RES MILITARIS
REVUE EUROPEENNE D ETUDES EUROPEAN JOURNAL OF MILITARY STUDIES

Social Science Journal

Examining The Impact Of Financial Inclusion On CO2 Emission In BRICS: Evidence From Panel Data Analysis

By

Sehar Asif
Lahore School of Accountancy & Finance, The University of Lahore, Pakistan
Email: asifsehar750@gmail.com

Amber Zafar
Lahore School of Accountancy & Finance, The University of Lahore, Pakistan
Email: amber.mab1@gmail.com

Usman Zahoor
Lahore School of Accountancy & Finance, The University of Lahore, Pakistan.
Email: usman.zahoor@uolcc.edu.pk

Muhammad Shahbaz
Senior Auditor, Accountant General Punjab Lahore. Pakistan.
Email: shaheen14366@yahoo.com

Ahmed Shahzad
The Institute of Management Sciences (Pak-AIMS, Lahore), Lahore, Pakistan
Email: greataryan786@gmail.com

JEL Classification: M41; G31; G32

Abstract

Research background: The impact of financial inclusion on CO_2 emissions could be either positive or negative. From the first point, financial inclusion makes it easier for organizations and businesses to access financial systems, facilitating the funding of green technologies. Second, increased access to financial services raises industrial and manufacturing output, which can lead to higher CO_2 emissions. Furthermore, growing financial inclusion enables people to afford energy-intensive devices such as air conditioners and automobiles. Because they emit more greenhouse gases, their use poses a major ecological concern.

Purpose of the article: This study aims to examine the impact of financial inclusion on CO_2 emissions in the BRICS countries.

Methods: This study used ARDL and Granger causality to examine the link between financial inclusion and CO_2 emissions from 1980 to 2019.

Findings & value added: Increased financing, according to the study's conclusions, will raise CO_2 emissions. However, this study has two shortcomings. The first is that no research has been conducted to define the relationship between CO_2 emissions and BRICS financial inclusion. Furthermore, in previous studies, serial correlation, heteroscedasticity, long-short causality, and data restrictions were not problematic.

Keywords: Financial inclusion;co_2 $emission$; economic growth; industrialization; trade openness

Introduction

The disastrous repercussions of climate change on human health and environmental sustainability have received global attention. According to (Wawrzyniak and Doryn, 2020), the widespread use of nonrenewable energy sources and industrial waste is largely to blame for rising greenhouse gas emissions. Given that CO2 emissions account for 70% of total greenhouse gas emissions, it is widely assumed that they are a major contributor to environmental degradation (Sarkodie et al., 2020).

The impact of financial inclusion on CO_2 emissions theoretically may be either favorable or unfavorable. From one perspective, financial inclusion makes it easier for organizations to access financial systems, which facilitates the funding of green technologies. Better ecological practices in this aspect reduce climate change contributions (IPA, 2017). From a 2nd perspective, increased access to financial services boosts industrial and manufacturing output, which can lead to higher CO2 emissions (Jensen, 1996). Additionally, greater financial inclusion helps people afford energy-consuming products like air conditioners, cars, etc. Their uses pose a serious ecological risk since more greenhouse gases are released. Two empirical studies, Le et al. (2020) and Renzhi and Baek (2020), have so far shown a connection between financial inclusion and CO2 emissions. The results of this research, however, are ambiguous and conflicting.

This study can contribute to the literature in three ways. First, while research on the relationship between financial inclusion and climate change is exceedingly rare, a few studies have examined the effect of financial inclusion on climate change (Le et al., 2020). As a result, this study fills a gap about how financially inclusive systems effect CO2 emissions. The BRICS countries were chosen as the study's sample area for the following reasons.

First, according to the most recent data, the economies of the BRICS nations, which comprise the majority of developing countries, are the most robust and expanding (Le et al., 2019). They have strong economies due to an abundance of rich resources, technological innovation, and affordable labor (Radulescu et al.2014). These characteristics distinguish these countries.

Second, B.R.I.C.S. countries are among the top producers of carbon emissions, as well as sufferers of climate change and grappling with financial access issues (Le et al., 2019; Le et al., 2020). In 2013, BRICS nations accounted for more than 40% of global CO_2 emissions, out of a total of 72.2%. Liu et al.(2017a). As a result, the BRICS countries are projected to have a significant impact on climate change (Le et al., 2020).

In contrast, 34.4% of persons have a formal bank account, compared to 64% who do not have access to any financial services. This highlights the importance of improving financial inclusion in this region so that individuals and businesses can engage in green projects and reduce CO2 emissions.

The third way our work contributes to the field is that it differs in six ways from recent notable studies that ignore long-short causality, heteroscedasticity, serial correlation, and pairwise causality concerns, such as Le et al. (2020) and Renzhi and Baek (2020).

Literature Review

Financial Inclusion and CO_2 emission

Financial development must include financial inclusion (Le et al., 2020). The theoretical and empirical foundations of financial development have been investigated to demonstrate a connection between financial inclusion and carbon emissions.

Various researchers argue that financial development exacerbates environmental deterioration by increasing CO2 emissions for the following reasons. First, a stable financial system decreases borrowing rates, incentivizing businesses to raise capital to enhance production, which raises CO_2 emissions (Raghotla and Chatidi, 2020).Second better credit management increased financial prosperity encourages people to buy more energy-efficient products which increase CO_2emissions (Koshta et al., 2020); (Gök, 2020). Third, forecasters regard capital markets as key indicators of economic growth; because of the widespread use of fossil fuels, CO2 emissions rise as a result of the stock market's continued performance, attracting both individual and institutional investors and stimulating production and consumption activities (Rajpurohat and Sharma, 2020).

Industrialization, Economic Growth, Population, Trade openness, foreign direct investment, Natural resources, Income, and CO_2

Numerous studies in Turkey (Pata, 2018) have revealed a substantial association between industrialization and CO2 emissions (Majeed & Tauqir, 2020). Similarly, trade openness, economic growth, and CO2 emissions have a long-term relationship in Sub-Saharan African nations (Sun et al. 2020; Le et al. 2016). The study found a U-shaped association between urbanization and CO_2 emissions using a sample of SAARC countries from 1994 to 2013. According to the findings, rising CO2 emissions in SAARC countries were considerably influenced by both population increase and economic growth (Anser et al. 2020).

According to the aforementioned literature analysis, there is still controversy and inconsistent data on the theoretical and empirical consequences of financial inclusion on CO2 emissions. However, two downsides arise. The first is a lack of research on the relationship between financial inclusion and CO2 emissions. Furthermore, no research has been conducted to define the relationship between CO2 emissions and BRICS financial inclusion. Furthermore, in previous studies, serial correlation, heteroscedasticity, long-short causality, and data restrictions were not problematic.

Research Method

Research hypotheses

Based on the literature research, we developed the following eight hypotheses:

H1: Financial inclusion has a significant impact on $\mathbf{CO_2}$ emissions.
H2: Industrialization has a significant impact on $\mathbf{CO_2}$ emissions.
H3: Trade openness has a significant impact on $\mathbf{CO_2}$ emissions.
H4: Population growth has a significant impact on $\mathbf{CO_2}$ emissions.
H5: Economic growth has a significant impact on $\mathbf{CO_2}$ emissions.
H6: Foreign direct investment has a significant impact on $\mathbf{CO_2}$ emissions.
H7: Income has a significant impact on $\mathbf{CO_2}$ emissions.
H8: Natural resources have a significant impact on $\mathbf{CO_2}$ emissions.

Data collection

This study uses a sample of BRICS countries from 1998 to 2019. This study employed 200 observations from 40 years of panel data from five nations. The variables' data came from the World Bank's GFDD and WDI.

Model And Variables

This study employs Dietz and Rosa's (1997) STIRPAT model to investigate the relationship between financial inclusion and CO2 emissions.

$$\ln Co_{2_{it}} = \beta_0 + \beta_1 lnFIN_{it} + \beta_2 lnIND_{it} + \beta_3 lnTO_{it} + \beta_4 lnPOP_{it} + \beta_5 lnECO_{it} + \beta_6 lnFDi_{it} + \beta_7 lnINC_{it} + \beta_8 lnNAT_{it} + e_{it}$$

For this research financial inclusion has been measured through different variables like Bank branches per 100,000 adults, ATMs per 100,000 adults, outstanding deposits with commercial banks % of GDP, Outstanding Loans with commercial banks % of GDP, and Domestic credit to the private sector by banks % of GDP. This construct has been collected for BRICS countries and PCA to develop a single meaningful construct as Index. It may be noted that for BRICS the Bartlett sphericity test has a P-value less than 0.05 which shows that the set of variables are excellent for factorial analysis and these variables are beneficial for data.

Similarly, the KMO test analyzes how structures are acceptable for factor analysis. The KMO number should be between 0 and 1. According to (Dauriat et al., 2011; Rea & Rea, 2016), a number between 0.5 and 0.6 is optimal, while some writers set this value at 0.5. In Brazil, the KMO score is 0.57 which is low from 0.6 but according to cited above, we can consider it fair. Similarly, for Russia it is 0.68, for India 0.66, for China is 0.70 and for South Africa, it is 0.76 which is above from threshold value of 0.60. The second half battle to construct an index is to identify the factors in each country; explain the variance through Eigenvalue. The Factors selection is based upon Eigenvalue criteria stated that above 1 all factors to be considered in developing an index (Webb & Lan, 2006).

The factor analysis for Brazil shows the first two components describing the proportion of variance as 0.70 and 0.21. These two factors account for 0.91% of total financial inclusion. These components are chosen based on Eigenvalue criterion (Patil, Singh, Mishra, & Donavan, 2008). Similarly, Tables IV, V, VI, and VII depict the factor analysis for Russia, India, China, and South Africa. Component-1 explains the most financial inclusion in these countries. Thus, bank branches per 100,000 adults will be a crucial feature in the formulation of the index for Russia, India, China, and South Africa. It has Eigenvalues of 4.54, 4.15, 4.20, and 4.78, with maximum variations explaining 0.91%, 0.83%, 0.84%, and 0.96%. These components are chosen using Eigenvalue criteria (Patil et al., 2008).

Table X shows the descriptive statistics for the dependent and independent variables. The mean of CO2 is 1.26 and the standard deviation is 1.06 almost close to the mean value. It is indicating carbon dioxide emission in the air. All BRICS countries have a mean value of 0.03 or 33% financial inclusion. This suggests that further financial inclusion is still required in these countries. The standard deviation, however, is extremely significant, hovering around 1.31. A high degree of variation shows that nations are implementing financial inclusion.

Table XI shows the correlation analysis results. According to the findings, trade openness and CO_2 emission are positively and significantly correlated up to 13.44. Moreover, the negative yet significant relationship between population growth and CO_2 emissions is up to -9.47. Similarly, CO_2 emissions have a significant and positive relationship with natural resources up to 7.41. Industrialization and CO_2 emissions have a significant and positive link. Another aspect of the relationship is income growth, which has a negative but negligible -1.34 association with CO_2 emissions. Financial inclusion and CO_2 emissions have a significant, positive relationship that can approach 2.47. While there is currently a slight but positive correlation between FDI and CO_2, the relationship between economic growth and CO_2 is both significant and favorable, up 2.48. Correlation study concluded that all independent variables have the lowest correlation with each other. The lowest value among independent variables indicates that high multi-collinearity is unlikely (Daoud, 2017; Mansfield & Helms, 1982). The chosen panel model also meets the panel OLS and simple OLS model requirements. The chosen model also meets the requirement that the variables' relationships are consistent.

Table XII displays the outcomes of four separate unit root tests. All unit root tests reveal that CO_2 emissions, FDI, natural resources, and population growth are non-stationary at the level but become stationary at the difference. This signifies that the variable has a trend over time, and its behavior changes as its values diverge. While the first test implies that financial inclusion, industrialization, and trade openness are stationary at the level, the other three tests suggest that they are stationary at the difference. This suggests that the tests may disagree, but overall, financial inclusion, industrialization, and trade openness appear to be more stationary at the difference. The unit root tests, including the Levin, Lin, and Chu t* test demonstrates that economic growth is stationary at the level, implying that its behavior remains consistent throughout time and that there is no need to address differences in its values. Similarly, the Levin, Lin & Chu t* test shows that income growth is stationary at the difference, indicating that the variable's behavior changes over time, and analyzing the differences in its values is necessary.

Finally, the units root test in Table XII shows variable integration that is mixed. Others are motionless at the difference, while some are stationary at the level. This finding shows that studying the short- and long-term correlations between these variables using a panel ARDL cointegration analysis would be the best strategy.

Results

ARDL CO-Integrating and Long Run Form

Table XIII displays the ARDL results. Long-term empirical studies suggest that BRICS financial inclusion reduces CO_2 emissions by up to 5%. It demonstrates that a 1% increase in financial inclusion causes a 1% increase in CO_2 emissions. The findings suggest that greater financial inclusion raises CO_2 emissions in the BRICS region. This conclusion shows that citizens in the BRICS countries were more reliant on fossil fuels in order to afford energy-consuming products. The frequent use of these things raises the region's CO_2 emissions. These findings corroborate (Agbenyo, Jiang, & Antony, 2019; Hussain et al., 2021; Le et al., 2020). Similarly, FDI and population expansion have a considerable impact on CO_2 emissions, up to 10%. It demonstrates that a 1% increase in FDI and population growth results in a 4% and 41% increase in CO_2 emissions.

Income has positive but insignificant, Natural resources and Trade openness have insignificant and negative impacts on CO_2 emission with respective percentages: 22%,-1%, and -2%. It demonstrates that these aspects have never been considered for climate change factors. Economic growth reduces CO_2 emissions by up to 5%. It means that if economic growth changes by 1%, CO_2 emissions will increase by 1%. It concludes that the main cause of rising carbon emissions in the BRICS countries is expanding economic activity.

Furthermore, industrialization reduces CO_2 emissions by up to 5%. It means that a 1% change in industrial growth will result in a 4% rise in CO_2 emissions. Because so much fossil fuel is burnt during industrial production, the data show that industrialization raises CO_2 emissions. This observation is supported by the findings of Al-Mulali & Ozturk (2015) and Wang et al. (2018).

ARDL CO-Integrating and Short Run Form

Table XIV shows that financial inclusion reduces CO_2 emissions by 5%. Furthermore, it reveals that a 1% increase in financial inclusion results in a 1% increase in CO_2 emissions. This study agrees with (Agbenyo et al., 2019; Hussain et al., 2021; Le et al., 2020). Nonetheless, the short-term influence of FDI, GDP growth, and natural resources on CO_2 emissions is limited. Similarly, economic growth, trade openness, and industrialization have a significant up to 5% but economic growth and trade openness have a positive impact while industrialization hurts CO_2 emission. It means that a 1% rise in economic growth, trade openness, and industrialization will raise CO_2 emissions by 2%, 7%, and 24%, respectively.

From 1981 to 2019, this study looked at the influence of financial inclusion on CO_2 emissions in the context of other macroeconomic factors in the BRICS region. Three major OLS assumptions were examined for this study. The serial correlation has been evaluated using the LM test shown below.

Serial Co-relation LM Test

The results of Table XV reveal that the model has no collinearity; the Chance of F statistic is greater than the 5% significance criterion.

Heterocedasticity Test ARCH

As shown in Table XVI, the model does not exhibit heteroscedasticity, and the Probability of the F statistic is significant at a level larger than 5%.

Granger Causality

According to empirical evidence, Table XVII shows a one-way relationship between CO_2 emissions and financial inclusion. The D-H panel Granger causality test (Bakirtas & Akpolat, 2018) demonstrated unidirectional causality between financial inclusion and CO_2 emissions. A unidirectional causal link exists between ECO, POP, TO, and FDI. However, no causality was established for INC or NAR.

Discussion

This study investigates the effect of financial inclusion on CO_2 emissions. The findings support the hypothesis that financial involvement, which makes it easier for people and businesses to access financial services, pushes corporations to increase output and supply customers with energy-intensive technological equipment. The findings suggest that increasing economic growth leads to increased CO_2 emissions in the BRICS countries. This demonstrates how closely economic activity development is linked to an increase in CO_2 emissions in the BRICS countries. CO_2 emissions have increased considerably as the BRICS transitioned from undeveloped to developing economies during the last few decades. The

BRICS countries account for more than 40% of global CO_2 emissions.

It is expected that, in the coming decades, industrialization processes would contribute to stable economic growth as a result of increased economic activity, which will have a negative impact on a nation's ability to sustain its environment. The data show that using fossil fuels in industrial production increases CO_2 emissions. The number of energy combustion facilities develops in pace with industrial development, at the expense of environmental standards. Heavy industries also release potentially harmful pollutants into the atmosphere. The results show that natural resources, income, and trade openness are never seen as long-term climate change problems.

Conclusions

The purpose of this study is to examine the association between financial inclusion and CO_2 emissions in the BRICS countries. This study also looks at the long- and short-term links between financial inclusion and CO_2 emissions for the BRICS countries from 1980 to 2019. In the case of the BRICS, financial inclusion, population growth, economic development, industrialization, and foreign direct investment can be said to have a positive and significant impact on CO_2 emissions based on long-term outcomes.

On the other hand, the insignificant influence of increased commerce and natural resource availability on CO_2 emissions. However, income has a minor but positive effect on CO_2 emissions. While FDI, income growth, and natural resources have minimal short-term influence on CO_2 emissions in the BRICS region, financial inclusion, trade openness, population, and economic growth have positive and large long-term benefits. In the short run, industrialization has a considerable yet detrimental impact on CO_2 emissions. Financial inclusion and CO_2 emissions are causally related in a single direction, according to Granger causality findings.

To address the issues caused by climate breakdown, these policies must be addressed:

- It's important to support economic growth by funding ecologically friendly initiatives that can result in sustainable development, such as the use of solar and wind energy.
- Give the forest agency orders to enhance plantation to reduce CO_2 emissions.
- Encouraging the financial industry to focus on improving environmental quality by giving loans to assist investment in low-pollution initiatives that safeguard the environment and enable firms to adopt cutting-edge cleaner and environmentally friendly methods.

This study also has some drawbacks. To describe financial inclusion, just two elements—financial access and financial depth—were discussed. For a more in-depth understanding, study financial stability and efficiency. This analysis covered just BRICS countries from emerging markets. This research must be applied to all developing countries. To understand how gases such as SO_2 and NO_2 effect climate change, all gases other than CO_2 must be discussed. There are a few suggestions for further research on behalf of this study. It may be enhanced further by looking at a variety of variables to examine how BRICS financial inclusion influences climate change. By concentrating on a single country with a range of political, economic, cultural, ethnic, and religious traits, this research can be strengthened. Future studies should compare industrialized, emerging, and developing nations to inform decision-making and funding for stakeholders like governments, foreign investors, and fund managers.

References

Agbenyo, W., Jiang, Y., & Antony, S. (2019). Cointegration analysis of agricultural growth and financial inclusion in Ghana. Theoretical Economics Letters, 9(4), 895-911. DOI: 10.4236/tel.2019.94058.

Al-Mulali, U., & Ozturk, I. (2015). The effect of energy consumption, urbanization, trade openness, industrial output, and political stability on the environmental degradation in the MENA (Middle East and North African) region. Energy, 84, 382-389. DOI.org/10.1016/j.energy.2015.03.004

Anser, M. K., Alharthi, M., Aziz, B., & Wasim, S. (2020). Impact of urbanization, economic growth, and population size on residential carbon emissions in the SAARC countries. Clean Technologies and Environmental Policy, 1-14. DOI10.1007/s10098-020-01833-y.

Bakirtas, T., & Akpolat, A. G. (2018). The relationship between energy consumption, urbanization, and economic growth in new emerging-market countries. Energy, 147, 110-121. DOI.org/10.1016/j.energy.2018.01.011.

Daoud, J. I. (2017). Multicollinearity and regression analysis. Paper presented at the Journal of Physics: Conference Series. DOI 10.1088/1742-6596/949/1/012009.

Dauriat, F. Z., Zermatten, A., Billieux, J., Thorens, G., Bondolfi, G., Zullino, D., & Khazaal, Y. (2011). Motivations to play specifically predict excessive involvement in massively multiplayer online role-playing games: evidence from an online survey. European Addiction Research, 17(4), 185-189. doi.org/10.1159/000326070.

Dietz, T., & Rosa, E. A. (1997). Environmental impacts of population and consumption. Environmentally significant consumption: Research directions, 92-99.

Gök, A. (2020). The role of financial development on carbon emissions: a Meta-regression analysis. Environmental Science and Pollution Research, 1-19. doi.org/10.1007/s11356-020-07641-7.

Hussain, S., Ahmad, T., & Shahzad, S. J. H. (2021). Financial Inclusion and CO2 Emissions in Asia: Implications for Environmental Sustainability. doi.org/10.21203/rs.3.rs-245990/v1.

Jensen, A. L. (1996). Beverton and Holt's life history invariants result from the optimal trade-off of reproduction and survival. Canadian Journal of Fisheries and Aquatic Sciences, 53(4), 820-822. doi.org/10.1139/f95-233.

Karedla, Y., Mishra, R., & Patel, N. (2021). The impact of economic growth, trade openness, and manufacturing on CO2 emissions in India: an autoregressive distributive lag (ARDL) bounds test approach. Journal of Economics, Finance and Administrative Science. doi.org/10.1108/JEFAS-05-2021-0057.

Le, T. H., Le, H. C., & Taghizadeh-Hesary, F. (2020). Does financial inclusion impact CO2 emissions? Evidence from Asia. Finance Research Letters, 101-451. doi.org/10.1016/j.frl.2020.101451.

Le, T. H., Chuc, A. T., & Taghizadeh-Hesary, F. (2019). Financial inclusion and its impact on financial efficiency and sustainability: Empirical evidence from Asia. Borsa Istanbul Review, 19 (4), 310-322. doi.org/10.1016/j.bir.2019.07.002.

Le, T. H., & Quah, E. (2018). Income level and the emissions, energy, and growth nexus: evidence from Asia and the Pacific. International economics, 156, 193-205. doi.org/10.1016/j.inteco.2018.03.002.

Le, T. H., Chang, Y., & Park, D. (2016). Trade openness and environmental quality: International evidence. Energy policy, 92, 45-55. doi.org/10.1016/j.enpol.2016.01.030.

Liu, X., & Bae, J. (2018). Urbanization and industrialization impact of CO2 emissions in China. Journal of cleaner production, 172, 178-186. doi.org/10.1016/j.jclepro.2017.10.156.

Majeed, M. T., & Tauqir, A. (2020). Effects of urbanization, industrialization, economic growth, energy consumption, financial development on carbon emissions: An extended STIRPAT model for heterogeneous income groups. Pakistan Journal of Commerce and Social Sciences (PJCSS), 14(3), 652-681. hdl.handle.net/10419/224955.

Mansfield, E. R., & Helms, B. P. (1982). Detecting multicollinearity. The American Statistician, 36(3a), 158-160. doi.org/10.2307/2683167.

Pata, U. K. (2018). The effect of urbanization and industrialization on carbon emissions in Turkey: evidence from ARDL bounds testing procedure. Environmental Science and Pollution Research, 25(8), 7740-7747. doi.org/10.1007/s11356-017-1088-6.

Patil, V. H., Singh, S. N., Mishra, S., & Donavan, D. T. (2008). Efficient theory development and factor retention criteria: Abandon the ‘eigenvalue greater than one criterion. Journal of Business Research, 61(2), 162-170. doi.org/10.1016%2Fj.jbusres.2007.05.008.

Raghutla, C., & Chittedi, K. R. (2020). Financial development, energy consumption, technology, urbanization, economic output, and carbon emissions nexus in BRICS countries: an empirical analysis. Management of Environmental Quality: An International Journal. doi.org/10.1108/MEQ-02-2020-0035.

Rea, A., & Rea, W. (2016). How many components should be retained from a multivariate time series PCA? doi.org/10.48550/arXiv.1610.03588.

Renzhi, N., & Baek, Y. J. (2020). Can financial inclusion be an effective mitigation measure? Evidence from panel data analysis of the environmental Kuznets curve. Finance Research Letters, 37, 101-725. doi.org/10.1016/j.frl.2020.101725.

Sarkodie, S. A., Adams, S., & Leirvik, T. (2020). Foreign direct investment and renewable energy in climate change mitigation: does governance matter? Journal of Cleaner Production, 263, 121262. doi.org/10.1016/j.jclepro.2020.121262.

Sun, H., Enna, L., Mooney, A., Tran, D. K., Rasoulinezhad, E., & Taghizadeh-Hesary, F. (2020). The long-run effects of trade openness on carbon emissions in sub-Saharan African countries. Energies, 13(20), 5295. doi.org/10.3390/en13205295.

Wang, L., Vo, X. V., Shahbaz, M., & Ak, A. (2020). Globalization and carbon emissions: Is there any role of agriculture value-added, financial development, and natural resource rent in the aftermath of COP21? Journal of Environmental Management, 268, 110712. doi.org/10.1016/j.jenvman.2020.110712.

Webb, J. R., & Lan, K. Q. (2006). Eigenvalue criteria for existence of multiple positive solutions of nonlinear boundary value problems of local and nonlocal type. Topological Methods in Nonlinear Analysis, 27(1), 91-115. doi.org/10.12775/TMNA.2006.003.

Wawrzyniak, D., & Doryń, W. (2020). Does the quality of institutions modify the economic growth-carbon dioxide emissions nexus? Evidence from a group of emerging and developing countries. Economic research-Ekonomska istraživanja, 33(1), 124-144. doi.org/10.1080/1331677X.2019.1708770.

Annex

Table 1. *Bartlett test of Sphericity*

Countries	BRAZ	RUS	IND	CHI	SA
Chi-squ	362.1	432.0	470.6	376.5	487.1
Df	10	10	10	10	10
p-v	0.000	0.000	0.000	0.000	0.000
H0: variables are not intercorrelated					

Table 2. *KMO Test*

Variables	BRAZ	RUS	IND	CHI	SA
Bank branches per 100,000 adults	0.42	0.69	0.67	0.68	0.67
ATMs per 100,000 adults	0.64	0.85	0.65	0.56	0.68
Outstanding deposits with commercial banks % of GDP	0.54	0.67	0.61	0.90	0.94
Outstanding Loans with commercial banks % of GDP	0.66	0.64	0.63	0.59	0.68
Domestic credit to private sector by banks % of GDP	0.75	0.59	0.76	0.79	0.95
KMO over all Values	0.57	0.68	0.66	0.70	0.76

Factor Analysis

Table 3. *Brazil*

Comp	EV	Diff	Prop	Cum
Cmp1	3.51	2.48	0.70	0.70
Cmp2	1.03	0.58	0.21	0.91
Cmp3	0.45	0.43	0.09	1.00
Cmp4	0.02	0.01	0.00	1.00
Cmp5	0.00	.	0.00	1.00

Table 4. *Russia*

Comp	EV	Diff	Prop	Cum
Cmp1	4.54	4.18	0.91	0.91
Cmp2	0.37	0.30	0.07	0.98
Cmp3	0.07	0.05	0.01	1.00
Cmp4	0.02	0.01	0.00	1.00
Cmp5	0.00	.	0.00	1.00

Table 5. *India*

Comp	EV	Diff	Prop	Cum
Cmp1	4.15	3.45	0.83	0.83
Cmp2	0.70	0.56	0.14	0.97
Cmp3	0.14	0.13	0.03	1.00
Cmp4	0.01	0.01	0.00	1.00
Cmp5	0.00	.	0.00	1.00

Table 6. *China*

Comp	EV	Diff	Prop	Cum
Cmp1	4.20	3.52	0.84	0.84
Cmp2	0.69	0.61	0.14	0.98
Cmp3	0.08	0.04	0.02	0.99
Cmp4	0.04	0.03	0.01	1.00
Cmp5	0.00	.	0.00	1.00

Table 7. *South Africa*

Comp	EV	Diff	Prop	Cum
Cmp1	4.78	4.64	0.96	0.96
Cmp2	0.13	0.08	0.03	0.98
Cmp3	0.06	0.03	0.01	0.99
Cmp4	0.03	0.03	0.01	1.00
Cmp5	0.00	.	0.00	1.00

Table 8. *Construction of Financial Inclusion Index*

Symbol	Description
FI (1)	Measured as commercial banks' branches per 100,000 adults
FI (2)	Calculated as ATMs per 100,000 adults
FI (3)	Measured as the outstanding deposits in banks divided by GDP
FI (4)	Measured as the outstanding loans with banks divided by GDP
FI (5)	Measured as domestic credit with banks divided by GDP

Table 9. *Description of Variables*

Variables	Symbol	Description
Industrialization	Log(IND)	It is measured as industry (including construction), value added % of GDP
Trade openness	Log(TO)	It is measured as trade % of GDP
Population Growth	Log(POPG)	It is measured in Population growth (annual %)
Economic Growth	Log(ECOG)	It is measured in GDP per capita.
Foreign Direct Investment	Log(FDI)	It is measured in foreign direct investment, net inflows % of GDP
Income	Log(INC)	It is measured in GDP per capita (constant 2010 US$)
Natural Resources	Log(NAR)	It is measured in total natural resources rents % of GDP
Carbon Emission	log(CO2)	It is calculated as CO2 in metric tons per capita

Table 10. *Descriptive Statistics*

Descriptive Stat	LNCO2	LNFII	LNFDI	LNECO	LNINC	LNIND	LNNAR	LNPOP	LNTO
Mean	1.26	0.03	1.02	1.36	7.98	3.33	1.38	0.94	3.53
Median	0.97	0.19	0.88	1.68	8.69	3.31	1.38	1.07	3.65
Max	3.29	1.98	2.52	3.31	9.62	3.87	2.96	1.74	4.71
Min	-0.80	-2.21	-0.71	-2.59	5.39	2.64	-0.05	-0.45	2.50
Std. Dev.	1.06	1.31	0.75	1.42	1.31	0.36	0.61	0.54	0.48
Obs	200	200	200	200	200	200	200	200	200

Table 11. *Correlation*

Probability	LNTO	LNPOP	LNNAR	LNIND	LNINC	LNFII	LNFDI	LNECO	LNCO2
LNPOP	-0.46	1							
	-7.38	-----							
	0	-----							
LNNAR	0.38	-0.24	1						
	5.83	-3.50	-----						
	0	0.0006	-----						
LNIND	-0.13	0.53	-0.09	1					
	-1.83	8.70	-1.28	-----					
	0.07	0	0.20	-----					
LNINC	-0.01	0.34	-0.24	0.63	1				
	-0.17	5.14	-3.45	11.51	-----				
	0.87	0	0.001	0	-----				
LNFII	0.52	-0.45	-0.20	-0.24	0.22	1			
	8.61	-7.08	-2.87	-3.44	3.21	-----			
	0	0	0.00	0.00	0.00	-----			
LNFDI	0.21	-0.30	-0.21	-0.02	0.39	0.61	1		
	3.09	-4.47	-3.00	-0.23	5.89	10.88	-----		
LNECO	0.01	-0.18	-0.03	0.24	-0.07	0.10	0.21	1	
	0.15	-2.64	-0.43	3.46	-1.00	1.45	2.96	-----	
	0.88	0.01	0.67	0.00	0.32	0.15	0.00	-----	
LNCO2	0.69	-0.56	0.47	0.35	-0.10	0.17	0.05	-0.17	1
	13.44	-9.47	7.41	5.22	-1.34	2.47	0.76	2.49	-----
	0	0	0	0	0.1805	0.0142	0.4506	0.0137	-----

Table 12. *Unit Root Analysis*

		At level I(0)		At Difference I(1)		Cross Secs	OBS
Variables	**Test**	**t- stat**	**Prob**	**t- stat**	**Prob**		
LNCO2	Levin, Lin & Chu t*	-0.09	0.47	-8.32	0.0000	5	186
	Im, Pesaran and Shin W-stat	0.25	0.60	-8.08	0.0000	5	186
	ADF - Fisher Chi-squ	15.90	0.10	80.32	0.0000	5	186
	PP - Fisher Chi-squ	3.86	0.95	97.42	0.000	5	195
LNFII	Levin, Lin & Chu t*	-2.29	0.01	-4.21	0.0000	5	180
	Im, Pesaran and Shin W-stat	0.61	0.73	-3.95	0.0000	5	180
	ADF - Fisher Chi-squ	5.55	0.85	37.4286	0.0000	5	180
	PP - Fisher Chi-squ	4.02	0.95	51.2178	0.0000	5	190
LNFDI	Levin, Lin & Chu t*	-1.06	0.14	-13.57	0.0001	5	188
	Im, Pesaran and Shin W-stat	-0.43	0.33	-13.22	0.0002	5	188
	ADF - Fisher Chi-squ	14.53	0.15	131.54	0.0003	5	188
	PP - Fisher Chi-squ	14.56	0.15	124.38	0.0004	5	190
LNECO	Levin, Lin & Chu t*	-8.55	0.00	-17.96	0	5	192
	Im, Pesaran and Shin W-stat	-7.50	0.00	-15.89	0	5	192
	ADF - Fisher Chi-squ	70.86	0.00	153.04	0	5	192
	PP - Fisher Chi-squ	67.82	0.00	125.82	0	5	195

LNINC	Levin, Lin & Chu t*	3.69	1.00	-9.33	0	5	190
	Im, Pesaran and Shin W-stat	4.52	1.00	-8.88	0	5	190
	ADF - Fisher Chi-squ	1.05	1.00	85.01	0	5	190
	PP - Fisher Chi-squ	0.82	1.00	86.81	0	5	190
LNIND	Levin, Lin & Chu t*	-1.85	0.03	-7.63	0	5	188
	Im, Pesaran and Shin W-stat	0.16	0.56	-8.02	0	5	188
	ADF - Fisher Chi-squ	8.06	0.62	79.38	0	5	188
	PP - Fisher Chi-squ	10.55	0.39	105.99	0	5	190
LNNAR	Levin, Lin & Chu t*	-1.25	0.11	-15.29	0	5	190
	Im, Pesaran and Shin W-stat	-2.08	0.02	-14.44	0	5	190
	ADF - Fisher Chi-squ	18.52	0.05	146.26	0	5	190
	PP - Fisher Chi-squ	16.92	0.08	148.61	0	5	190
LNPOP	Levin, Lin & Chu t*	-0.84	0.20	-2.23	0.0128	5	175
	Im, Pesaran and Shin W-stat	0.82	0.79	-3.25	0.0006	5	175
	ADF - Fisher Chi-squ	8.21	0.61	28.64	0.0014	5	190
	PP - Fisher Chi-squ	2.38	0.99	40.90	0	5	190
LNTO	Levin, Lin & Chu t*	-1.32	0.09	-9.19	0	5	188
	Im, Pesaran and Shin W-stat	-1.06	0.14	-9.64	0	5	188
	ADF - Fisher Chi-squ	15.91	0.10	95.56	0	5	188
	PP - Fisher Chi-squ	18.22	0.05	119.07	0	5	190

Table 13.*ARDL Long Run*

Variable	Coeff	Std. Error	t-Stat	Prob
DLNFDI	0.04	0.02	1.74	0.08
DLNINC	0.22	0.25	0.88	0.38
DLNPOP	0.41	0.15	2.82	0.01
LNECO	0.01	0.01	2.77	0.01
LNFII	0.01	0.01	1.96	0.05
LNIND	0.04	0.02	2.20	0.03
LNNAR	0.00	0.01	-0.11	0.91
LNTO	-0.02	0.02	-1.06	0.29
C	-0.07	0.07	-0.90	0.37

Table 14.*ARDL Short Run*

Variables	Coeff	Std. Error	t-Stat	Prob
D(DLNFDI)	0.02	0.01	1.45	0.15
D(DLNINC(-2))	-0.11	0.07	-1.64	0.10
D(DLNPOP)	0.60	0.10	5.84	0
D(LNECO)	0.02	0.00	4.54	0
D(LNFII(-1))	0.01	0.01	1.90	0.06
D(LNIND(-1))	-0.24	0.09	-2.73	0.01
D(LNNAR)	0.00	0.01	-0.11	0.91
D(LNTO(-2))	0.07	0.03	2.23	0.03
CointEq(-1)	-0.78	0.08	-9.73	0
R-squ	0.52	Mean depent var		0.01

Adjusted R-squ	0.46	S.D. dependent var	0.07
S.E. of reg	0.05	Akaike info criterion	-2.97
Sum squ resid	0.41	Schwarz criterion	-2.57
Log likelihood	282.37	Han-Quinn criter.	-2.81
F-stat	8.03	Durbin-Watson stat	1.94
Prob(F-stat)	0		

Table 15. *LM Test*

F-stat	**0.87**	**Prob. F (2,151)**	**0.42**
Obs*R-squ	2.00	Prob. Chi-Squ (2)	0.37

Table 16. *ARCH Test*

F-stat	**0.32**	**Prob. F (1,168)**	**0.57**
Obs*R-squ	0.33	Prob. Chi-Squ (1)	0.57

Table 17. Granger Causality

X → Y	**DLCo2**	**LNFII**	**LNIND**	**LNTO**	**DLNPOP**	**LNECO**	**DLNFDI**	**DLNINC**	**LNNAR**
DLCo2	–	√	*X*	√	√	*x*	*X*	*X*	*X*
LNFII	√	–	*X*	√	*X*	√	√	*X*	*X*
LNIND	√	√	–	√	*X*	√	√	*X*	*X*
LNTO	√	√	*X*	–	√	√	√	*X*	*X*
DLNPOP	*X*	√	*X*	√	–	√	*X*	*X*	*X*
LNECO	*X*	√	*X*	*X*	*X*	–	√	*X*	*X*
DLNFDI	*X*	*X*	*X*	*X*	*X*	*x*	–	*X*	*X*
DLNINC	*X*	*X*	*X*	√	*X*	√	√	–	*X*
LNNAR	*X*	√	*X*	*X*	√	√	*X*	*X*	–