

How do Macroeconomic Conditions Affect GDP? (BRICS Case Study)

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Abstract: - One of the international institutions in the spotlight is BRICS. Because the countries incorporated in it (Brazil, Russia, India, China, and South Africa) have a fairly high income. Thus, the purpose of this study is to see what factors contribute to economic growth in BRICS countries. The method in this study is Fully Modified Ordinary Least Square (FMOLS). By using a variable of investment, labor force, and electrical energy consumption. Based on the results of the study, there is a positive influence on BRICS revenue.

Key-Words: - income, Electrical Energy, FMOLS, GDP, Investment, Labor Force.

Received: March 13, 2024. Revised: August 17, 2024. Accepted: September 9, 2024. Published: October 7, 2024.

1 Introduction

With the performance of BRICS countries in the economic field, they are certainly indeed optimistic about achieving this goal, [1]. BRICS' economic growth is highly anticipated by several other countries, which was not in 2021 when the Covid-19 pandemic still shook the world. BRICS contributed 25.61014 percent to the world's Gross Domestic Product (GDP). According to [2], the NDB has approved 70 infrastructure and sustainable development projects worth US\$ 25.07 billion over the past five years, including loans provided under the NDB Emergency Assistance Facility among member states.

Gross Domestic Product (GDP) of a country is a measure of the success of a country, both in terms of human resources and natural resources, because the country's GDP comes from various supporting sectors, such as agriculture, industry, investment, and others GDP is generally calculated based on two approaches, namely the sectoral or business field approach and the usage approach. In addition, GDP is also calculated based on current prices and constant prices. The value of gross domestic product divided by the number of country population in certain period of time, [3].

BRICS has evolved into a strong platform for dialogue and cooperation, [4]. The high GDP obtained by a country is one of the indicators of a country's welfare, which is indeed inseparable from the factors that influence it. This requires an in-depth analysis to determine what affects a country's GDP level to produce appropriate and effective

regulation. One factor that supports a country's economy is energy, especially electrical energy. Electricity is necessary for economic, social, and cultural progress in all developed, developing, and less developed countries, [5]. In addition, electricity is one of the basic needs that are very important for human life, where almost all human activities are related to electrical energy, [6].

Energy can be divided into two, namely renewable energy and non-renewable energy. Although sustainable energy use is still minimal in BRIS countries, BRICS countries strive for sustainable energy use. This shows that BRICS supports sustainable development. One aspect of energy planning is the relationship between the energy sector and economic growth. Energy planning scenario is an assumption or direction of policy in energy planning that will be carried out, [7].

India is the country with the highest average consumption of electrical energy compared to other BRICS countries. However, the GDP value obtained by India is still below China, with a relatively lower average use of electrical energy consumption than India. This shows that other factors affect a country's GDP. GDP is also heavily influenced by human resources. China and India are the most populous countries in the world, making it an opportunity and a challenge for the economy.

Based on research conducted by [8], found that the labor force has a positive effect on GDP, while based on research, [9], found that the labor force

hurts GDP. Research from, [10], revealed that based on other than labor and capital stocks, electrical energy is a much-needed input to produce goods and services. Thus, this study includes capital, an investment, to see its effect on GDP. Some economists view that the formation of investment is an essential factor responsible for the growth and development of a country's economy. According to [11], some economists believe investment formation is essential to a country's economic growth and development. Increasing capital stocks will increase productivity, production capacity, and quality, encouraging economic growth, [12]. This is in line with research conducted by [13], [14] which found that investment has a significant positive effect on GDP. Meanwhile, [15], found that investment does not affect GDP. Previous research differences underlie this research to produce the latest studies. The novelty of this study is distinguished by the object of study, the year of analysis, and the combination of variables used to see its effect on GDP. The purpose of this research is to identify the factors that influence GDP. The variables used are electricity consumption, workforce, and investment in BRICS countries. The benefit of this research is expected to be one of the policy recommendations for BRICS countries in particular and can be adapted by other countries to achieve economic prosperity.

Gross Domestic Product (GDP) is the total value of goods and services produced in a country by both domestic and foreign citizens in a year [16]. According to [17], economic growth is measured by GDP. One of the factors that significantly affect GDP is energy. Energy as a resource in the economy has an important role, especially electrical energy, which is a primary need for households and companies. Based on Adam Smith's Classical theory and the neo-classical economic views of Robert Solow and Trevor Swan, four factors affect the economic growth of the population, the number of stocks of capital goods, the area of land and natural resources, and the level of technology used, [18], in this study using electrical energy consumption to represent natural resource variables.

The amount of electricity consumption is directly linked to a country's economic growth due to the expansion of the global economy and the increase in per capita income demanding electricity-based equipment, [19]. Based on research conducted by, [19], in their research entitled "Electricity Consumption and Economic Growth: A Revisit Study of Their Causality in Malaysia" found that electricity consumption has a positive effect on Malaysia's economic growth. According to [20],

Solow's growth model shows that economic outputs are influenced by capital, labor force, and technology changes.

Research conducted by [21], found interesting results, namely that the population has a negative relationship to economic growth, while the labor force positively influences economic growth. The research conducted by Utama also distinguishes male labor and female labor, where male labor has a negative and significant impact on economic growth. The female workforce significantly influences economic growth in the five countries of the Organization of Islamic Cooperation (Indonesia, Pakistan, Egypt, Nigeria, and Bangladesh). Research from, [22], found that the labor force significantly affects economic growth.

Research from, [23], in Harrod-Domar's theory, capital formation is seen as an expenditure that will increase the ability of an economy to produce goods, and as an expenditure that will increase the effective demand of the entire community. So it can be concluded that economic growth can increase with investment. This study used Gross Fixed Capital Formation (GFCF) data as an indicator for investment. Gross fixed capital formation is an expenditure made by the government for capital goods investment activities, not for consumption activities, which includes developing and improving infrastructure in a country, [24].

The positive relationship between gross fixed capital formation and GDP was found to have a significant positive correlation in the research, [25]. According to [26], investment will increase production capacity by increasing the company's capital goods so that total production will impact the amount of income and continuously affect the national income of a country. The study results align with the research, [27]. Increasing the GFCF will create an expanded scale that can create jobs to increase public consumption and improve a country's economy.

2 Methodology and Variables

The type of data in this study uses secondary data, namely data obtained from the World Bank and Energy Information Administration (EIA) institutions. This study used a panel data set from 5 regions covering Brazil, Russia, India, China, and South Africa (BRICS). The period used in this study was between 1992-2021. The determination of the research timeframe is based on the availability of the latest data, which includes economic growth, electrical energy consumption, labor force, and investment in BRICS countries. In those years, there

was also economic development in the BRICS country. At the same time, the selection of BRICS countries is because the strength of these countries is tremendous, even with a small number. One of the BRICS members is China, with the most populous population in the world, so this study also included labor force variables to see how it affects economic growth in the long term.

To determine the long-term relationship between electrical energy consumption, labor force, and investment to economic growth in BRICS countries from 1992 to 2021, the method used is Fully Modified Ordinary Least Square (FMOLS) with data processing tool EViews 10. This study used a specific model, as seen in Equation 1.

$$\text{LNGDP} = \beta_0 + \beta_1 \text{LNENC}_{it} + \beta_2 \text{LNLF}_{it} + \beta_3 \text{LNGFCF}_{it} + \varepsilon_{it} \quad (1)$$

Where LNGDP is the logarithm of natural Gross Domestic Product (USD), LNENC is the logarithm of natural electrical net consumption (Billion kWh), LNLF is the natural logarithm of the labor force (Soul), LNGFCF is the natural logarithm of Gross Fixed Capital Formation (USD), β_0 is Constant, $\beta_1, 2, 3$ is Coefficient, ε is Residual, i am Region (5 countries of BRICS). T is time (1992-2021).

The first method is after a literature review and hypothesis development. Furthermore, a descriptive statistical analysis of research variables was carried out. Before the data is tested using the FMOLS method, stationarity, and cointegration tests are carried out. The first is related to stationary testing. According to [28], this method is carried out so that the data avoids spurious regression between dependent and independent variables. Spurious regression is a condition where the coefficient of determination is relatively high, but the relationship between the dependent variable and its independent variable has no meaning. This study used the Augmented Dickey-Fuller (ADF) and Phillips Perron (PP)-Fisher test methods. The provision is that when the probability value is above the significance level (0.05), the data is declared non-stationary, and vice versa. The data is declared stationary when the probability value is below the significance level. A first different stationary test is carried out when the data is not stationary at the level. Data that is already stationary at first can be continued testing with cointegration tests.

According to [28], a cointegration test was carried out to determine whether the variables studied had a long-term equilibrium relationship. This study uses the Kao Residual Cointegration Test method. Kao in Baltagi (2013), [29], uses a residual-

based standard approach of DF and ADF tests to test cointegration in panel data by adopting a step procedure performed by Eagle-Granger. Data is declared cointegrated when the probability value is smaller than the significance level (0.05). After the data is declared cointegrated, the FMOLS test can be carried out.

3 Result and Discussion

3.1 Result

The first condition for FMOLS to be met is that all research variables must be stationary. Research conducted by [30], suggests that the latest literature shows that panel-based unit root tests have higher strength than unit root tests based on individual time series. In Table 1, it can be seen that only the labor force variables (LNLF) are stationary at the level and first different. In contrast, the gross domestic product (GDP), electricity consumption (LNENC), and investment (LNGFCF) variables are not stationary at this level. This can be seen from the labor force probability value of less than the significance level (0.05), while other variables have a more excellent probability value than the significance level. Because the data is not stationary at the level, it is necessary to carry out further testing on the first difference. After the first different test was carried out, it was discovered that all variables used in this study were stationary, so the first condition for the FMOL model was met. Thus, the next test can be carried out, namely the cointegration test (Table 1).

Table 1. Unit Root Panel Test

Variable	Root Method	Unit	
		Level	1 st Different
LNGDP	ADF-Fisher	0.8731	0.0000*
	PP-Fisher	0.9347	0.0000*
LNENC	ADF-Fisher	0.9544	0.0000*
	PP-Fisher	0.7849	0.0000*
LNLF	ADF-Fisher	0.0013*	0.0156*
	PP-Fisher	0.0000*	0.0000*
LNGFCF	ADF-Fisher	0.8601	0.0005*
	PP-Fisher	0.8884	0.0000*

Note: *significant at 5%

After the stationary test is carried out and confirmed that all static data is first different, the cointegration test is carried out. The cointegration test is carried out by testing the stationariness of the residual so that an adjustment occurs towards a long-term balance between variables. In other

words, two variables are said to be cointegrated if the two random variables move together with the same pattern even though the two variables are each random walks. The cointegration test in this study used the Kao Residual Cointegration Test method. The cointegration test output is presented in Table 2. Table 2 shows that the ADF probability is 0.0000, where the figure is smaller than the significance level. So it can be concluded that the variables used in this study are cointegrated in the long term. Both conditions for the FMOLS test have been met. The next step is to estimate FMOSL.

Table 2. Kao Residual Cointegration Test Results

ADF	t-Statistic	Prob.
	-5.626874	0.0000
Residual variance	0.002600	
HAC variance	0.002337	

Both conditions for conducting the FMOLS test have been met and are related to the FMOLS estimation output shown in Table 3. The use of the FMOLS method to determine the long-term effect of electricity consumption variables, labor force, and investment on gross domestic products in BRICS countries in 1992-2021. Based on Table 3, it can be known the probability value that shows the coefficient and statistical value of each variable used in this study.

The variable t-static values of electricity consumption (LNENC), the labor force (LNLF), and investment (LNGFCF) were 3.615958 and 1.9892296, respectively. and 48.94104. As for the t-table value with the degree of freedom (n-k), where n is the number of observations and k is the number of free and bound variables used, the value of the degree of freedom=146 is obtained from (150-4). Based on this, it can be seen that each t-statistical value of the free variable is greater than the t-table value, so it is concluded that the variables of electrical energy consumption, labor force, and investment have a significant effect on GDP in the BRICS country in 1992-2021. In Table 3, it is also known that the regression coefficient (R2) value in this study is 0.995686, meaning that the consumption of electrical energy, labor force, and investment can affect the GDP variable of 99.5686 percent. In comparison, the remaining 0.4314 percent is explained by other variables not included in the model.

Table 3. FMOLS Test Results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNENC	0.010430	0.002884	3.615958	0.0004
LNLF	0.252419	0.126889	1.989296	0.0487
LNGFCF	0.856046	0.017491	48.94104	0.0000
R-squared	0.995686	Mean dependent var	27.6020	2
Adjusted R-squared	0.995465	S.D. dependent var	1.12975	9
S.E. of regression	0.076079	Sum squared resid	0.79296	3
Long-run variance	0.012752			

3.2 Discussion

The value of the coefficient of electrical energy consumption is 0.010430, meaning that if the consumption of electrical energy increases by 1 percent, then the GDP in BRICS countries will increase by 0.010430 percent, ceteris paribus. The results of this study are by Classical Economic Theory, where one of the factors of economic growth is natural resources. Electrical energy is included in natural resources vital to a country's economy. This research is also by the Neo-Classical Theory, which states that an increase in energy consumption reflects an increase in the economy, [31]. The increase in electricity consumption identifies the high purchasing power of electricity by the public (both for household and corporate consumption), which shows that people's incomes are also high to increase GDP, thus to the positive correlation between energy consumption and GDP. Different results are shown by research conducted by [32], which found that increased consumption of electrical energy will have a negative effect on GDP.

This research is in line with research conducted by [33], in their research entitled "Influence of Electricity Consumption of Industrial and Business, Electricity Price, Inflation and Interest Rate on GDP and Investments in Indonesia" The findings suggest that the path coefficient on electricity consumption to GDP is 0.951. CR = 37.06 means that electrical consumption has a significant favorable influence on GDP. The results of this study also, in line with research conducted by [34], in their research entitled "The Relationship between Electricity Consumption and Economic Growth in China," found that there is a one-way positive causality between electricity consumption and economic growth, meaning that electrical energy consumption has a positive effect on economic growth.

The findings in this study are by the phenomenon identified in the descriptive statistical analysis, China with large energy consumption accompanied by high GDP obtained in 2021. Nonetheless, BRICS is a developing country in terms of resource production and management and requires a consistent supply of energy resources; BRICS countries must monitor energy consumption, focusing on the energy supply-demand gap and its components and facilities provided to local and foreign investors, [35]. South Africa, with the lowest average energy consumption compared to other countries, is one of the most intensive economies globally. Based on the report of the (India Council for Research on International Economic Relations (ICRIER) (2021), [36], mentions that South Africa has one of the most energy-intensive economies globally and accounts for about 40% of all electricity on the African continent. In addition, the ICRIER report (2021) states that access to electricity in Brazil has reached almost the entire population with 99.8% housing coverage, 97% of good quality services, and by the end of 2020, as many as 86.7 million electricity meters installed covering 86% of households. The use of large electrical energy consumption can increase economic growth.

This condition still needs to pay attention to the limited resources in meeting the needed electrical energy consumption. Using electricity that does not apply sustainable principles can reduce the country's margins to a low level. In the long run, it is feared that it will harm the environment and lead to expensive repair costs. BRICS countries have an excellent opportunity to realize a sustainable economy. Solar and wind-based power generation has been India's cheapest source of bulk power generation since 2018, driven by successful auctions and falling equipment costs worldwide, [37]. When viewed from the opportunities in India and China, wind resources are the most targeted potential to develop sustainable energy in these countries.

India is the country with the highest consumption of renewable energy compared to other BRICS countries. Moreover, it can be known that the most effective use of renewable energy comes from hydroelectric. Thus governments in India can optimize hydroelectric use to meet energy consumption needs. The government needs to work with the private sector and the public to use sustainable energy for the long-term sustainability and prosperity of the country. Other countries such as Brazil, Russia, China, and South Africa can optimize the use of renewable energy. The latest aggregate data on Brazil's electricity and energy

sources was published in 2021, referring to data from 2020. Among the sources of electricity in Brazil, hydropower accounted for 652 percent, followed by biomass (91 percent), wind energy (88 percent), natural gas (83 percent), and other energy sources. Russia has the potential for hydroelectric, wind, water, geothermal, biomass, and solar energy. While China has the potential for safe and structured solar, wind, water, and nuclear energy. South Africa has the potential for renewable energy development in wind and solar. In an effort to increase the development of renewable energy following the potential of each country, there needs to be the preparation of an implementable planning document as well as a comprehensive and transparent implementation plan.

The value of the labor force coefficient is 0.252419, meaning that if the labor force increases by 1 percent, then GDP in BRICS countries will increase by 0.252419 percent, *ceteris paribus*. This study's results support Robert Solow and Trevor Swan's theory that the labor force positively influences economic growth. The study's results do not align with the research conducted by [38], in his research entitled "Contemporary Indonesian GDP: Context of Analysis at Unemployment, Labor Force and Poor People." The negative influence of the labor force on GDP is caused by the lack of skills of the labor force, so the labor force increases but is not accompanied by increased output which results in a decrease in the amount of GDP.

Research conducted by [21] and [39], found that the labor force positively and significantly affects GDP. According to [40], the country's GDP is calculated based on the total income each resident earns in economic activity and the total costs incurred to obtain goods and services. So the more productive a country is, supported by the labor force, the more it will increase its GDP. Thus, the labor force can increase GDP in the BRICS countries. The high labor force in BRICS countries that have a positive correlation can also be used as a reference for other developing countries to adopt appropriate policies in each country. The findings in this study follow the phenomenon already identified in the descriptive statistical analysis; China, with the most significant labor force, also corresponds to the high GDP obtained. The relatively lower labor force compared to other BRICS countries is also accompanied by a lower GDP obtained by South Africa compared to other countries. The number of inhabitants certainly influences the high labor force.

The country with the largest population is China, followed by India. This condition shows that BRICS has a vast population. The high number of people in

BRICS countries, especially China and India, needs to be considered to improve the quality of human resources. The government can improve soft and hard skills built since school in collaboration with the private sector. Improving these skills certainly pays attention to the needs of the abilities needed in the future. If the increase in population is not accompanied by an increase in the quality of resources, it can cause demographic problems and is not by the sustainable development goals.

The value of the investment coefficient is 0.856046, meaning that if investment increases by 1 percent, then GDP in BRICS countries will increase by 0.856046 percent, *ceteris paribus*. The results of this study support Harrod-Domar's theory, which states that capital can increase people's effective demand and as an expenditure that will increase the ability of the economy to produce goods and services. From this statement, it can be seen that investment has a multiplier effect. According to [41], investment can generate income and increase economic production capacity by adding capital stocks. Investment can create jobs to reduce unemployment and poverty, improving welfare.

Research from [42], is similar to the findings of this study. Investment is essential in economic development and supports improving the production process, so investment and GDP have a positive influence. The results of this study are supported by findings from [43]. However, there are differences in the results of research conducted by, [44], which found that investment negatively influences GDP in long-term conditions.

The most significant investment is in China at 29.4577 percent. The high investment in China can improve the economy, and the high GDP of China accompanies this. What needs to be considered when a country has a significant investment value is that the budget for allocating funds should be intended for productive sectors that can improve the economy. Not only physical investment but also human capital investment, this is also considering that China is one of the countries with the most populous population in the world.

4 Conclusion

Based on the results of FMOLS, it is known that in the long term, the consumption of electrical energy, labor force, and investment significantly positively affects GDP in BRICS countries. Electrical energy consumption in BRICS countries is predominantly supported by hydroelectric. If hydroelectric optimization continues to be pursued, the significant need for electrical energy in BRICS countries can be

met without harming the environment.

Environmental damage due to economic activities will lead to more expensive repair costs in the future. In other words, optimizing the use of sustainable energy is essential. The phenomenon of BRICS countries can be used as an example for developing countries that need electrical energy to utilize sustainable energy.

The use of sustainable energy can support sustainable development. This is accompanied by efforts to reduce the number of people in countries with high reflections (such as China and India). Improving the quality of human resources through improving the quality of education is very important. It can also delay marriage because a person is educated and gets married at a mature age. If this is done, the existing workforce can have the necessary work skills and create a healthy generation in the future. This can be accompanied by convenience for investors investing in BRICS countries. In addition, BRICS countries should strive for more prosperity in South Africa. Based on the results, value, GDP, investment, and labor force in South Africa occupy the bottom position compared to other BRICS countries. One of South Africa's potentials is gold as a significant mine. The policies implemented in South Africa should provide leeway for investors to invest in the country. Thus, it can create jobs and ultimately improve the South African economy.

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Contribution of Individual Authors to the Creation of a Scientific Article (Ghostwriting Policy)

The author contributed in the present research, at all stages from the formulation of the problem to the final findings and solution.

Sources of Funding for Research Presented in a Scientific Article or Scientific Article Itself

The research in this manuscript is supported by Informatics and Business Institute Darmajaya.

Conflict of Interest

The author has no conflicts of interest to declare.

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