

A Comparison of China and the Other BRICS Countries: How Did China Surpass the Others?

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Abstract

We compare China's performance to the performances of Brazil, India, and South Africa over the 1985-2011 period. We look into several areas including patent applications by residents, scientific and technical journal articles, final consumption expenditure, exports, household consumption, government consumption, gross capital formation, gross domestic savings, age dependency ratio, foreign direct investment, energy production, and domestic credit to private sector. We find that, out of the twelve measures that we examine, China's annual percentage improvement was significantly better than the other three BRICS countries in only three measures. These are patent applications by residents, scientific and technical journal articles, and energy production. These findings indicate that science and innovation had been very important for China's development. Also, the country's efforts in energy production including its partnerships in other countries had been key to its economic development.

Keywords: BRICS, GDP, emerging markets, China, development

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1. Introduction

BRICS is an acronym for an informal group of countries initiated by Russia in 2006 which consists of Brazil, Russia, India, China and South Africa. South Africa is the newest addition to this group in 2010. Based on a joint statement by member countries after the first BRIC summit in 2009, the goals of the group include “to promote dialogue and cooperation among our countries in an incremental, proactive, pragmatic, open and transparent way. The dialogue and cooperation of the BRIC countries is conducive not only to serving common interests of emerging market economies and developing countries, but also to building a harmonious world of lasting peace and common prosperity.”

In essence, each member of BRICS is a major economy of each of the regions they represent, e.g. Russia and China are key members of APEC, Brazil is

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an important member of MERCOSUR, India is a member of the South Asian Association for Regional Cooperation, and South Africa in the African Union. The significance of BRICS is undeniable, e.g. in 2013, BRICS economy accounted for about 27 percent of the global GDP, formed 42 percent of the entire global population, and the land size of these five countries covers 26 percent of the world.

This paper compares China's performance to the performances of other BRICS countries, namely Brazil, India, and South Africa over the 1985-2011 period. We look into several areas including patent applications by residents, scientific and technical journal articles, final consumption expenditure, exports, household consumption, government consumption, gross capital formation, gross domestic savings, age dependency ratio, foreign direct investment, energy production, and domestic credit to private sector.

We find that, out of the thirteen measures that we examine, China's annual percentage improvement was significantly better than the other three BRICS countries in only three measures. These are patent applications by residents, scientific and technical journal articles, and energy production. These findings indicate that science and innovation had been very important for China's development. Also, the country's efforts in energy production including its partnerships in other countries had been key to its economic development.

This paper is organized as follows: Section 2 presents the literature review associated with BRICS countries. In section 3, we describe the data and methodology used to help address our questions. Section 4 provides empirical findings, while section 5 concludes.

2. Literature Review

O'Neill (2001) was one of the first authors to show the significance of BRIC by comparing several metrics of these four countries with the G7, including the GDP weight based on the purchasing power parity (PPP) at the end of 2000. On a PPP basis, China was the 2nd largest economy in the world at that time, while India was the 4th largest. As a group, the GDP size of the BRIC was approximately 23% of the world total. Each of the BRIC countries' GDP was bigger than Canada (a G7 member), and China and India were also bigger than Italy (another member of the G7). He suggested that based on the PPP-based GDP, China and India could easily replace Italy and Canada in G7; that an expansionary monetary or fiscal policy in China would likely have more global repercussion than similar policies in Italy; and given that China was the fourth largest individual country then ahead of Germany based on the USD Broad trade-weighted index, fiscal or monetary policy changes in China might be more important to the US than equivalent German policy changes. He also projected that the combined share of the nominal GDP of the BRIC will rise to about 36% of the world economy by 2010.

In another paper, Wilson and Purushothaman (2003) suggested that over the next 50 years, BRIC economies could become a much larger force in the world economy. They estimated GDP growth, income per capita and currency

movements in the BRICS economy until 2050. According to their estimates, by 2025, BRIC economies could account for over half of the size of the G6 (in USD terms), and would surpass the G6 before 2040. They predicted that of the then G6 members, only the US and Japan would be among the six largest economies in USD terms by 2050. In other words, the list of ten largest economies in the world might look different in 2050, and even by 2025, the annual increase in USD spending from the BRIC would be twice that of the G6, and four times higher by 2050.

In determining the key factors related to economic growth, studies employ multiple variables including factors related to market openness, education or development of human capital as well as non-human capital, financial development, health development, etc. For example, the probability of a change in economic leadership among BRICS countries, on the basis of an analysis of diverse macroeconomic performance and comprehensive indices, which characterized economic development and participation in world financial and economic processes were investigated by Leksiutina (2017). This study ran a comparative analysis of the current situation, the development prospects of the Chinese and Indian economies, and the role of each country in the global economy designed to give a balanced assessment of the probability of a change in BRICS economic leadership.

In another paper, the determinants of growth among BRICS countries were investigated by Iyidogan et al. (2018). They examined whether the following variables affected growth, i.e. GDP per capita growth, trade openness, gross capital formation, gross domestic savings, research and development expenditure, government expenditure on education, primary school enrollment rate, secondary school enrollment rate, and domestic credit to finance sector. Utilizing data between 2000-2016, they found that growth in BRICS countries seemed to be significantly affected by trade openness, gross domestic savings, research and development expenditure and domestic credit to finance sector (a proxy for financial development).

Key determinants of economic growth in developed and developing countries were examined by e.g. Chirwa and Odhiambo (2016). They found that in developing countries, foreign aid, foreign direct investment, fiscal policy, investment, trade, human capital development, demographics, monetary policy, natural resources, reforms and geographic, regional, political and financial factors appeared to be significant. On the other hand, physical capital, fiscal policy, human capital, trade, demographics, monetary policy and financial and technological factors were significant determinants of economic growth in developed economies.

An earlier work by Barro (2003) employed an empirical framework that relates the real per capita growth rate to two categories of variables, i.e. the initial levels of state variables, and the policy variables and national characteristics. The first category comprises variables such as the stock of physical capital and human capital in the forms of educational attainment and health. The second category

includes government consumption, domestic investment, international openness, fertility rate, macroeconomic stability, and maintenance of the rule of law and democracy. He found that initial human capital was positively related to growth. Economic growth was also positively related to rule of law and market openness, and negatively related to the ratio of government consumption and inflation.

Utilizing data set from 59 developing economies between 1990-2019, Ahuja and Pandit (2020) studied the causal connection between government spending and economic growth, controlling for government revenue, terms of trade, investment, population, inflation rate and unemployment. Their findings indicated that the association between GDP and government spending is unidirectional where causality ran from government expenditure to national income, which implied that public spending in developing countries acts contributed to GDP growth. They also found that economic growth is positively associated with the total investment, tax revenue, and trade openness.

Ligade (2019) and Hisham et al. (2018) also studied whether innovation and healthcare development were related to growth in BRICS countries respectively. Ligade (2019), for example, compared the research publications in pharmacology, toxicology and pharmaceuticals between India and other BRICS countries. Ligade's study stated that according to the Innovation Cooperation Plan (2017-2020) framed by BRICS, innovation is the main driving force for continuous development and primary role in promoting economic growth of the said regions. The plan also outlined the commitment of the BRICS countries towards innovation-based research, establishing science parks and bolstering training of technology transfer. Overall, the US, China, India were the leaders as far as research publication in pharmacology, toxicology and pharmaceuticals were concerned.

Hisham et al. (2018), on the other hand, examined the current health and healthcare scenario between India and other BRICS nations, i.e. Brazil, Russia, China and South Africa. Since BRICS comprised important nations, and with ever increasing globalization, it was safe to say that global health depended vastly on the health of the people of BRICS nations. Therefore, they looked at increased health financing by looking at the country's health expenditure as a percentage of GDP. Essentially, the primary level of care could be strengthened with adequate personnel and equipment e.g. in terms of hospital beds, physicians and nurses/midwives per capital and public health insurance system, degree of financial decentralization of healthcare, and share of private sector contribution towards health in terms private health expenditure per capita.

Several other papers further discuss the differences between China and the other BRICS countries and the future of BRICS. Hooijmaaijers (2019) argues that China uses BRICS to reshape global economic governance, but that its independent initiatives like Belt and Road Initiative and the Asian Infrastructure Investment Bank have created frictions with the other BRICS countries. Pant (2013) asserts that the group was overhyped from the start and that the group's decline is due to not being able to convert their growing economic power into effective diplomatic

clout. Macfarlane (2006) argues that Russia is not an emerging power, it is in fact a state that has recently experienced substantial damage. Armijo (2007) states that the BRIC countries can be divided into two groups: the first group will likely remain authoritarian, while the others are securely democratic. Glosny (2010) argues that China has been benefiting from its cooperation with the other BRIC countries, but that due to each nation's relations with the Western nations, they are likely to accept the current global economic order. Cheng et al. (2007) asserts that the combined economies of BRIC nations are likely to become the largest economic group by mid-century. The authors highlight some of the country-specific obstacles that would prevent this from happening. Cheng (2015) argues that China's Shanghai Co-operation Organization helped China by improving its international image and status, but that it created new demands and more monitoring by international institutions. The author also contends that, unlike India, Brazil and South Africa, the lack of democracy and human rights in China harms its international image. O'Neill (2001) argues that due to the increasing economic power of the BRIC countries, organizations like the G7 should be adjusted to include BRIC representatives. Laidi (2011) argues that BRICS is strong defensively (i.e. each country defends its sovereignty) but weak offensively. They are weak offensively because they pursue narrow national objectives. Also, they are distrustful of one another.

3. Data and Methodology

In this study, we compare China's indicators to three other BRICS countries' indicators. These countries are Brazil, India, and South Africa. We access the data through World Bank's website (<https://data.worldbank.org/indicator>). Since World Bank does not have data on all of the variables for Russia, we do not include Russia in our analysis. Due to data availability at the time we start our research, we examine the 1985-2011 period.

For these countries, we focus on several indicators including inventions, science, total consumption, government and household consumption, capital formation, savings, exports, working-age population, foreign direct investment net inflows, credit to private sector, and energy production. The variables are shown below. The more detailed definitions can be found on the World Bank website.

GDPpercap: GDP per capita (constant 2005 US\$)

Patent: Patent applications, residents

Scientific: Scientific and technical journal articles

Finalcons: Final consumption expenditure (% of GDP)

Gengovfinal: General government final consumption expenditure (% of GDP)

Grosscap: Gross capital formation (% of GDP)

Grossdom: Gross domestic savings (% of GDP)

Householdcons: Household final consumption expenditure (% of GDP)

Exports: Exports of goods and services (% of GDP)

Agedep: Age dependency ratio (% of working-age population)
Foreigndir: Foreign direct investment, net inflows (% of GDP)
Domesticcred: Domestic credit to private sector by banks (% of GDP)
Energyprod: Energy production (kt of oil equivalent)

Table 1 shows the summary statistics for the annual percentage increase in these thirteen measures for these four countries (Brazil, India, China, and South Africa) for the whole period. The mean annual increase in GDP per capita was 3.95% for these countries.

The table shows that the mean annual increase in patent applications by residents was 11.39% for these countries (including China). The mean annual increase in the number of scientific and technical journal articles was 7.69%. Therefore, overall, these countries improved in terms of innovations and science over time.

The Summary Stats for the % Change in all Variables

Table 1

	Mean	Median	Std	Min	Max
GDPpercap	3.95	3.09	4.21	-5.94	13.57
Patent	11.39	5.61	56.32	-78.71	548.55
Scientific	7.69	6.39	9.67	-8.81	49.82
Finalcons	-0.16	-0.23	2.8	-7.04	12.88
Gengovfinal	0.93	0.55	5.51	-10.21	24.47
Grosscap	0.98	0.00	8.82	-25.04	25.84
Grossdom	0.37	0.98	7.55	-29.53	20.61
Householdcons	-0.39	-0.53	3.22	-9.02	9.56
Exports	3.28	3.9	12.46	-28.02	50.67
Agedep	-1.45	-1.31	0.89	-4.36	0.15
Officialexc	92.96	3.82	358.88	-28.23	2310.11
Foreigndir	66.49	1.55	338.6	-412.69	3084.94
Domesticcred	7.64	2.58	61.42	-67.06	604.29
Energyprod	3.25	3.18	2.94	-3.31	12.46

Source: Authors' own work

Household consumption went down by 0.39% on average, annually, while general government final consumption went up by 0.93% (Final consumption expenditure went down by 0.16% annually). Gross domestic savings went up by 0.37% annually, and gross capital formation went up by 0.98% annually.

Exports went up by 3.28% annually. Domestic credit to private firms by banks went up by 7.64% annually. Foreign direct investment net inflows went up by an enormous 66.49% annually. Age dependency ratio (i.e. the ratio of

dependents to working age population) went down by 1.45% annually, which was good. Finally, Energy production went up by 3.25% annually for these countries (including China).

In this paper, we will show the trend in each of these variables for each country graphically. Next, we will compare China's annual improvement numbers to the other three countries' numbers to see the areas in which China had an edge over the other three BRICS countries. To examine this, we will use Mann-Whitney-Wilcoxon tests to compare China to the other countries.

4. Empirical Results

Table 2-Panel A shows the summary statistics for the annual percentage increase in the thirteen measures (including the GDP per capita) for China. Table 2-Panel B does the same for the remaining three BRICS countries. As can be seen from the table, China's mean annual increase in GDP per capita was 9.10%, while the corresponding value for the other three countries was only 2.23%. China's economic growth was enormous during this period.

Summary Stats for China versus other BRICS Countries

Table 2

Panel A. China					
	Mean	Median	Std	Min	Max
GDPpercap	9.10	9.21	2.70	2.43	13.57
Patent	20.69	19.54	17.22	-14.05	62.20
Scientific	16.33	14.77	10.83	-1.58	49.82
Finalcons	-1.07	-0.76	2.78	-6.62	3.38
Gengovfinal	-0.21	0.63	4.19	-10.21	9.14
Grosscap	1.02	-0.05	5.46	-6.17	18.74
Grossdom	1.60	0.97	3.98	-5.17	10.58
Householdcons	-1.30	-1.34	3.56	-8.70	3.76
Exports	5.49	2.90	15.53	-23.63	50.67
Agedep	-1.77	-1.54	1.40	-4.36	0.15
Foreigndir	13.24	-1.01	39.50	-18.96	136.60
Domesticcred	2.81	2.03	7.57	-11.21	22.66
Energyprod	4.72	4.75	3.39	-1.01	12.46
Panel B. Other BRICS Countries					
	Mean	Median	Std	Min	Max
GDPpercap	2.23	2.13	3.06	-5.94	8.84
Patent	8.29	1.93	64.10	-78.71	548.55
Scientific	4.81	4.20	7.30	-8.81	31.01
Finalcons	0.14	-0.23	2.76	-7.04	12.88
Gengovfinal	1.31	0.55	5.86	-8.46	24.47
Grosscap	0.97	0.24	9.72	-25.04	25.84
Grossdom	-0.04	0.98	8.40	-29.53	20.61

Householdcons	-0.09	-0.30	3.07	-9.02	9.56
Exports	2.54	3.90	11.28	-28.02	35.75
Agedep	-1.35	-1.29	0.62	-2.72	0.05
Foreigndir	84.24	4.10	389.33	-412.69	3084.94
Domesticcred	9.25	3.00	70.83	-67.06	604.29
Energyprod	2.76	2.78	2.62	-3.31	10.35

Source: Authors' own work

China's mean annual increase in patent applications by residents was 20.69%, while the corresponding value for the other three countries was only 8.29%. Also, while China's mean annual increase in scientific and technical journal articles was 16.33%, while the corresponding value for the other three countries was only 4.81%. In terms of both patents and scientific and technical articles, China had improved much more than the other three countries.

The table shows that China's mean annual change in final consumption expenditure as a percentage of GDP was -1.07% (i.e. a decline), while the corresponding change for the other three countries was 0.14% (i.e. an increase). Also, while China's mean annual change in general government final consumption expenditure was -0.21% (i.e. a decline), while the corresponding value for the other three countries was 1.31% (i.e. an increase). Adding to these, while China's mean annual change in household final consumption expenditure was -1.30%, the corresponding value for the other three countries was -0.09%. In terms of all three consumption measures, we are seeing that China had reduced consumption, while the other three countries did not.

In terms of gross capital formation as a percentage of GDP, the table shows that the mean annual change for China was 1.02%, while the corresponding change for the other countries was 0.97%. In terms of gross domestic savings as a percentage of GDP, the table shows that the mean annual change for China was 1.60% (i.e. an increase in savings), while the corresponding change for the other countries was -0.04% (i.e. a decline in savings).

The table shows that China had increased its exports much more than the other three countries did. China's mean annual percentage change in exports was 5.49%, while the change was only 2.54% for the other countries. China also reduced its age dependency more than the other countries did. While its age dependency went down by 1.77% annually, the drop for the other countries was 1.35%.

In terms of attracting foreign direct investments, China did worse than the other three countries. Its mean annual change was 13.24% and this was worse than the other countries' 84.24% change. In terms of increasing domestic credit to private sector by banks, China did worse than the other three countries. Its mean annual change was 2.81% and this was worse than the other countries' 9.25% change. Finally, in terms of energy production, China did much better than the other three countries. Its mean annual change was 4.72% and this was better than the other countries' 2.76% change.

Table 3 shows the results of our nonparametric tests that compare China's annual change in the thirteen measures (including the GDP per capita) to those of the other three BRICS countries. China's annual change in GDP per capita (mean=9.10%, median=9.21%) was significantly higher than the corresponding change (mean=2.23%, median=2.13%) for the other BRICS countries ($p<0.0001$).

Tests Comparing China and Other BRICS Countries

Table 3

	China		Other BRICS		Wilcoxon
	Mean	Median	Mean	Median	
GDPpercap	9.10	9.21	2.23	2.13	<0.0001
Patent	20.69	19.54	8.29	1.93	<0.0001
Scientific	16.33	14.77	4.81	4.20	<0.0001
Finalcons	-1.07	-0.76	0.14	-0.23	0.1443
Gengovfinal	-0.21	0.63	1.31	0.55	0.5161
Grosscap	1.02	-0.05	0.97	0.24	0.8423
Grossdom	1.60	0.97	-0.04	0.98	0.4781
Householdcons	-1.30	-1.34	-0.09	-0.30	0.1593
Exports	5.49	2.90	2.54	3.90	0.6124
Agedep	-1.77	-1.54	-1.35	-1.29	0.4551
Foreigndir	13.24	-1.01	84.24	4.10	0.9671
Domesticcred	2.81	2.03	9.25	3.00	0.9252
Energyprod	4.72	4.75	2.76	2.78	0.0113

Source: Authors' own work

The table shows that China's annual change in patent applications by residents (mean=20.69%, median=19.54%) was significantly higher than the corresponding change (mean=8.29%, median=1.93) for the other BRICS countries ($p<0.0001$). The table also shows that China's annual change in scientific and technical journal articles (mean=16.33%, median=14.77%) was significantly higher than the corresponding change (mean=4.81%, median=4.20) for the other BRICS countries ($p<0.0001$). In terms of energy production, China's annual change (mean=4.72%, median=4.75%) was significantly higher than the corresponding change (mean=2.76%, median=2.78) for the other BRICS countries ($p=0.0113$). We do not see any significant difference between China and the other three countries in terms of the other variables.

5. Conclusion

This paper compares China's performance to that of other members of BRICS, i.e. Brazil, India, and South Africa over the 1985-2011 period. For these countries, we focus on thirteen indicators associated with inventions, science, total consumption, government and household consumption, capital formation, savings, exports, working-age population, foreign direct investment net inflows, credit to

private sector, and energy production. We exclude Russia in our analysis due to the unavailability of data.

Overall, we find that the mean annual increase in GDP per capita was 3.95% for BRICS countries over the sample period. We also find that over the years, BRICS countries improved in terms of innovations and science, as indicated by the mean annual increase in patent applications by residents of 11.39% for these countries (including China), and the mean annual increase in the number of scientific and technical journal articles of 7.69%. As for the other indicators (also annual averages), household consumption went down by 0.39%, while general government final consumption went up by 0.93%; gross domestic savings went up by 0.37%; gross capital formation increased by 0.98%; exports rose by 3.28%; domestic credit to private firms by banks went up by 7.64%; foreign direct investment net inflows increased by an enormous 66.49%; age dependency ratio (i.e. the ratio of dependents to working age population) declined by 1.45%, which was good; and finally, energy production improved by 3.25%.

We also analyze the trend in each of the 13 indicators for each country between 1985 to 2011. Overall, we find the following:

- *GDP per capita.* While all four BRICS countries showed improvement after 1993 in GDP per capita, China's improvement was much stronger than the other three countries.
- *Patent applications by residents.* China's improvement in patent applications had been much stronger than other BRICS countries.
- *Scientific and technical journal articles.* South Africa had seen a small but steady growth in this measure, while India and Brazil did slightly better. Compared to the other three countries, China had the highest improvement.
- *General government final consumption expenditure.* All four countries had seen ups and downs in government expenditures (as a percentage of GDP) throughout the period. For example, it had been relatively flat for China and India, South Africa had seen a small increase, while Brazil had a large increase in this measure over the years.
- *Gross capital formation.* While Brazil and South Africa had been almost flat, both China and India's capital formation (as a percentage of GDP) improved especially after year 2000.
- *Gross domestic savings.* There was a downward trend for Brazil and South Africa, but an upward trend or improvement for both China and India.
- *Household final consumption expenditure.* South Africa's household final consumption expenditure as a percentage of GDP went up, but not for Brazil (almost flat). Both China and India saw a reduced household consumption during the same period.
- *Exports of goods and services.* While Brazil and South Africa's exports of goods and services (as a percentage of GDP) had been almost flat,

both China and India had improved (although China saw a temporary decline between 2006 and 2009).

- *Age dependency ratio.* In all four countries, the age dependency ratio had gradually declined (i.e. improved) over the period.
- *Foreign direct investment net inflows.* In all four countries, there were ups and downs in the net inflows of FDI (as a percentage of GDP). Overall, for the whole period, all countries improved (i.e. attracted more net inflows). Specifically, Brazil improved until year 2000, and then declined. India improved until year 2008, and then declined. South Africa saw its peak in year 2001, while China reached its peak in 1993.
- *Domestic credit to private sector by banks.* China, India and South Africa's domestic credit to private sector by banks' (as a percentage of GDP) gradually increased over the period. Brazil had ups and downs, but overall, it was almost flat.
- *Energy production.* While India, Brazil and South Africa increased their production gradually over the period, China's improvement was much more pronounced, especially after year 1999.

In order to see the areas in which China had any significant edge over the other three BRICS countries, we compare China's annual improvement numbers to the other three countries' numbers. We find that in addition to the GDP per capita, China was only statistically and significantly better than other BRICS countries in three areas, namely patent applications by residents, scientific and technical journal articles, and energy production. For the other variables, our analysis did not detect any significant difference between China and the other three countries, even though the figures for China seemed to be better in most cases. Detail comparison for each variable is as the following:

- China's mean annual increase in GDP per capita was 9.10%, while the corresponding value for the other three countries was only 2.23%.
- China's mean annual increase in patent applications by residents was 20.69%, while the corresponding value for the other three countries was only 8.29%. While China's mean annual increase in scientific and technical journal articles was 16.33%, the corresponding value for the other three countries was only 4.81%.
- China's mean annual change in final consumption expenditure as a percentage of GDP was -1.07%, while the corresponding change for the other three countries was 0.14%. While China's mean annual change in general government final consumption expenditure was -0.21%, the corresponding value for the other three countries was 1.31%. Also, while China's mean annual change in household final consumption expenditure was -1.30%, the corresponding value for the other three countries was -0.09%.
- The mean annual change of gross capital formation (as a percentage of GDP) for China was 1.02%, while the corresponding change for the other countries was 0.97%.

- The mean annual change of gross domestic savings as a percentage of GDP for China was 1.60%, while the corresponding change for the other countries was -0.04%.
- China's mean annual percentage change in exports was 5.49%, while the change was only 2.54% for the other countries.
- While China's age dependency went down by 1.77% annually, the average drop for other countries was 1.35%.
- China's mean annual change or attracting foreign direct investment was 13.24%, which is lower than the other countries' 84.24% change.
- The mean annual change in increasing domestic credit to private sector by banks for China was 2.81%, lower than the other countries' 9.25% change.
- China's energy production's mean annual change was 4.72%, which was higher than the other countries' 2.76% change.

Therefore, in conclusion, our nonparametric analyses show that out of the thirteen measures that we examine, China's annual percentage improvement was statistically and significantly better than the other three BRICS countries in only three measures which include patent applications by residents, scientific and technical journal articles, and energy production. These findings indicate that science and innovation seemed to be very important for China's development. Also, the country's efforts in energy production including its partnerships in other countries had been key to its superior economic development compared to other BRICS countries.

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