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# TRENDS IN ENERGY CONSUMPTION AND EMISSIONS IN BRICS: ANALYZING THE DATA AND THE FACTORS AFFECTING ENERGY EFFICIENCY

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## ABSTRACT

There has been growing awareness about global warming and sustainable development, especially because of the dependence on non-renewable energy resources and its effect on emissions. This paper analyses the trends in energy consumption and $CO_2$ emissions in BRICS nations for the period 2000-2020. Data shows that though there has been a rise in both energy consumption and emissions, the inter-country trends are quite different after population differences have been included. Therefore per capita trends are equally important because countries with large population need more energy resources to meet the growing needs of people. Analysis of trends in energy intensity and emission intensity shows both to be declining, thereby indicating a move towards greater energy efficiency. A panel data fixed effects model is used to estimate the effect of various factors on the energy and emission intensities. Results show that GCF has a negative relation with both intensities, while the effect of population is positive. Paris Agreement dummy variable shows that average intensities were lower after the implementation of the Paris Climate Accord.

**Keywords**: BRICS, $CO_2$ Emissions, Energy Consumption, Energy Intensity, Emission Intensity, Fixed Effects Model, Panel Data

## 1. Introduction

Consumption of non-renewable sources of energy and the concomitant effect on carbon dioxide ($CO_2$) emissions have acquired importance ever since there has been rising worldwide awareness about global warming and sustainable development. Though in the Paris Agreement individual member nations have pledged to meet their commitments, the goals can be achieved more

  

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rapidly if groups of nations take steps together to achieve greater energy efficiency. BRICS nations, consisting of Brazil, Russian Federation, India, China, and South Africa, represent one such group of major emerging economies that can make a substantial contribution towards reducing rising emissions and moving towards a more energy efficient economy. BRICS is a part of twenty countries classified as emerging markets (Duttagupta & Pazarbasioglu, 2021), which makes them comparable with each-other in terms of numerous economic and social variables. For example, the World Bank classifies countries into four income groups. All the countries fall in the upper-middle income group, except India that's falls into low-middle income group. Since 2011, the share of this group as a whole in world GDP has been more than 20%, with the share being 25.24% in the year 2020. The percentage share in global primary energy consumption in the last decade has been more than 35%, with the share being almost 40% in the year 2020. The percentage share in total carbon dioxide emissions as compared to the rest of the world in the last decade has been more than 40%, with the share being almost 45% in 2020 (BP Statistical Review of World Energy, 2021). Therefore, as a group, BRICS can play a significant role in moving towards a more sustainable consumption of non-renewable energy resources.

The objective of this paper is to analyse the trends in energy consumption and $CO_2$ emissions and energy intensity and emission intensity in BRICS for a sample period of 2000 to 2020[1]. There are substantial inter-country differences within this group, that can arise due to heterogeneity in economic, technical and developmental factors. The paper allows for population differences to compare the per capita trends with the absolute consumption trends. Finally, a panel data fixed effects model is estimated to study the effect of factors like Research and Development (R&D) Expenditure, Gross Capital Formation (GCF), Population, Human Development Index (HDI) and the Paris Climate Accord, on the energy intensity and emission intensity of BRICS.

Results show that all the individual BRICS nations registered a rise in energy consumption and $CO_2$ emissions. But the country-wise trends in absolute values of energy consumption and $CO_2$ emissions are different from the per capita values. Therefore, allowing for population differences is vital, since countries with large population also require consumption of more energy resources to meet people's needs. Results from the econometric models show that GCF has a negative relation with both energy intensity and emission intensity, while the effect of population is positive. Paris Agreement dummy variable shows that average intensities were lower after the implementation of the Paris Climate Accord.

[1] Though South Africa joined the group in 2010, it is included in the analysis since 2000 for the sake of completeness.

  

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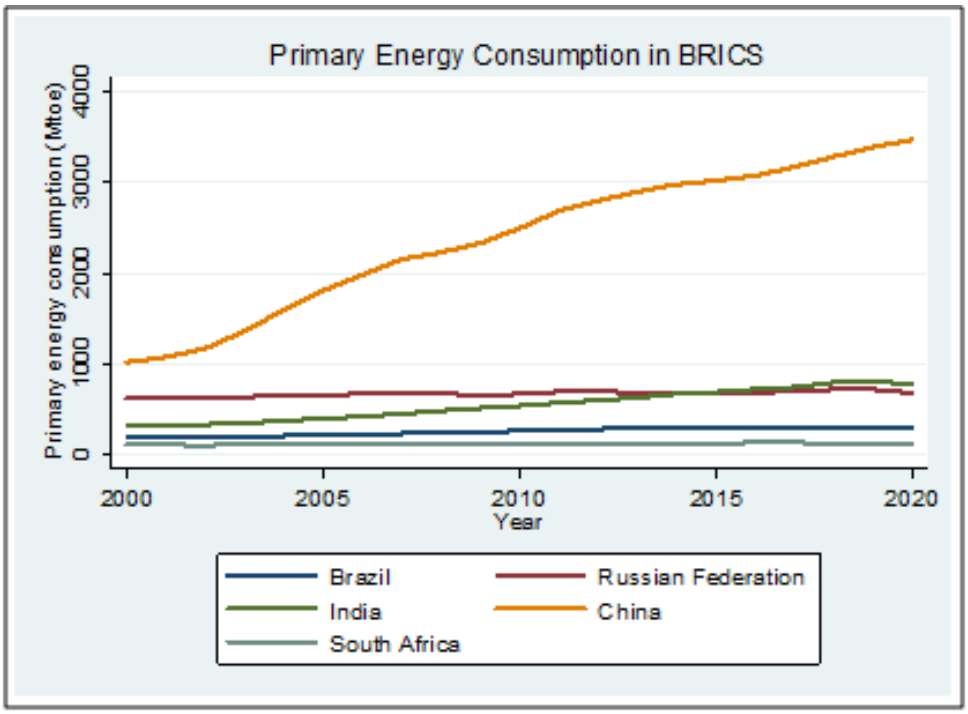
## 2. Analyzing trends in energy consumption and $CO_2$ emissions and their efficiencies in BRICS, 2000-2020

### 2.1 Trends in energy consumption and $CO_2$ emissions in BRICS

The overall trends in total primary energy consumption and $CO_2$ emissions is rising for all the BRICS nations. But there are significant inter-country differences. The upward trend is especially pronounced for China, while it is quite erratic for the Russian Federation, as evident from Figure 1 given below.

**Figure 1: Trends in Primary Energy Consumption for BRICS (in Million tonnes of oil equivalent)**




Data Source: BP Statistical Review, 2021

As per Statista, 2020, China was the largest consumer of primary energy in the world in the year 2020, followed by India at number 3, Russian Federation at number 4 and Brazil at number 9. South Africa did not figure in the list of top ten primary energy consumers of the world. The upward trend is expected because these countries have registered a rise in GDP as well. A rise in economic activity will be accompanied by a rise in energy consumption because both variables have a positive correlation, as the scatter graph given in Figure 2 shows.

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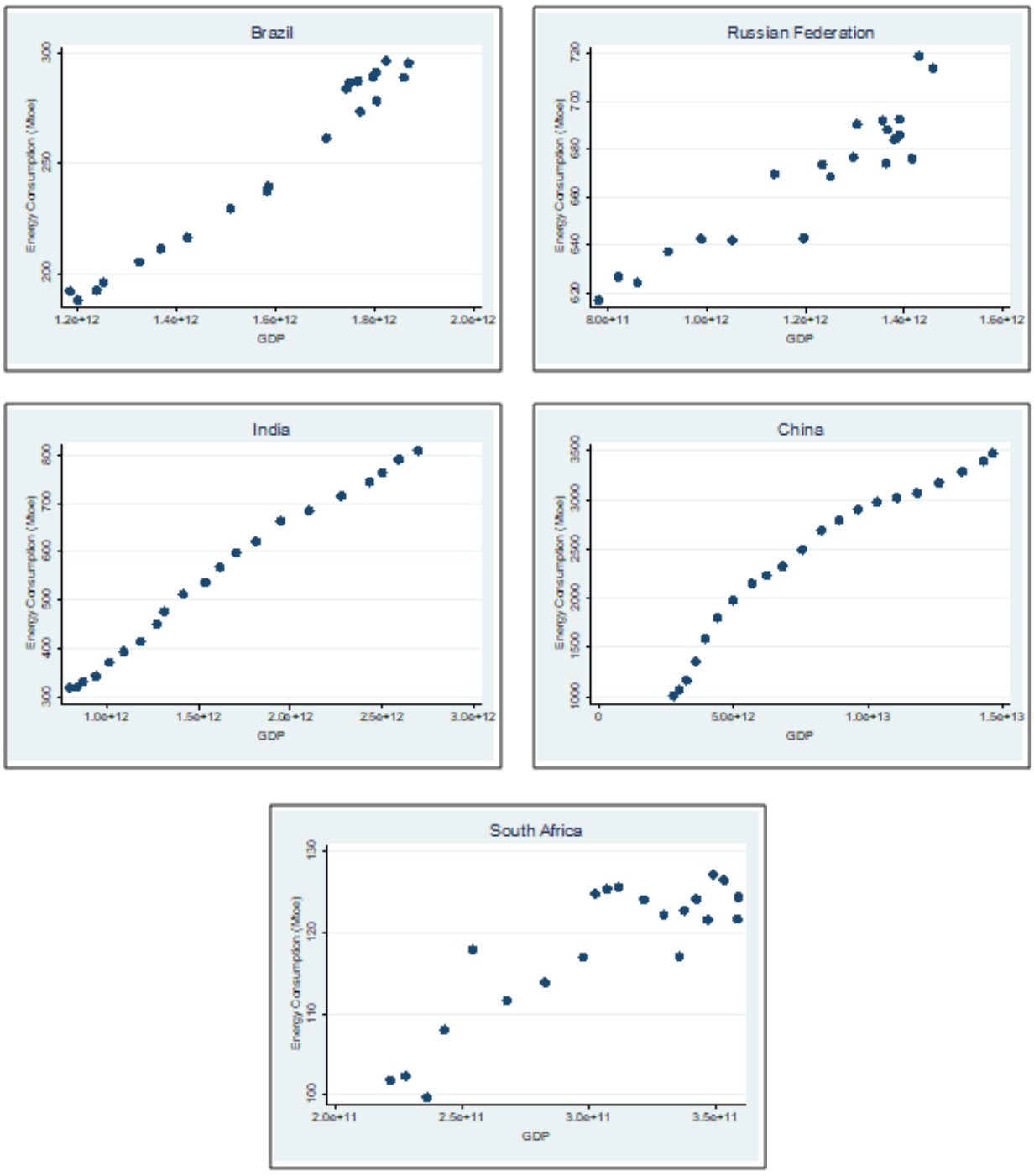
**Figure 2: Relation between Energy Consumption (Mtoe) and GDP (constant 2015 US$)**




Data Source: BP Statistical Review, 2021 and Indicators, The World Bank

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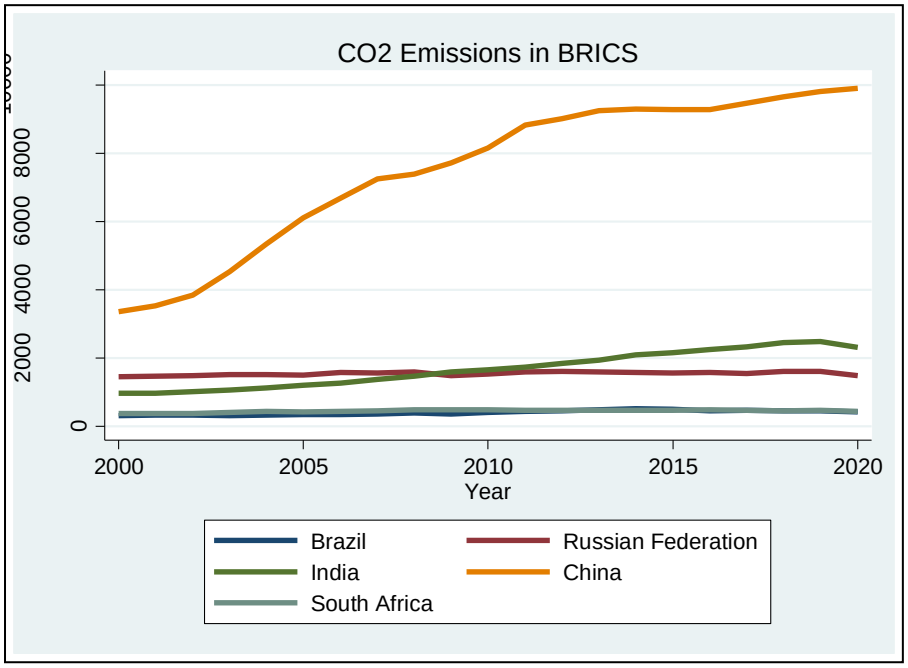
Rising economic activity, accompanied by rising energy consumption will also cause a rise in $CO_2$ emissions. Figure 3 shows that $CO_2$ emissions follow a trend similar to primary energy consumption.

**Figure 3: Trends in carbon dioxide emissions for BRICS (Million tonnes of CO2)**




Data Source: BP Statistical Review, 2021

China is the largest emitter as of 2020, followed by India at number 3, and the Russian Federation at number 4 (Statista, 2020). Both Brazil and South Africa are not a part of the global top ten $CO_2$ emitters, and the graph shows them to have the lowest share.

However, neither the trends in energy consumption nor emissions consider the variations in population that exists between nations. Comparison between different BRICS countries will be more substantive if population differences are incorporated in the analysis. A country with a larger population will also need more resources, including energy, to meet the needs of its people and for growth. For example, as per the US Census Bureau, China was the most populated country as on July 2021, followed by India. Brazil and the Russian Federation were the seventh and nineth most populated countries respectively. Using data from the World Development indicators, we find that the average percentage share of individual BRICS countries in the last decade as a proportion of the world population was the highest for China at 18.77%, followed by India at 17.82%, Brazil at 2.78%, Russian Federation at 1.96% and South Africa at 0.75%. Therefore, for a more meaningful assessment of the trends, it is important to look at the per

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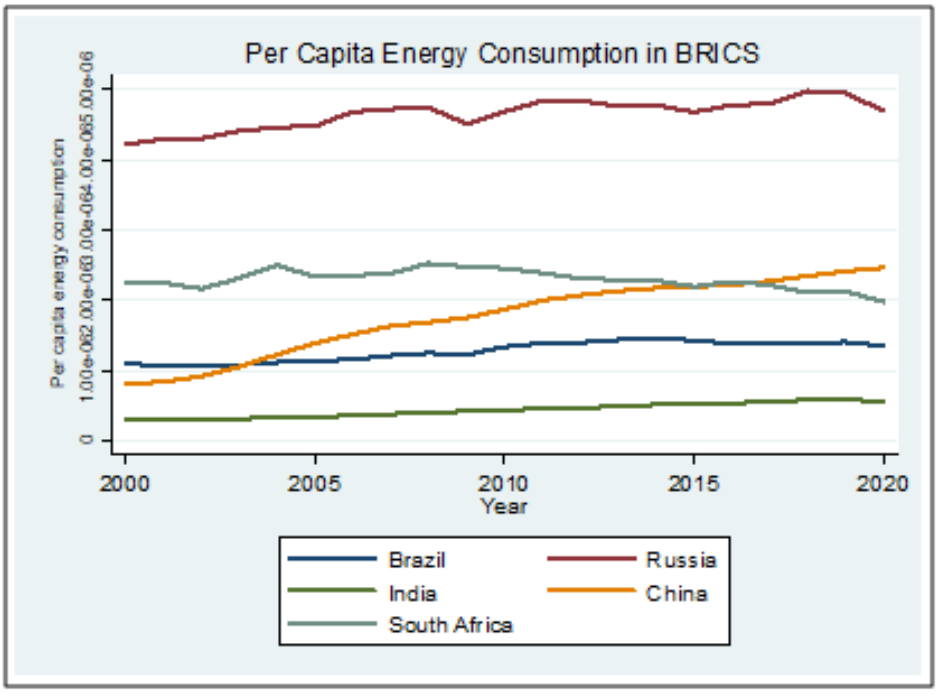
capita contributions in energy consumption and carbon dioxide emissions. Sustainable development is not only about achieving economic development without depleting our natural resources, but also about welfare of the population.

**Figure 4: Trends in Per capita primary energy consumption for BRICS (Mtoe per person)**




Data Source: BP Statistical Review, 2021 and Author's own calculations

Figure 4 shows that when energy consumption is considered on a per capita basis, the Russian Federation has the largest share. South Africa's share was the second largest till 2015-2016, although the share has been declining consistently in the sample period. After 2016, per capita energy consumption in China became the second largest, and it has been rising since then. However, India, that was the third largest consumer of energy in absolute terms, has the lowest share in per capita energy consumption. These trends are in sharp contrast to the trends in absolute energy consumption, where China had the largest share and the share of South Africa was the lowest. Figure 5 shows how the shares change for energy consumption and per capita energy consumption in the BRICS nations in the year 2018[2].

[2] Year 2018 was chosen as it was a normal year. Due to the onset and then continuance of the COVID-19 pandemic, 2019-2020 were not chosen because energy consumption might not follow its usual trend.

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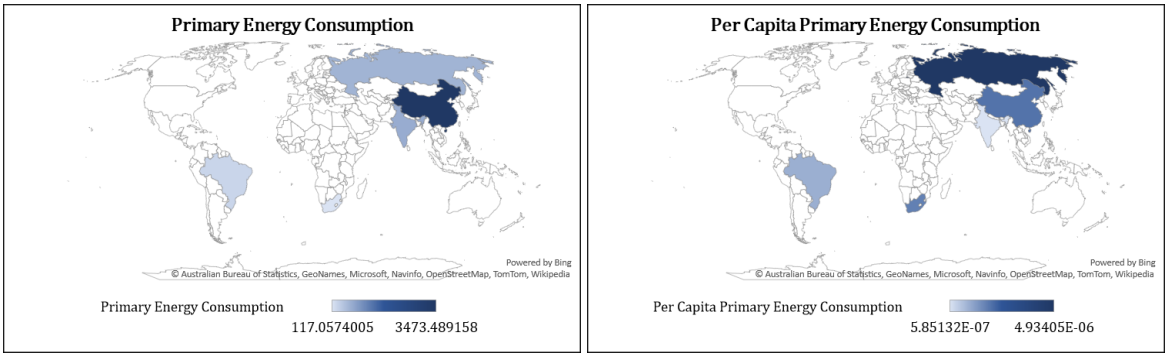
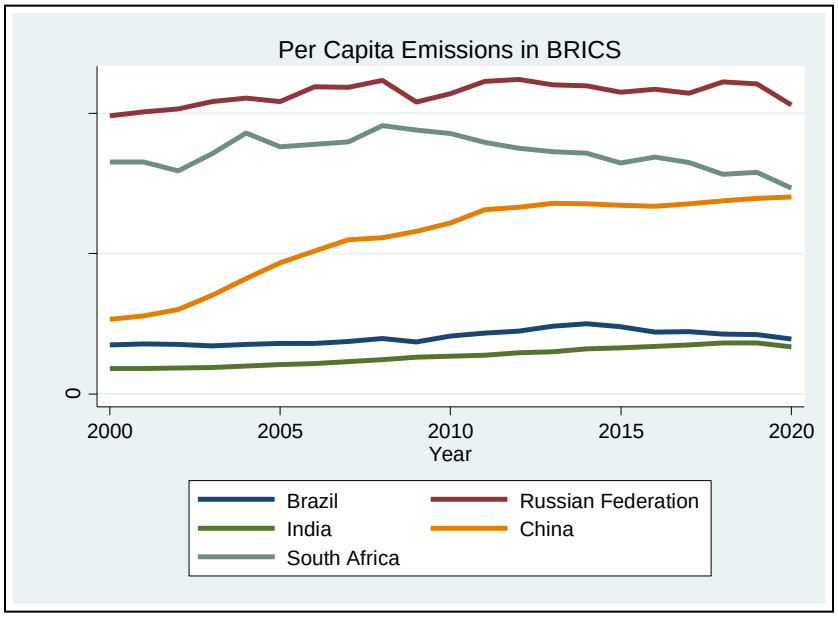
**Figure 5: Energy consumption and Per capita energy consumption in BRICS in 2018**




Similarly, as Figure 6 shows, trends in per capita $CO_2$ emissions is very different from trends in $CO_2$ emissions.

**Figure 6: Trends in per capita carbon dioxide emissions for BRICS (Million tonnes of CO2 per person)**




Data Source: BP Statistical Review 2021, Indicators The World Bank and Author's own calculations

Per capita $CO_2$ emissions is the highest for the Russian Federation, followed by South Africa. The trend is rising for China, but it's still below that of South Africa. Despite being the most populated country of the world, China has a lower per capita energy consumption and emissions as compared to South Africa that does not even figure in the top ten most populated countries of the world. Likewise for India, despite being the second most populated country of the world, the

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per capita energy consumption and carbon dioxide emissions is the lowest. The maps in Figure 7 show the changing share of BRICS nations in total and per capita $CO_2$ emissions in the year 2018.

**Figure 7: $CO_2$ emissions and Per capita $CO_2$ emissions in BRICS in 2018**


Therefore, it is important to compare the per capita figures to allow for population differences across nations so that global targets can be set accordingly. An interesting result that data analysis of rate of growth of per capita energy consumption and per capita emissions is that the growth rates were higher before the Paris Accord was brought into force, and lower after the implementation of the same. It is not clear from the data if the fall in the rate of growth is due to the climate agreement or due to the world wide slowdown in economic activity due to the COVID pandemic. Also, with reference to South Africa, the paper finds that the rate of growth of per capita energy consumption and per capita emissions is higher before 2010 when South Africa was not a part of BRICS, and it was lower post 2010 when South Africa became a part of BRICS.

### 2.2 Trends in energy intensity and emissions intensity in BRICS

The last sub-section shows that overall energy consumption and emissions has been rising for BRICS as a group. However, another question is if energy consumption is becoming more efficient overtime, with technological innovations or investment in research and development? The efficiency in energy consumption can be measured using energy intensity. Energy intensity is defined as energy consumed (in million tonnes of oil equivalent) per unit of GDP (in constant 2015 US$). An improvement in energy intensity can help to reduce emission intensity as well, where emission intensity is defined as the ratio of carbon dioxide emissions (in million tonnes of $CO_2$) to GDP (in constant 2015 US$). If the cumulative rate of growth of primary energy is lower than the cumulative rate of growth of GDP, then the country is becoming more energy

  

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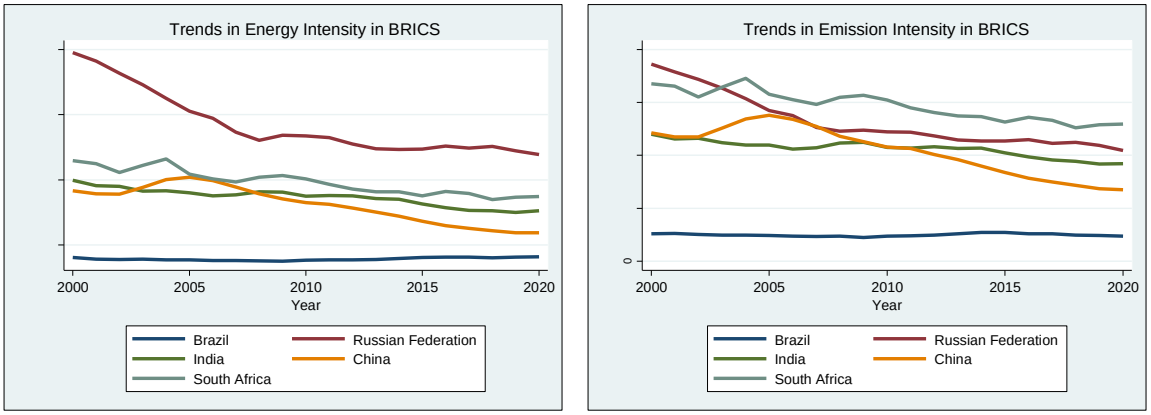
efficient. Similarly, if the cumulative rate of growth of $CO_2$ emissions is lower than cumulative rate of growth of GDP, there is a fall in the nation's emission intensity.

A closer inspection of the annual data for energy intensity and emission intensity shows a declining trend for most of the BRICS nations in Figure 8.

**Figure 8: Energy intensity (Mtoe per US$) and Emission Intensity (MtCO2 per US$) in BRICS**




Data Source: Author's own calculations

All the countries recorded a fall in energy intensity in the period 2000 to 2020. The Russian Federation had the highest energy intensity, while Brazil recorded the lowest energy intensity. Emission intensity also recorded a decline, with the trend being the lowest for Brazil. South Africa has the highest emission intensity, just like it had the highest per capita $CO_2$ emissions.

## 3. Econometric Model and Variables

The paper estimates two fixed effects model using panel data to analyse the effect of some of the general factors that influence the energy intensity and emisison intensity of BRICS. The sample period is from 2000 to 2020. The fixed effects model is as follows:

$$Y_{it} = \alpha_t + \lambda_t + \beta_0 + \beta_1 X_{it} + \beta_2 \, (Paris\ Agreement\ dummy) + \mathcal{E}_{it}$$

where $Y_{it}$ is the dependent variable *Energy Intensity* of the $i^{th}$ BRICS nation in year $t$ for the first fixed effects model and *Emission Intensity* of the $i^{th}$ BRICS nation in year $t$ for the second fixed effects model. $\alpha_t$ and $\lambda_t$ are the time invariant country and year fixed effects respectively. Energy Intensity is defined as the ratio of energy consumed (in million tonnes of oil equivalent) to GDP (in constant 2015 US$). Emission intensity is defined as the ratio of carbon dioxide emissions (in

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million tonnes of $CO_2$) to GDP (in constant 2015 US$). $X_{it}$ includes the following independent variables.

Research and Development (R&D) Expenditure and Gross Capital Formation (GCF) will have a negative correlation with energy intensity and emission intensity. As per the World Development Indicators, World Bank, R&D Expenditure is defined as the percentage of GDP and includes both capital and current expenditures in the four main sectors. It covers basic research, applied research, and experimental development. A rise in R&D expenditure is expected to improve the efficacy in energy use, and hence it should have a negative correlation with energy intensity. Gross Capital Formation is defined as outlays on additions to the fixed assets of the economy plus net changes in the level of inventories. According to the 2008 SNA, net acquisitions of valuables are also considered capital formation (World Development Indicators, World Bank). A rise in GCF is considered to be a proxy for greater capitalization of the production process. Therefore, it should help in reducing the use of energy per unit GDP.

Since the world is concerned with sustainable development policies, quality of life for the people should be considered as an integral part of the same. Human Development Index or HDI is an indicator of the social development of a country. HDI is defined by UNDP as a summary measure of average achievement in key dimensions of human development: a long and healthy life, being knowledgeable and have a decent standard of living. It is the geometric mean of normalized indices for each of the three dimensions. Just like countries with large popualtion need more energy to meet the requirements of its people, more energy is also needed to maintain a better quality of life for the population. Hence, a positive correlation is expected between energy cosumption and HDI. In the 2013 paper Ouedraogo investigates the causal relationship between energy consumption and HDI, and other variables for 15 developing countries for the period 1988-2008. The empirical results show that there exists a negative cointegration between energy consumption and HDI. In 2015 Azam et al. estimated a log-linear model to show that HDI has a positive and statistically significant effect on energy consumption. The study is conducted for Indonesia, Malaysia and Thailand. If there is a negative correlation between energy intensity and HDI, then that implies that there is greater efficency in energy use, without compromising on social development.

Population is another variable that should be factored in. As the graphical analysis in the previous section shows, trends in per capita energy consumption and per capita emisisons is very different from energy consumption and emisisons. A country with a large population will have greater demands on its energy resources, and a higher energy intensity, culminating in to higher emisison intensity. The higher demand for energy can arise due to higher demand for industralisation to provide empoyment to the growing population, more pressure on power generation, etc. In the Indian case, long run positive, statistically significant relation exists

  

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between population density and $CO_2$ emissions (Ohlan, 2015). For USA, population growth causes a deterioration in environmental quality (Khan, I., et. al., 2021). Population has been further categorised into urban and rural popualtion, where urban population refers to people living in urban areasand rural population refers to people living in rural areas, both defined by national statistical offices (World Development Indicators, World Bank). On the one hand, greater urbanisation puts more strain on the energy resources of a country, but it can also promote more efficiency in energy use in terms of greater investment in energy saving equipments, transport services, etc.

Finally a dummy variable, *Paris Agreement Dummy*, has been included to estimate if the energy intensity and emission intensity in the period post the implementation of the agrement, has a lower energy intensity and emission intensity than the pre-agreemnt period. To the best of knowledge, the effect of this dummy variable has not been estimated in the context of BRICS nations.

Data on energy consumption and $CO_2$ emissions has been taken from BP Statistical Review of World Energy, 2021. Data on all the independent variables has been taken from World Development Indicators, World Bank.

## 4. Results and Discusson

Table 1 gives the summary statistics of the data.

**Table 1: Summary Statistics**

| Variable | Obs | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| Energy Consumption | 105 | 791.9133 | 896.547 | 99.70909 | 3473.489 |
| $CO_2$ Emissions | 105 | 2311.654 | 2846.786 | 306.3777 | 9899.335 |
| GDP | 105 | 2.54E+12 | 3.28E+12 | 2.22E+11 | 1.46E+13 |
| R&D Expenditure | 93 | 1.076988 | 0.36462 | 0.65282 | 2.14058 |
| Gross Capital formation | 105 | 8.87E+11 | 1.48E+12 | 2.98E+10 | 6.37E+12 |
| Population | 105 | 5.92E+08 | 5.73E+08 | 4.50E+07 | 1.41E+09 |
| Urban Population | 105 | 2.69E+08 | 2.37E+08 | 2.56E+07 | 8.67E+08 |
| Rural Population | 105 | 3.22E+08 | 3.67E+08 | 1.93E+07 | 8.98E+08 |
| HDI | 100 | 0.68444 | 0.080251 | 0.495 | 0.824 |

  

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The two group one tail mean comparison test at 1% level of significance, shows that the average energy intensity before the Paris Agrement was implemented, is greater than the average energy intensity after the implementation of the Paris Agrement. The result holds true for emission intensity as well.

Table 2 shows the results of the fixed effects model with energy intensity as the dependent variable.

**Tabe 2: Effect of variables on the Energy Intensity of BRICS for the years 2000-2020**

| Variables | Model 1 | Model 2 |
|---|---|---|
| *ln(R&D Expenditure)* | 0.253***<br>(0.0658) | 0.418***<br>(0.117) |
| *ln(Gross Capital Formation)* | -0.337***<br>(0.0983) | -0.372***<br>(0.110) |
| *ln(Population)* | 1.323***<br>(0.249) | |
| *ln(Urban Population)* | | 0.571**<br>(0.236) |
| *ln(Rural Population)* | | 0.889***<br>(0.284) |
| *ln(Human Development Index)* | 1.124<br>(0.818) | 0.210<br>(1.113) |
| *Paris Agreement Dummy* | -0.313***<br>(0.0705) | -0.0577<br>(0.107) |
| *Constant* | -38.15***<br>(6.482) | -39.16***<br>(9.070) |
| Observations | 93 | 93 |
| R-squared | 0.987 | 0.985 |
| Year Fixed Effects | Yes | Yes |
| Firm Fixed Effects | Yes | Yes |

*Note: Energy Intensity, defined as the ratio of energy consumption to GDP, is the dependent variable.*

**,** and ***: Null hypothesis rejected at 10%, 5% & 1%; levels of significance respectively.*

*Robust Standard Errors in parenthesis.*

R&D Expenditure as a percentage of GDP has a positive and statistically significant effect on energy intensity. It is likely that the R&D expenditure was not specifically directed towards

  

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improving the energy intensity of countries. GCF, however, has a negative and statistically significant relation with energy intensity. Greater investment in fixed capital will make the country more energy efficient. A rise in population will put more demands on the energy resources, and there exists a positive and statistically significant effect on energy intensity. In model 2, population has been categorised into urban and rural population. A 1% rise in rural population causes a greater rise in energy intensity. Rural areas may have access to lesser number of energy efficient equipments, unlike the urban areas, that can cause a difference in impact on energy efficiency.

As per the results, there is no link between human development, given by HDI , and energy intensity. Finally the differential intercept coefficient of Paris Agreement dummy is negative and statistically significant in Model 1. This implies that the average energy intensity of BRICS nations before the Paris Accord was implemented, is greater than the average energy intensity after the implementation of the Accord.

Table 3 estimates the effect of variables on the emission intensity of BRICS nations.

**Tabe 3: Effect of variables on the Emission Intensity of BRICS for the years 2000-2020**

| Variables | Model 3 | Model 4 |
|---|---|---|
| *ln(Energy Consumption)* | 0.753***<br>(0.0908) | 0.853***<br>(0.0847) |
| *ln(R&D Expenditure)* | -0.0482<br>(0.0589) | 0.284***<br>(0.106) |
| *ln(Gross Capital Formation)* | -0.483***<br>(0.0857) | -0.489***<br>(0.0923) |
| *ln(Population)* | 1.116***<br>(0.191) | |
| *ln(Urban Population)* | | 0.197<br>(0.142) |
| *ln(Rural Population)* | | 1.283***<br>(0.199) |
| *ln(Human Development Index)* | -0.833<br>(0.888) | -2.065**<br>(0.969) |
| *Paris Agreement Dummy* | -0.234***<br>(0.0842) | 0.0844<br>(0.0808) |

  

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| | | |
|---|---|---|
| *Constant* | -34.74***<br>(5.673) | -41.48***<br>(6.018) |
| Observations | 93 | 93 |
| R-squared | 0.995 | 0.996 |
| Year Fixed Effects | Yes | Yes |
| Firm Fixed Effects | Yes | Yes |

*Note: Emission Intensity, defined as the ratio of $CO_2$ emissions to GDP, is the dependent variable.*
**,** and ***: Null hypothesis rejected at 10%, 5% & 1%; levels of significance respectively.*
*Robust Standard Errors in parenthesis.*

A 1% increase in energy consumption increases emission intensity, as per Models 3 and 4. The effect is statistically significant. R&D expenditure has a positive effect on emission intensity, similar to energy intensity. A 1% rise in GCF, signifying greater investment in fixed assets, causes emission intensity to fall. This could be explained by its similar negative effect on energy intensity as well. A rise in population will lead to a rise in emission intensity. But a rise in urban poulation does not have a statistically significant effect on emission intensity. Human development has a significant effect on emission intensity as per model 4. Finally, as per model 3, emission intensity was lower for BRICS nations after the Paris Accord was signed and applied.

## 5. Conclusion

BRICS as a group has recorded a rise in the consumption of primary energy in the last 21 years. Its share as a percentage of the world consumption of primary energy has remained close to 40% in the last decade. However, the paper finds that there are substantial inter-country differences, with China's share alone being more than 20% of the total global primary energy consumption. Within BRICS in the last decade, China had the highest share in primary energy consumption (close to 60%), followed with a considerable gap, by the Russian Federation and India. Brazil's share remained more than 5%, while South Africa had the lowest share with little more than 2%. But a very important component is population. Countries with large population will have to use more energy to meet the needs of its people. Within BRICS, the share of the Russian Federation is the highest in energy consumption per capita (more than 40% in the last decade), with a share of approximately 5% in total BRICS population in the last decade. South Africa's and China's average share in BRICS energy consumption in the last ten years was 20%, with a population share of only 2% and 44% respectively. Brazil, with a population share of 7%, had a 12% share in per capita energy consumption. India's average share in per capita energy consumption was the lowest at 5%, while it has share of approximately 40% in BRICS population. Similar

  

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differences within BRICS nations appear while comparing total $CO_2$ emissions and per capita $CO_2$ emissions. These differences between absolute and per capita consumption and emissions show that variation in population have to be emphasized upon, while setting any kind of global targets.

The paper also analyzed trends in energy intensity and emission intensity. While all BRICS nations registered a declining trend, the cumulative rate of decline in energy intensity and emission intensity were the highest for the Russian Federation and China respectively. The paper also estimated a panel data fixed effects model to evaluate the effect of various factors on energy intensity and emission intensity of BRICS. Results show that in general greater use of fixed assets will help to reduce both energy and emission intensities. Rise in population will also cause both intensities to rise, thereby emphasizing on the need to factor in population differences when trends in energy consumption or emissions is studied. Though the direction of the effect remains the same, irrespective of the location of the population in urban or rural areas, the positive effect is higher for rural population. Finally average energy intensity and emission intensity was lower after the Paris Climate Accord was implemented in 2016. However, since there has been a world-wide slowdown post 2019 due to the COVID pandemic, more data is needed to check if the fall in intensities is due to the agreement or due to the pandemic.

**References**

Azam, M., Khan, A., Zaman, K., and Ahmad, M. 2015. Factors determining energy consumption: Evidence from Indonesia, Malaysia and Thailand. Renewable and Sustainable Energy Reviews, 42: 1123-1131.

BP Statistical Review of World Energy. 2021. https://www.bp.com/

Khan, I., Hou, F., and Le, H. 2021. The impact of natural resources, energy consumption, and population growth on environmental quality: Fresh evidence from the United States of America. Science of the Total Environment, 754.

Ohlan, R. 2015. The impact of population density, energy consumption, economic growth and trade openness on $CO_2$ emissions in India. Natural Hazards, 79: 1409–1428.

Ouedraogo, N.S. 2013. Energy consumption and human development: Evidence from a panel cointegration and error correction model. Energy, 63: 28-41.

R. Duttagupta, and C. Pazarbasioglu. 2021. Miles to go. Finance and Development, International Monetary Fund.

Statista. 2020. https://www.statista.com/

  

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The World Bank Data. https://data.worldbank.org/indicator

United States Census Bureau. www.census.gov/popclock/

  