Bulletin of Business and Economics
ISSN - 2409 - 9368
http://rfh.org.pk/jur/magazine-category/bbe

EXPLORING THE RELATIONSHIP BETWEEN ENERGY USAGE AND ECONOMIC GROWTH: IN THE PERSPECTIVE OF BRICS NATIONS

SYED FAZAL REHMAN[1], HADYA FATIMA CHEEMA[2]

ABSTRACT

We investigated the relation among energy usage and economic growth for BRICS nations using panel data from 1990 to 2019 in this study. GDP per capita as our dependent variable and Energy use, Gross fixed capital formation, Total Labor force are our independent variables. We applied Pedroni's test cointegration, Kao residual cointegration test, and Johansen fisher cointegration test for panel data. 2 out of these 3 techniques have reflected the presence of long-run cointegration and equilibrium relationship among our variables. Our panel ECM revealed the presence of long causality between the variables. Unidirectional causality by dependent variable on independent variables is observed in pairwise testing for causality. But no evidence of the presence of any causal effect of energy use on economic expansion is found. Outcomes of FMOLS estimation reflected energy usage as an insignificant variable.

Keywords: Economic expansion, Economic growth, Energy,
JEL Codes: O40, P18

I. INTRODUCTION

BRICS is the grouping of 5 main developing countries which include; China, Russia, Brazil, India, and South Africa, these countries comprise 23% of the worlds GDP, 42% of the world's population, 30% of the region, and 18% of the worldwide trade. The BRIC states are recognized by a large group of other promising developing sectors by their segment and financial potential to rank among the world's biggest and most powerful economies in the current 21st century. (Demir & Ersan, 2017) BRIC nations, a gathering of nations to think about given their undeniably significant function on the world's economic system. They enjoy some perks which make them the emerging economies of the world like; low labor prices, good demographics, and plenty of natural resources. The term was instituted by an economist Jim O'Neill in 2001 as an abbreviation for the four nations, which were considered to be at a comparable phase of economic development. In 2009 the heads of the four nations held their first summit and in 2010 BRIC turned into a proper foundation. South Africa started endeavors to join the BRIC gathering and on December 24, 2010, was welcomed to join BRIC. The main goal of BRICS was laying the foundation of an impartial, democratic, and multi-polar world order, however, later BRICS turned into a political association, particularly after South Africa united with them.

From 2000 to 2008, the brick countries accumulated contribution of the global economic GDP rose from 16% to 22%. Jointly, the BRIC nations represented 30% of the expansion in worldwide yield during the time. Until this point, the size of China's economy and movement of its improvement has out-removed those of its BRIC countries. China contributed more than half in comparison to the other BRIC nations. From 200 to 2008, 15 percent of the rise in the global economic output was by China. (Loo, 2018) states that just china has shown a stable and expected growth out of the 4 nations, and the other BRICS countries are not progressing as anticipated. The connection between energy utilization and economic development decides the idea of energy issues just as development issues. The ideal energy strategy for the nation can likewise be resolved if the connection between energy utilization and economic development is accurately decided since CO2 discharges related to energy utilization triggers worldwide

[1] Department of Economics, Comsats University, Islamabad Campus.
[2] Department of Economics, Comsats University, Islamabad Campus.

global warming, which is considered to affect people in the future. On the off chance that energy utilization now gives economic development in a nation, diminishing energy utilization to avoid its negative effect on the climate will be a good policy (Bayat et al., 2017). As the emerging economies of the world, they are producing more and more, which results in more usage of energy resources, so these BRICS countries are playing a great role in the world energy markets. Wu et al., (2017) portrays that the BRIC countries have experienced shocking economic advancement during the previous few decades. Notwithstanding, quite a fast improvement actuated an enormous utilization of natural resources, which is giving rise to environmental problems. As per information from the Us energy information administration, the BRICS countries, which are being led by the next anticipated word superpower china, these national will contribute 38% of global primary usage by the year 2025, this was 27% in 2005. Some of these countries will manage this energy demand and usage better in comparison to the others.

As a benefit of their resource endowment and the kind of their energy usage, Russia and Brazil are moderately energy-secure countries. Russia and Brazil were the second and ninth biggest oil producers in 2011, respectively. The world's fifth-largest coal maker and the world's biggest maker and exporter of petroleum gas were Russia, a year ago. As far as concerns, Brazil is for the most part relies on hydropower for electricity production, and ongoing seaward oil finding may before long launch it into the positions of significant oil exporters. China and India are the less independent, however prevalent foundation and a unified government position China better to fulfill its rising energy need. India has the most volatile energy condition out of the other BRICS countries and it possibly has the most unexpected future for energy usage. As stated by (Berardi, 2015), the information introduced in reports of the World Bank, the United Nations Environment Program, is contrasted and national reports just as with studies for research. This study shows that the BRIC nations have already used energy in comparison to the developed nations, and the extension of their structure stock raises a basic earnestness for energy effectiveness in buildings. The measures received in developed states are inadequate to ensure a huge decrease in their energy utilization in buildings. The objective of writing this paper is to investigate the relationship and between energy utilization and economic development and growth for India, Russia, China, and Brazil South Africa BRICS nations. (Wu et al., 2017) The BRIC nations have encountered great economic progress during the last few decades. Notwithstanding, quite a fast improvement actuated an enormous utilization of natural resources, which is giving rise to environmental problems. Yıldırım et al., (2019) states that, there exists a bi-directional causality among connection energy utilization and financial development for BRICS nations. An expansion in GDP prompts an expansion in energy utilization and an expansion in energy utilization prompts an expansion in GDP.

II. LITERATURE REVIEW

In this section, we have displayed some previous researches and explorations on the topic. The effect of biomass energy still happens to be a debatable issue, and there is no agreement between researchers. Past researchers gave attention to the impacts of biomass energy utilization on financial development and the environment. While most examinations demonstrate that the utilization of biomass energy improves financial development and adds to natural assurance, a few investigations show the contrary outcome. Their study wanted to add to the current writing by finding the impact of biomass energy utilization on human improvement in these groups of nations (BRICS) in the period 1990–2015. Utilizing econometric models and methods which can tackle the issue of cross-sectional reliance and heterogeneity of slant, for example, CIPS and CADF unit root tests, LM bootstrap board cointegration test, Continuously-Updated Fully-Modified (CUP-FM) and Continuously-Updated Bias-Corrected (CUP-BC) assessors, and Dumitrescu-Hurlin board causality test, our outcomes uncover that biomass energy utilization give a rise to human advancement in BRICS nations and bidirectional causality is present between these two factors. These outcomes might be a proposal for policymakers to advance the use of biomass energy.(Wang et al., 2020)

Zhang & Wang (2019) mention that lately, BRICS nations have started giving extraordinary significance to renewable and environmentally friendly energy development and effectively advanced the move of economic form of structure towards services industry, to accomplish the decoupling of economic improvement by carbon emission. Many researchers often disregard the cross-sectional reliance and heterogeneity problems, they can lead to biased results. This research paper chooses the panel data of BRICS nations during 1996–2017 and utilizes the common correlated effect mean gathering (CCEMG), which consists of the cross-sectional reliance and heterogeneity presumptions, to investigate the impact of renewable power utilization and administration industry improvement on CO2 emanations in BRICS nations. Moreover, we use the random-effects model and pooled assessed least squares model, just as completely altered OLS model for correlation. The outcomes demonstrate that improving the extent of

sustainable power utilization in all-out energy utilization is a viable measure to lessen CO2 emanations in BRICS nations. Besides, the consistently rising share of the service sector to economic development in BRICS nations during the same time frame doesn't add to diminish CO2 emission.

Wang (2019) their research papers explore biomass energy utilization and environmental contamination in BRICS nations by applying the generalized framework technique for the second (GMM) model for observational assessment from the period of 1992 to 2013. The outcomes show that biomass energy utilization carries on as a perfect fuel source in diminishing environmental contamination. Shahbaz et al., (2018) revealed that their paper inspects the deviated effect of globalization and economic development on energy utilization in BRICS nations, applying the NARDL bounds method for exploring the presence of asymmetric cointegration between the variables. The outcomes uncover that energy utilization is emphatically and adversely influenced by the good and bad globalization stuns. A positive and good shock in financial and economic growth advances energy utilization, while a negative shock lessens energy utilization. As stated by Aydin (2019) In this examination, the connection between economic development and biomass energy utilization has been inspected inside the structure of the production function for the BRICS nations in the time period of 1992-2013 utilizing the cross-sectional (CIPS) panel unit root test, the Westerlund and Edgerton bootstrap LM board cointegration test, and the bootstrap board causality test that permit cross-sectional reliance. The outcomes show that the development theory is legitimate in Brazil and India; notwithstanding, the protection speculation is substantial in China and South Africa. The speculation that applies to Russia is the feedback theory. The fundamental finding is that BRICS nations should expand the utilization of biomass energy utilization to supportable climate, advance economic development, and diminishing energy reliance.

Adedoyin et al., (2020) revealed that, for growth in BRICS nations, and to accomplish a decrease in the degrees of CO2 emissions for green and sustainable development, more rigid environmental-energy-related guidelines are inescapable. In this manner, for policymakers, it is indispensable to strengthen the utilization of rigid guidelines as these economies open up to more utilization of coal energy. Be that as it may, the need to move, the energy blend in BRICS to renewables is appropriate in a period of worldwide environmental cognizance for cleaner fuel sources. Tamazian et al., (2009) paper examine the linkage among economic and monetary turn of events and a decrease in environmental quality in BRIC economies for the period 1992 – 2004. As the proportion of power, we likewise present and analyze the conduct of results thinking about USA and Japan. We utilize the achievable general least squares (FGLS) strategy to assess the environmental effect of the economic and monetary turn of events. Simultaneously, our examination satisfies the econometric analysis of the Environmental Kuznets Curve featured by Stern (2004). Our discoveries affirm the presence of EKC as the outcomes show that economic improvement diminishes environmental corruption with more significant levels of economic development. The outcomes additionally uncover that monetary improvement is a fundamental factor to diminish the CO2 per capita outflows.

The goal of the investigation is to look at the four components of green development i.e., energy, climate, wellbeing, and wealth in BRICS nations. The examination inspects the connection between energy utilization, climate, wellbeing, and its subsequent effect on BRICS′ economic development. The general outcomes demonstrate that environmental factors deleteriously affect the BRICS economic development, while fuel sources altogether increment economic development in the nations. Wellbeing consumptions and framework required appropriate consideration of fruitfulness and mortality related medical problems in the BRICS nations. The outcomes accentuated the significance of green development and manageable formative arrangements that help to facilitate the development cycle and government assistance of the nations (Zaman et al., 2016). Energy utilization as a determinant of economic development is an issue that has been talked about as of late in the hypothesis of economics. In this investigation, the connection between energy utilization and economic development in BRICS nations from 1990 to 2013 is dissected by board information examination. As per the aftereffects of experimental examination, preservation speculation in Russia and criticism theory in Brazil, and nonpartisanship speculation in different nations are found (Bayat et al., 2017). The principal motivation behind this examination is to assess the causality connection between energy utilization and economic development for developing nations. Yearly information of 22 created nations was inspected by utilizing Dumitrescu Hurlin board causality investigation. Accordingly, it was resolved that there is a bidirectional connection between energy utilization and economic improvement for these states. This condition gives two distinct outcomes. Initially, energy utilization impacts economic advancement for these nations. While thinking about this outcome, it tends to be said that any impediment in energy utilization will confine economic development. Also, it was additionally presumed that degree of

economic development is the primary explanation of energy utilization for created nations. All in all, created nations will, in general, have more energy utilization when their economies are developing (Dinçer et al., 2017)

Azam (2019) the research assesses the effect of energy, environmental contamination, human resources, economic development of BRICKS nation 1981-2015. Important symptomatic tests, the Panel Fully Modified Ordinary Least Squares (F.M.O.L.S.), Robust Least Squares (R.L.S.) strategies, and the Dumitrescu-Hurlin. This investigation assesses the effect of energy, environmental contamination, human resources, development in finance, from 1981 to 2015. Consequently, given the discoveries, this investigation suggests that the BRICS nations' policy formers need to figure public strategy to guarantee satisfactory energy supply, upgrade unfamiliar ventures, improve healthcare area, and direct environmental contamination to accomplish development more sustainably. Financial advancement drives industrialization, which expanded the estimation of extricated natural resources. Inordinate use of natural resources, through horticulture, deforestation, and mining can influence the climate. In such a manner, the current examination explores the impacts of natural resources' wealth on carbon dioxide (CO2) emissions. The investigation utilizes yearly board information crossing from 1990 to 2015 in BRICS nations. The expanded mean gathering (AMG) board calculation, hearty to cross-sectional reliance and heterogeneity, deduces the heterogeneity impact of natural resources on CO2 emissions among BRICS nations. Bounty of natural resources mitigates CO2 discharge in Russia, yet adds to pollution in South Africa. Likewise, natural resources help to shape the Environmental Kuznets Curve (EKC) theory in Brics countries. At last, the causality examination recommended criticism theory among CO2 emission and natural resources (Danish et al., 2019)

Financial improvement seems to increment environmental debasement in India. The primary supporters of environmental debasement are economic development, urbanization, and energy utilization financial improvement. The outcomes additionally backup the presence of environmental Kuznets bends for the Indian economy (Sehrawat et al., 2015). Dogan & Deger, (2016) state that because of the cointegration investigation, it was seen that the arrangement was cointegrated in the long period. Then again, causality investigation results proposed a unidirectional causality connection from complete energy utilization to economic development and another unidirectional causality relationship from globalization to economic development. Ultimately, no causality relationship between energy utilization and globalization existed. Downie, (2015) tells that worldwide administration and worldwide exchanges, interviews with G20 energy authorities, and the perceptions of the author, a previous representative to G20 negotiations, this article analyzes whether the BRICs as an alliance have the limit and eagerness to drive considerable worldwide energy administration change. In doing as such, it features the issues with the BRICs as an alliance on energy and considers the possibilities for energy change considering China's expanding commitment with energy administration in front of it facilitating the G20 Summit in 2016.

III. DATA, METHODOLOGY, AND RESULTS

The model has been selected following the methodologies of Ali (2011), Ali (2015), Ali (2018), Ali and Bibi (2017), Ali and Ahmad (2014), Ahmad and Ali (2016), Audi and Ali (2016), Ali and Audi (2016), Ali and Audi (2018), Ali and Rehman (2015), Audi and Ali (2017), Ali and Naeem (2017), Audi and Ali (2017), Ali and Zulfiqar (2018), Ali et al., (2016), Arshad and Ali (2016), Ashraf and Ali (2018) Haider and Ali (2015), Sajid and Ali (2018), Ali and Senturk (2019), Kassem et al, (2019), Ali and Bibi (2020), Sulehri and Ali (2020) and Audi et al., (2021). We have utilized annual based data, extracted from the World Bank Website for BRICS nations.Our framework of panel data contains GDP per capita (constant 2010 US$) as a dependent variable and Gross fixed capital formation (constant 2010 US$), Energy use (kg of oil equivalent per capita), Total Labor force as our independent variable.

To examine the long-run relationship between the variables, the unit root test is the very first step to be taken. There are many types of unit root testing but here we are using the augmented dickey fuller test on our panel data to determine their level of stationarity. In order to apply panel cointegration testing, all the variables of our panel data must be stationary at first difference. The null hypothesis for this test is that variables have a unit root, whereas the alternative hypothesis says that the variable is stationary. Now if we look at **Table 1**, it reflects that all our variables are stationary at first difference because their p-value is less than 0.005 at the 5% significance level which leads to the rejection of null hypothesis. Thus, we can say that all of our panel data variables are integrated into order one.

Table 1: Panel unit root tests

Variable	Named As	P-value	Result
GDP per capita (constant 2010 US)	**Lgdp**	0.0006	stationary at first difference
Energy use (kg of oil equivalent per capita)	**Lenergy**	0.0001	stationary at first difference
Gross fixed capital formation (constant 2010 US$)	**Lgfc**	0.0019	stationary at first difference
Total Labor force	**Llabor**	0.0312	stationary at first difference

Table 2: Panel Cointegration Testing

Pedroni Panel Cointegration Test		
Null Hypothesis = No cointegration	(Within Dimension) Statistic	Prob value
Panel v statistic	-0.537607	0.7046
Panel rho statistic	0.910127	0.8186
Panel PP statistic	0.648413	0.7416
Panel A D F statistic	1.393139	0.9182
	(Between Dimension)	
Group rho statistic	1.938551	0.9737
Group PP statistic	1.538946	0.9381
Group A D F statistic	2.760002	0.9971

Table 3

Kao Residual Cointegration Test	
Variables = lgdp , lenergy , lgfc , llabor	
Null Hypothesis = No cointegration	
t statistic	prob value
-2.771182	0.0028

After panel unit root testing, we are going to apply (Pedroni, 1999, 2004) panel cointegration test to determine the presence of long-run cointegration between our variables.

$$Y_{it} = \alpha_{it} + \delta_{it} + \beta_{1i}E_{it} + \beta_{2i}K_{it} + \beta_{3i}L_{it} + \varepsilon_{it} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{Eq(1)}$$

Where E is reflecting variable of energy use, K for gross fixed capital formation, L for the total labor force, and Y for real GDP per capita.

Now if we look at **Table 2** which reflects the results of the panel cointegration test proposed by (Pedroni, 1999, 2004). **Table 2** comprises of 2 portions I.e., within dimension and between dimension. Within dimension contains panel cointegration stats and Between dimension contains stats of group mean panel cointegration. If we look at the p-value of test statistics for between dimension approach, we can see that the p-value of all these stats is greater than 0.05, which lead towards the acceptance of the null hypothesis of "no cointegration" at a 5% significance level. Now if we look at test statistics for between dimension approach, we can see that the p-value of all these stats are greater than 0.05, causing us to accept the null hypothesis and conclude

that there is no cointegration at the 5% significance. This reflects the absence of an equilibrium relationship between lgdp, lenergy, lgfc, llabor in the long run.

After applying Pedroni cointegration test for panel data, we are now using Kao residual cointegration test for panel data proposed by (Kao, 1999) to check the presence of cointegration between our variables. If we look at **Table 3** which contains the empirical results of this test. We can see that the p-value of this test is less than 0.005 which lead us towards the rejection of the null hypothesis of no cointegration at a 5% significance level. This result reflects the presence of an equilibrium relationship between our dependent and independent variables in the long run.

To get more evidence about the presence of cointegration between our variables, we have conducted another test known as "johansen fisher cointegration test" for panel data. **Table 4** presents the empirical results of this test.

Table 4

Johansen Fisher Panel Cointegration Test				
Variables = lgdp , lenergy , lgfc , llabor				
Null Hypothesis = No cointegration				
Hypothesized no of CE(s)	Fisher stat (trace test)	Prob value	Fisher stat (max eigen test)	Prob value
None	76.59	0.0000	55.93	0.0000
at most 1	31.20	0.0005	25.23	0.0049
at most 2	15.46	0.1161	12.55	0.2499
at most 3	16.39	0.0891	16.39	0.0891

Now if we look at **Table 4**, we can see that it reflects the number of cointegrating equations. If we look at none, we can see that the p-value of both the trace stat and max eigen stat lead us to not accept, the null hypothesis of no cointegration. Now if we focus on the p values of no of cointegrating equations at most 1, we can see that both p values are leading us towards the rejection of the null hypothesis. Now if we repeat the same exercise for no of cointegrating equations at most 2 and 3, we can see that their p values have more value than 0.05, forcing us to accept the null hypothesis of no cointegration. So, we can say that the number of the cointegrating equation is 1 and there is evidence of long-run cointegration and equilibrium relationship between our variables.

Table 5

Panel Fully modified least squares (FMOLS)			
Variable	Coefficient	t statistic	prob value
Lenergy	0.252125	1.379721	0.1699
Lgfc	0.500016	8.557414	0.0000
Llabor	-0.279769	-2.189652	0.0302
R square = 0.992508			
Adjusted R square = 0.992125			

After obtaining evidence of the presence of cointegration, we applied a fully modified OLS (FMOLS) technique proposed by (Pedroni, 2000), to estimate our panel data variables. **Table 5** provides the results of FMOLS estimation. Our variables are in natural log form, so we can interpret them as estimates of elasticity. **Table 5** reflects that a 1% increase in lenergy will increase lgdp by 0.252125% and vice versa. It shows that a 1% increase in lgfc will cause a 0.500016% of increment in lgdp and vice versa. The p-value of lgfc shows that the variable is significant. The table reflects that a 1% increase in llabor will cause a -0.279769% decrease in lgdp and vice versa.

D(LGDP) = C(1)*(LGDP(-1) - 3.18248440339*LENERGY(-1) -

0.434065624478*LGFC(-1) - 1.85777317264*LLABOR(-1) +

61.1196197583) + C(2)*D(LGDP(-1)) + C(3)*D(LGDP(-2)) + C(4)

***D(LENERGY(-1)) + C(5)*D(LENERGY(-2)) + C(6)*D(LGFC(-1)) + C(7)**

***D(LGFC(-2)) + C(8)*D(LLABOR(-1)) + C(9)*D(LLABOR(-2)) + C(10)……Eq(2)**

Table 6

Johansen Fisher Panel Error Correction Model		
Dependent variable = D(LGDP)		
	Coefficient	prob value
C(1)	-0.003159	0.0489
C(2)	0.524203	0.0003
C(3)	0.153403	0.3122
C(4)	0.056038	0.5123
C(5)	-0.070152	0.3722
C(6)	-0.057056	0.2748
C(7)	0.050088	0.3448
C(8)	0.563675	0.0200
C(9)	-0.207778	0.3873
C(10)	0.008390	0.0457

We have utilized a panel vector error correction test proposed by Engle and Granger (1987) to check the causality. **Eq (2)** is the cointegrated equation used to estimate the ECM model. C (1) is the ECM term in Table 6 which is significant at a 5% significance level and its negative sign reflects that the variable is converging towards the equilibrium in the long run. It also reflects the presence of long run causality of independent variables (lenergy, lgfc, labor) on the dependent variable (lgdp).

Table 7

Wald Test		
Null Hypothesis = C(4)=C(5)=C(6)=C(7)=C(8)=C(9)= 0		
Test statistic	Value	Probability
F stat	1.455950	0.1988
Chi square	8.735701	0.1890

To check the short-run causality, we have conducted a Wald test on the coefficients C (4), C (5), C (6), C (7), C (8), C (9) of **Eq (2)**. If all these coefficients are jointly influencing the dependent variables, then we can say that there is a short-run causality from independent variables to the dependent variable. From Table 7, we can see that the chi sq p-value of the Wald test is greater than 0.05. Thus, we accept the null hypothesis and conclude that there is no evidence of short-run causality by independent variables on our dependent variable.

To further analyze the short-run causal effect, we have conducted a pairwise granger causality test to examine the pairwise causality. If we look at **Table 8**, we can see that the null hypothesis is the same throughout. Considering the null hypothesis first pair that "lenergy does not granger cause lgdp" we can see that its p-value is greater than 0.05, which force us to accept null hypothesis and conclude that there is no evidence of short run causality. Now if we look at the p value null hypothesis that "lgdp does not granger cause lenergy" is less than 0.05, so we reject null and conclude that there is a uni directional causality from lgdp to lenergy. Now considering the second pair, we can see that p value of null hypothesis "lgfc does not granger cause lgdp" is greater than 0.005 and the p value of "lgdp does not granger cause lgfc" is less than 0.05, so we come to an end that that there is a uni directional causality from lgdp to lgfc. Now considering the third pair, we can see that p value of null hypothesis "llabor does not granger cause lgdp" is greater than 0.05 and the p value of "lgdp does not granger cause llabor" is lower than 0.005, so we conclude that there is a uni directional causality from lgdp to llabor. Now considering the fourth pair, we can see that p value of null hypothesis "lgfc does not granger cause lenergy" is less than 0.05 and p value of "lenergy does not granger cause lgfc" is greater than 0.05, so we can say that there is a uni directional causality from lgfc to lenergy. Presently we think about fifth pair, we can see that p value of null

hyopthesis "llabor doesn't granger cause lenergy" is more than 0.05 and p value of "lenergy doesn't granger cause llabor" is lower than 0.05, so we can say that there is a uni directional causality from lenergy to llabor. Presently we think about the last pair, we can see that p term of null hypothesis "llabor doesn't granger cause lgfc" is under 0.05 and p estimation of "lgfc doesn't granger cause llabor" is under 0.05, so we can say that there is a bi directional causality among llabor and lgfc.

Table 8

Pairwise Granger Causality Tests	
Null Hypothesis	Prob value
lenergy does not granger cause lgdp lgdp does not granger cause lenergy	0.8646 0.0126
lgfc does not granger cause lgdp lgdp does not granger cause lgfc	0.5689 1.E-05
llabor does not granger cause lgdp lgdp does not granger cause llabor	0.1455 0.0218
lgfc does not granger cause lenergy lenergy does not granger cause lgfc	0.0014 0.0668
llabor does not granger cause lenergy lenergy does not granger cause llabor	0.0901 6.E-07
llabor does not granger cause lgfc lgfc does not granger cause llabor	0.0008 0.0172

IV. CONCLUDING REMARKS

To understand the relation in between energy utilization and economic expansion from the perspective of BRICS countries, we carried out the above exercise. Our empirical results reveal a lot of variation in the relations among energy utilization and economic expansion. We have used the panel data from 1990 to 2019 for these countries. Our results for cointegration testing reflect the presence of long-run cointegration and the equilibrium relation amongour variables. The error correction model reflects the presence of a long-run causal relationship between the dependent and independent variables but there is an absence of short-run causal impact of independent variables jointly on our dependent variable. In pairwise causality checks, we observe that gdp has a unidirectional causal effect on all of these independent variables. Gross fixed capital formation is having a unidirectional causal effect on energy usage and energy usage is having a unidirectional causal effect on labor. There is bi-directional causality between labor and gross fixed capital formation. But there is no causal effect of energy usage on economic expansion. In our FMOLS results, we can see that our variable of energy usage is insignificant. Apergis & Payne (2009) also examined the same relationship for CIS countries by utilizing two different panels, In one panel Russia and excluding Russia in the other. Their findings confirmed the presence of long-run bi-directional causality between economic growth and energy utilization. We can say that Russia dominates the BRICS nations in natural gas, oil, and other sources of energy use. But no other country has as much meaningful effect of energy consumption on economic development, that is why our results are unable to reflect any positive effect of energy usage on GDP development.

REFERENCES

Adedoyin, F. F., Gumede, M. I., Bekun, F. V., Etokakpan, M. U., & Balsalobre-lorente, D. (2020). Modelling coal rent, economic growth and CO2 emissions: Does regulatory quality matter in BRICS economies? *Science of the Total Environment*, *710*, 136284.

Ahmed, K., & Ali, A. (2016). Rising Population and Food Insecurity Linkages in Pakistan: Testing Malthusian Population Growth Theory. *International Journal of Economics and Empirical*, 4 (1), 1-8.

Ali, A. & Naeem, M.Z. (2017). Trade Liberalization and Fiscal Management of Pakistan: A Brief Overview. *Policy Brief-Department of Economics, PU, Lahore*. 2017 (1), 1-6.

Ali, A. (2011). Disaggregated import demand functions of Pakistan; An empirical Analysis. M-Phil Thesis, NCBA&E, Lahore, Pakistan, 1-70.

Ali, A. (2015). *The impact of macroeconomic instability on social progress: an empirical analysis of Pakistan*. (Doctoral dissertation, National College of Business Administration & Economics Lahore).

Ali, A. (2018). Issue of Income Inequality Under the Perceptive of Macroeconomic Instability: An Empirical Analysis of Pakistan. *Pakistan Economic and Social Review*, 56(1), 121-155.

Ali, A. and Bibi, C. (2017). Determinants of Social Progress and its Scenarios under the role of Macroeconomic Instability: Empirics from Pakistan. *Pakistan Economic and Social Review* 55 (2), 505-540.

Ali, A., & Ahmad, K. (2014). The Impact of Socio-Economic Factors on Life Expectancy in Sultanate of Oman: An Empirical Analysis. *Middle-East Journal of Scientific Research*, 22(2), 218-224.

Ali, A., & Audi, M. (2016). The Impact of Income Inequality, Environmental Degradation and Globalization on Life Expectancy in Pakistan: An Empirical Analysis. *International Journal of Economics and Empirical Research*, 4 (4), 182-193.

Ali, A., & Audi, M. (2018). Macroeconomic Environment and Taxes Revenues in Pakistan: An Application of ARDL Approach. *Bulletin of Business and Economics* (BBE), 7(1), 30-39.

Ali, A., & Rehman, H. U. (2015). Macroeconomic instability and its impact on the gross domestic product: an empirical analysis of Pakistan. *Pakistan Economic and Social Review*, 285-316.

Ali, A., & Şenturk, İ. (2019). Justifying the Impact of Economic Deprivation, Maternal Status and Health infrastructure on Under-Five Child Mortality in Pakistan: An Empirical Analysis. *Bulletin of Business and Economics*, 8(3), 140-154.

Ali, A., & Zulfiqar, K. (2018). An Assessment of Association between Natural Resources Agglomeration and Unemployment in Pakistan. *Pakistan Vision*, 19(1), 110-126.

Ali, A., Ahmed, F., & Rahman, F. U. (2016). Impact of Government Borrowing on Financial Development (A case study of Pakistan). *Bulletin of Business and Economics* (BBE), 5(3), 135-143.

Ali, A., Mujahid, N., Rashid, Y., & Shahbaz, M. (2015). Human capital outflow and economic misery: Fresh evidence for Pakistan. *Social Indicators Research*, *124*(3), 747-764.

Apergis, N., & Payne, J. E. (2009). Energy consumption and economic growth: evidence from the Commonwealth of Independent States. *Energy Economics*, *31*(5), 641–647.

Arshad, S., & Ali, A. (2016). Trade-off between Inflation, Interest and Unemployment Rate of Pakistan: Revisited. *Bulletin of Business and Economics (BBE)*, *5*(4), 193-209.

Ashraf, I., & Ali, A. (2018). Socio-Economic Well-Being and Women Status in Pakistan: An Empirical Analysis. *Bulletin of Business and Economics (BBE)*, 7(2), 46-58.

Audi, M & Ali, A. (2017). Socio-Economic Status and Life Expectancy in Lebanon: An Empirical Analysis. *Archives of Business Research*, 5(11), 159-170

Audi, M. & Ali, A. (2017). Environmental Degradation, Energy consumption, Population Density and Economic Development in Lebanon: A time series Analysis (1971-2014). *Journal of International Finance and Economics*, 17(1), 7-20.

Audi, M. Ali, A. & Roussel, Y. (2021). Aggregate and Disaggregate Natural Resources Agglomeration and Foreign Direct Investment in France. *International Journal of Economics and Financial Issues*, 11(1), 147-156.

Audi, M., & Ali, A. (2016). A Causality and Co-integration Analysis of Some Selected Socio-Economic Determinants of Fertility: Empirics from Tunisia. *Bulletin of Business and Economics (BBE)*, 5(1), 20-36.

Aydin, M. (2019). The effect of biomass energy consumption on economic growth in BRICS countries: A country-specific panel data analysis. *Renewable Energy*, *138*, 620–627.

Azam, M. (2019). Relationship between energy, investment, human capital, environment, and economic growth in four BRICS countries. *Environmental Science and Pollution Research*, *26*(33), 34388–34400.

Bayat, T., Tas, S., & Tasar, I. (2017). Energy consumption is a determinant of economic growth in BRICS countries or not. *Asian Economic and Financial Review*, *7*(8), 823–835.

Berardi, U. (2015). Building energy consumption in US, EU, and BRIC countries. *Procedia Engineering*, *118*, 128–136.

Demir, E., & Ersan, O. (2017). Economic policy uncertainty and cash holdings: Evidence from BRIC countries. *Emerging Markets Review*, *33*, 189–200.

Dinçer, H., Yüksel, S., & Adalı, Z. (2017). *Identifying causality relationship between energy consumption and economic growth in developed countries*.

Dogan, B., & Deger, O. (2016). How globalization and economic growth affect energy consumption: Panel data analysis in the sample of BRIC countries. *International Journal of Energy Economics and Policy*, *6*(4).

Downie, C. (2015). Global energy governance: do the BRICs have the energy to drive reform? *International Affairs*, *91*(4), 799–812.

Haider, A., & Ali, A. (2015). Socio-economic determinants of crimes: a cross-sectional study of Punjab districts. *International Journal of Economics and Empirical Research*, 3(11), 550-560.

Kao, C. (1999). Spurious regression and residual-based tests for cointegration in panel data. *Journal of Econometrics*, *90*(1), 1–44.

Kassem, M. Ali, A. & Audi, M. (2019). Unemployment Rate, Population Density and Crime Rate in Punjab (Pakistan): An Empirical Analysis. *Bulletin of Business and Economics (BBE),* 8(2), 92-104.

Loo, M. K. L. (2018). A comparative analysis of global competitiveness among BRIC nations: Implications for China. *International Journal of Organizational Business Excellence*, *1*(2), 99–120.

Pedroni, P. (1999). Critical values for cointegration tests in heterogeneous panels with multiple regressors. *Oxford Bulletin of Economics and Statistics*, *61*(S1), 653–670.

Pedroni, P. (2000). *Fully Modified OLS for Heterogeneous Cointegrated Panels* (Department of Economics Working Papers, Issues 2000–03). Department of Economics, Williams College. https://econpapers.repec.org/RePEc:wil:wileco:2000-03

Pedroni, P. (2004). Panel cointegration: asymptotic and finite sample properties of pooled time series tests with an application to the PPP hypothesis. *Econometric Theory*, 597–625.

Sajid, A. & Ali, A. (2018). Inclusive Growth and Macroeconomic Situations in South Asia: An Empirical Analysis. *Bulletin of Business and Economics (BBE),* 7(3), 97-109.

Sehrawat, M., Giri, A. K., & Mohapatra, G. (2015). The impact of financial development, economic growth and energy consumption on environmental degradation. *Management of Environmental Quality: An International Journal*.

Shahbaz, M., Shahzad, S. J. H., Alam, S., & Apergis, N. (2018). Globalisation, economic growth and energy consumption in the BRICS region: the importance of asymmetries. *The Journal of International Trade & Economic Development*, *27*(8), 985–1009.

Sulehri, F. A., & Ali, A. (2020). Impact of Political Uncertainty on Pakistan Stock Exchange: An Event Study Approach. *Journal of Advanced Studies in Finance*, 11(2), 194-207.

Tamazian, A., Chousa, J. P., & Vadlamannati, K. C. (2009). Does higher economic and financial development lead to environmental degradation: evidence from BRIC countries. *Energy Policy*, *37*(1), 246–253.

Wang, Z. (2019). Does biomass energy consumption help to control environmental pollution? Evidence from BRICS countries. *Science of the Total Environment*, *670*, 1075–1083.

Wang, Z., Bui, Q., & Zhang, B. (2020). The relationship between biomass energy consumption and human development: Empirical evidence from BRICS countries. *Energy*, *194*, 116906.

Wu, R., Geng, Y., & Liu, W. (2017). Trends of natural resource footprints in the BRIC (Brazil, Russia, India and China) countries. *Journal of Cleaner Production*, *142*, 775–782.

Yıldırım, D. Ç., Yıldırım, S., & Demirtas, I. (2019). Investigating energy consumption and economic growth for BRICS-T countries. *World Journal of Science, Technology and Sustainable Development*.

Zaman, K., bin Abdullah, A., Khan, A., bin Mohd Nasir, M. R., Hamzah, T. A. A. T., & Hussain, S. (2016). Dynamic linkages among energy consumption, environment, health and wealth in BRICS countries: green growth key to sustainable development. *Renewable and Sustainable Energy Reviews*, *56*, 1263–1271.

Zhang, Y.-J., & Wang, W. (2019). Do renewable energy consumption and service industry development contribute to CO 2 emissions reduction in BRICS countries? *Environmental Science and Pollution Research*, *26*(31), 31632–31643.