9	1.3	1.6	1.6
Russia	2.0	2.6	2.8	2.0
South Africa	0.5	0.5	0.5	0.5
Total	10.9	15.2	17.5	18.4

Source: calculated by the authors based on data from the World Bank World Development Indicators, World Bank, Washington, DC.

Table A9. Service exports (% of world service exports)

	2001-2007	2008-2010	2011-2014	2015-2019
Brazil	0.7	0.9	1.1	0.8
China	0.7	2.0	2.9	2.5
India	2.3	3.4	3.4	3.6
Russia	1.0	1.3	1.4	1.1
South Africa	0.6	0.6	0.4	0.3
Total	5.3	8.1	9.2	8.3

Source: calculated by the authors based on data from the World Bank World Development Indicators, World Bank, Washington, DC.

Table A10. Exports of BRICS to developing countries (% of total exports)

	2001-2007	2008-2010	2011-2014	2015-2019
Brazil	48.2	60.2	63.7	66.2
China	45.0	50.2	55.7	55.6
India	54.6	64.5	66.5	62.5
Russia	36.8	39.6	46.8	46.6
South Africa	36.4	49.1	64.5	62.7
Average BRICS	44.2	52.7	59.4	58.7
Average G20[16]	42.0	49.8	55.2	54.2
Average LDCs[17]	49.5	57.3	62.5	61.1

Source: calculated by the authors based on data from the World Bank World Development Indicators, World Bank, Washington, DC.

[16] Apart from the five BRICS countries, other developing countries of the G20 are Argentina, Indonesia, Mexico and Turkey.

[17] This is the average for all developing countries.

Table A11. Average annual growth of per capita GDP

	Standard deviation	
	2001-2007	2011-2019
Brazil	2.0	2.5
China	2.1	1.0
India	1.8	1.4
Russia	1.4	2.2
South Africa	1.2	0.9

Source: calculated by the authors based on data from the World Bank World Development Indicators, World Bank, Washington, DC.

Table A12. Exports of goods and services of the BRICS countries (% of GDP)

	Standard deviation	
	2001-2007	2011-2019
Brazil	1.4	1.2
China	6.3	3
India	3.4	2.8
Russia	2.1	1.6
South Africa	2.4	0.6

Source: calculated by the authors based on data from the World Bank World Development Indicators, World Bank, Washington, DC.

Table A13. External balance on goods and services of the BRICS Countries (% of GDP)

	Standard deviation	
	2001-2007	2011-2019
Brazil	2.0	1.2
China	2.8	0.8
India	1.3	1.8
Russia	1.7	1.6
South Africa	2.4	1.3

Source: calculated by the authors based on data from the World Bank World Development Indicators, World Bank, Washington, DC.

Table A14. Gross fixed capital formation of the BRICS countries (% of GDP)

	Standard	**deviation**
	2001-2007	2011-2019
Brazil	0.6	2.7
China	2.3	1.1
India	2.8	2.3
Russia	1.1	0.5
South Africa	2.0	0.9

Source: calculated by the authors based on data from the World Bank World Development Indicators, World Bank, Washington, DC.

Table A15. BRICS merchandise exports (% of GDP)

	2001-2007	2008-2010	2011-2014	2015-2019
Brazil	21.8	19.2	19.2	20.2
China	54.0	49.3	44.5	33.4
India	25.6	36.3	41.4	29.3
Russia	48.0	43.0	39.3	39.1
South Africa	47.6	53.2	58.8	56.5

Source: calculated by the authors based on data from the World Bank World Development Indicators, World Bank, Washington, DC.

Table A16. Test of stationarity at levels

Variables	Brazil	China	India	Russia	South Africa
PCI	-1.43	-1.17	0.02	-0.52	-0.97
	(0.56)	(0.68)	(0.96)	(0.88)	(0.76)
GFCF	-1.57	-0.82	-0.66	-0.51	-0.82
	(0.49)	(0.81)	(0.85)	(0.88)	(0.81)
EB	0.30	0.21	-0.82	-1.01	-2.47
	(0.26)	(0.1)	(0.81)	(0.74)	(0.12)
X	-0.69	-1.97	-1.95	-2.48	-1.65
	(0.84)	(0.30)	(0.30)	(0.12)	(0.45)
M	-1.74	-2.15	-1.37	-0.64	(-2.00)
	(0.41)	(0.22)	(0.59)	(0.86)	(0.28)

Note: The table reports the Z statistics. The *p-value* is denoted in ().

Table A17. Test of stationarity after taking first difference

Variables	Brazil	China	India	Russia	South Africa
PCI	-3.4	-2.83	-5.04	-3.39	-3.44
	(0.01)	(0.04)	(0.00)	(0.01)	(0.00)
GFCF	-3.44	-6.98	-5.22	-3.5	-3.33
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)
EB	-2.67	-6.84	-5.00	-3.41	-4.13
	(0.04)	(0.00)	(0.00)	(0.01)	(0.00)
X	-4.13	-4.36	-4.76	-4.45	-5.26
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
M	-5.47	-6.84	-3.05	-4.09	-4.98
	(0.00)	(0.00)	(0.03)	(0.00)	(0.00)

Note: The table reports the Z statistics. The *p-value* is denoted in ().

Table A18. Johansen's cointegration test

	Model 1			Model 2		
	Eigenvalue	Trace Statistic	5% critical value	Eigenvalue	Trace Statistic	5% critical value
			Brazil			
None		30.2151	29.68		95.8336	47.21
At most 1	0.50661	11.8471*	15.41	0.89658	39.1092	29.68
At most 2	0.3234	1.6897	3.76	0.66706	11.6144*	15.41
At most 3	0.06292			0.34834	0.9087	3.76
At most 4				0.0357		
			China			
None		42.7901	29.68		69.3598	47.21
At most 1	0.67842	14.4272*	15.41	0.71994	36.2679	29.68
At most 2	0.37961	2.492	3.76	0.55671	15.1161*	15.41
At most 3	0.09487			0.39443	2.0748	3.76
At most 4				0.0767		
			India			
None		38.6391	29.68		72.6165	47.21
At most 1	0.62125	14.3668*	1.54E+01	0.82342	29.2671*	29.68
At most 2	0.436	0.0491	3.76	0.54811	9.409	15.41
At most 3	0.00196			0.29925	0.5188	3.76
At most 4				0.02054		
			Russia			
None		31.1447	29.68		65.0525	47.21
At most 1	0.46239	15.0087*	15.41	0.71	34.106	29.68
At most 2	0.39902	1.7697	3.76	0.5828	12.2514*	15.41
At most 3	0.0658			0.28543	3.8495	3.76
At most 4				0.14271		
			South Africa			
None		43.8743	29.68		78.3307	53.12
At most 1	0.69644	14.0696*	15.41	0.70035	48.2025	34.91
At most 2	0.38939	1.7372	3.76	0.61935	24.0558	19.96
At most 3	0.06713			0.4529	8.9778*	9.42
At most 4				0.3017		

Table A19. Optimal lag selection

	Brazil		China		India		Russia		South Africa	
Lag	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
0	-1.3	-1.79	-1.43	-2.78	-1.53	-5.25	-0.66	-4.43	-3.93	-5.99
1	-5.24*	-8.44	-9.47	-11.43*	-8.81	-11.46	-5.55*	-9.61	-8.14	-11.44
2	-5.02	-8.45*	-9.76*	-10.99	-8.81*	-11.52*	-5.21	-10.08*	-8.27*	-11.96*

Note: * Indicates lag order selected by the Akaike information criterion. Most of the other criteria, such as final prediction error, Schwarz information criterion, Hannan-Quinn information criterion, give similar results.

Table A20. Vector error correction model (short-run dynamics)

VARIABLES	Brazil		China		India		Russia		South Africa	
	M1	M2	M1	M2	M1	M2	M1	M2	M1	M2
ECT	**-0.38*** **	**-0.33*** **	**-0.27***	**-0.25** **	**-0.17** **	**-0.63*** **	1.36**	0.60	1.80	5.73***
	(0.09)	**(0.13)**	**(0.14)**	**(0.12)**	**(0.07)**	**(0.21)**	(0.62)	(0.39)	(1.42)	(2.08)
PCI(L1)	0.24	-0.28	0.47*	0.65***	0.18	0.18	-0.49	2.38	-0.06	-2.70*
	(0.47)	(0.94)	(0.26)	(0.17)	(0.49)	(0.40)	(0.78)	(1.62)	(0.83)	(1.41)
PCI(L2)		-0.58	0.05		-0.79	-0.18		-1.27	-1.07	-1.86**
		(0.74)	(0.23)		(0.50)	(0.39)		(1.27)	(0.85)	(0.89)
GFCF(L1)	-0.29	-0.06	-0.04	**0.45** **	-0.17	-0.51	0.17	-0.75	-0.18	1.97
	(0.42)	(0.82)	(0.37)	**(0.21)**	(0.32)	(0.34)	(0.65)	(1.17)	(0.57)	(1.26)
GFCF(L2)		0.30	0.18		0.12	-0.40		0.92	1.35*	**2.74*** **
		(0.64)	(0.27)		(0.33)	(0.39)		(1.05)	(0.71)	**(0.90)**
EB(L1)	0.57		-0.05		0.15				0.49	
	(0.40)		(0.16)		(0.40)				(0.66)	
EB(L2)			-0.05		0.41				-0.68	
			(0.15)		(0.35)				(0.65)	
X(L1)		0.11		0.24		-0.73*		-1.05		-0.75
		(0.59)		(0.16)		(0.43)		(1.08)		(0.61)
X(L2)		-0.13				-0.85**		0.32		0.37
		(0.54)				(0.41)		(0.60)		(0.60)
M(L1)		0.13		0.05		**0.99** **		-1.19		0.31
		(0.70)		(0.18)		**(0.47)**		(1.15)		(0.79)
M(L2)		-0.02				**0.78** **	0.55	-0.17		-1.50**
		(0.72)				**(0.38)**	(0.56)	(0.90)		(0.72)
Constant	0.00	0.04	-0.04	-0.05	0.09*	-0.01	0.01	0.00	0.00	-0.00
	(0.03)	(0.05)	(0.03)	(0.03)	(0.04)	(0.04)	(0.04)	(0.06)	(0.03)	(0.03)
Observations	26	25	25	26	25	25	26	25	25	25

Note: () denotes the standard errors. *, **, *** denotes significance at 10, 5 and 1% respectively.

Table A21. VEC residual serial correlation LaGrange-multiplier test

	Model 1			Model 2		
Lags	**chi2**	**df**	***p-value***	**chi2**	**df**	**p-value**
Brazil						
1	11.2128	9	0.2614	12.6268	16	0.69982
2	6.6794	9	0.67046	12.0504	16	0.7405
China						
1	12.8385	9	0.17005	20.6861	16	0.19089
2	10.5126	9	0.3106	11.6104	16	0.77033
India						
1	4.8409	9	0.84795	10.0495	16	0.86403
2	10.7523	9	0.29307	17.8176	16	0.33469
Russia						
1	12.2891	9	0.1975	10.6633	16	0.82978
2	17.1744	9	0.04605	18.1212	16	0.31685
South Africa						
1	4.977	9	0.83631	11.5649	16	0.77335
2	4.909	9	0.84216	18.6308	16	0.28827

Note: Null hypothesis is the absence of autocorrelation at lag order.

Table A22. Jarque-Bera test of normality

	Model 1			Model 2		
Equation	**chi2**	**df**	***p-value***	**chi2**	**df**	***p-value***
Brazil						
ΔPCI	0.26	2	0.88	10.63	2	0.11
ΔGFCF	1.64	2	0.44	0.13	2	0.94
ΔEB	5.18	2	0.08			
ΔX				25.47	2	0.00
ΔM				1.09	2	0.58
ALL	7.08	6	0.31	37.32	8	0.00
China						
ΔPCI	1.21	2	0.55	1.50	2	0.47
ΔGFCF	2.92	2	0.23	0.50	2	0.78
ΔEB	0.40	2	0.82			
ΔX				1.34	2	0.51
ΔM				1.08	2	0.58
ALL	4.53	6	0.61	4.42	8	0.82
India						
ΔPCI	0.08	2	0.96	2.13	2	0.35
ΔGFCF	5.27	2	0.07	0.89	2	0.64

Table A22. Continued

	Model 1			Model 2		
Equation	**chi2**	**df**	***p-value***	**chi2**	**df**	***p-value***
ΔEB	0.39	2	0.83			
ΔX				0.02	2	0.99
ΔM				1.56	2	0.46
ALL	5.73	6	0.45	4.60	8	0.80
Russia						
ΔPCI	2.23	2	0.33	1.84	2	0.40
ΔGFCF	0.04	2	0.98	2.31	2	0.31
ΔEB	0.50	2	0.78			
ΔX				11.09	2	0.00
ΔM				1.36	2	0.51
ALL	2.78	6	0.84	16.59	8	0.03
South Africa						
ΔPCI	2.83	2	0.24	3.59	2	0.17
ΔGFCF	1.31	2	0.52	0.86	2	0.65
ΔEB	1.23	2	0.54			
ΔX				0.20	2	0.91
ΔM				0.25	2	0.88
ALL	5.37	6	0.50	4.89	8	0.77

Note: Null hypothesis is that the errors are normally distributed.

Table A23. VEC Granger causality/ Wald test (Model 1)

Country	**Dependent variable**	**Source of causality**		
		Short run (Wald chi sq statistic)		
		ΔPCI	**ΔGFCF**	**ΔEB**
Brazil	ΔPCI	_	0.47	2.06
			(0.49)	(0.15)
	ΔGFCF	0.13	_	**3.23***
		-0.71		**(0.07)**
	ΔEB	0.07	0.02	_
		(0.78)	(0.87)	
China	ΔPCI	_	0.01	0.1
			(0.91)	(0.75)
	ΔGFCF	1.72	_	0.25
		(0.18)		(0.61)
	ΔEB	1.11	**3.93****	_
		(0.29)	**(0.04)**	

Table A23. Continued

Country	Dependent variable	Source of causality		
		Short run (Wald chi sq statistic)		
		ΔPCI	ΔGFCF	ΔEB
India	ΔPCI	_	0.29	0.14
			(0.59)	(0.70)
	ΔGFCF	1.63	_	0.17
		(0.20)		(0.68)
	ΔEB	1.99	0.03	_
		(0.15)	(0.86)	
Russia	ΔPCI	_	0.07	0.97
			(0.79)	(0.32)
	ΔGFCF	0.57	_	0.89
		(0.44)		(0.34)
	ΔEB	0.95	0.64	_
		(0.32)	(0.42)	
South Africa	ΔPCI	_	3.79	1.39
			(0.15)	(0.49)
	ΔGFCF	4.43	_	1.26
		(0.10)		(0.53)
	ΔEB	1.61	3.82	_
		(0.44)	(0.14)	

Note: () denotes the *p-value*.

Table A24. VEC Granger causality/ Wald Test (Model 2)

Country	Dependent variable			Source of causality	
				Short run (Wald chi sq statistic)	
		ΔPCI	ΔGFCF	ΔX	ΔM
Brazil	ΔPCI	_	0.28	0.07	0.04
			(0.87)	(0.96)	(0.98)
	ΔGFCF	0.1	_	0.21	0.32
		(0.95)		(0.89)	(0.85)
	ΔX	0.41	1.11	_	4.47
		(0.81)	(0.57)		(0.10)
	ΔM	0.63	0.68	0.78	_
		(0.72)	(0.71)	(0.67)	

Table A24. Continued

Country	Dependent variable	Source of causality			
		Short run (Wald chi sq statistic)			
		ΔPCI	**ΔGFCF**	**ΔX**	**ΔM**
China	ΔPCI	_	**4.44****	2.17	0.06
			(0.03)	(0.14)	(0.80)
	ΔGFCF	1.33	_	0.18	0.02
		(0.24)		(0.67)	(0.89)
	ΔX	1.82	1.72	_	0
		(0.17)	(0.19)		(0.99)
	ΔM	0.11	0.05	0.07	_
		(0.73)	(0.82)	(0.79)	
India	ΔPCI	_	2.33	2.89	**4.47****
			(0.12)	(0.08)	**(0.03)**
	ΔGFCF	0.61	_	0.01	0.74
		(0.43)		(0.92)	(0.39)
	ΔX	0.01	0.1	_	**4.19****
		(0.93)	(0.75)		**(0.04)**
	ΔM	0.18	0.01	0.14	_
		(0.67)	(0.90)	(0.70)	
Russia	ΔPCI	_	1.01	1.19	1.08
			(1.60)	(0.55)	(0.58)
	ΔGFCF	2.06	_	1.06	1.54
		(0.35)		(0.58)	(0.46)
	ΔX	0.68	6.74**	_	3.39
		(0.71)	(0.03)		(0.18)
	ΔM	2.4	0.79	2.74	_
		0.3	0.67	0.25	
South Africa	ΔPCI	_	**9.46*****	1.71	4.48
			(0.00)	(0.42)	(0.10)
	ΔGFCF	**9.62*****	_	1.45	3.8
		(0.00)		(0.48)	(0.14)
	ΔX	2.02	0.56	_	3.38
		(0.36)	(0.75)		(0.18)
	ΔM	**11.34*****	**10.48*****	1.9	_
		(0.00)	**(0.00)**	(0.38)	

Note: () denotes the *p-value*.

Table A25. The cointegrating equations – long-run model (Model 1)

Country	Normalized variable			
		GDP (t-1)	GFCF (t-1)	EB (t-1)
Brazil	**PCI (t-1)**	_	**0.69*** **	**-2.01*** **
	GFCF (t-1)	**1.44*** **	_	**2.91*** **
	EB (t-1)	-0.49	0.34	_
China	**PCI (t-1)**	_	**1.23*** **	0.048
	EB (t-1)	**-20.43*** **	**25.16*** **	_
India	**PCI (t-1)**	_	**0.89*** **	0.17

Note: The equations with long-run causality are marked in bold. *, **, *** denotes significance at 10, 5 and 1% respectively. The signs of the coefficients are reversed for correct interpretation.

Table A26. The cointegrating equations – long-run model (Model 2)

Country	Normalized variable				
		GDP (t-1)	GFCF (t-1)	X (t-1)	M (t-1)
Brazil	**PCI (t-1)**	_	**1.89*** **	**3.93*** **	**-6.06*** **
	GFCF (t-1)	**0.52*** **	_	**-2.07*** **	**3.20*** **
	X (t-1)	**0.25***	**-0.48*** **	_	**1.54*** **
China	**PCI (t-1)**	_	**2.01*** **	**1.18*** **	**-1.92*** **
	M (t-1)	**-0.51** **	**1.04*** **	**0.61*** **	_
India	**PCI (t-1)**	_	**0.53** **	**0.79*** **	**-0.57*** **
	X (t-1)	**1.25*** **	**-0.66*** **	_	**0.71*** **

Note: The equations with long-run causality are marked in bold. *, **, *** denotes significance at 10, 5 and 1% respectively. The signs of the coefficients are reversed for correct interpretation.