Green Growth and Carbon Neutrality Targets in BRICS: Do ICT-Trade and Bank Credit Matter?

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Research Article

Keywords: ICT-trade, Bank credit, Carbon neutrality, Green growth

Posted Date: March 18th, 2022

DOI: https://doi.org/10.21203/rs.3.rs-1412326/v1

Abstract

Although the momentous rise in ICT-trade and financial development in BRICS, but their effect on green growth and carbon neutrality have not been explored. This study, thus, examines the effects of ICT-trade and bank credit on green growth and carbon neutrality in BRICS using CS-ARDL over the period 1996–2019. Empirical results prove that ICT-trade significantly increases green growth and reduces carbon emissions. More bank credit promotes green growth by reducing carbon emissions in long-run. Findings also showed that education boosts green growth and mitigate significantly carbon emissions. We also obtained consistent results from PMG-ARDL. Moreover, the stock market is found to have a negative impact on carbon emissions. The results of the PMG-ARDL method show that R&D increases green growth and reduces carbon emissions. Our outcomes may further strengthen the belief of policymakers in BRICS economies on the promotion of green growth.

Introduction

The issue of sustainability has become the central theme of most international forums. In this regard, the notion of green growth has received worldwide acceptance and become popular among policymakers, environmentalists, and empirics as a prerequisite of sustainable economic development. Superior environmental practices by minimizing the wastage of natural resources and capital go side by side with sustained economic growth under the idea of green growth. In the last few years, the idea of sustainable economic development has become the buzzword among the proponents of growth theory. The sustained and long-run economic growth path of any nation can be described as the idea of green growth. According to United Nations, Economic Social Commission for Asia and Pacific (UNESCAP, 2006) the replacement of conventional economic structure with a more sustained and green economic structure through the implementation of prudent policies and strategies is called green growth. In simple words, we can say that the idea of green growth keeps the concepts of environment and development together[1]. On the other hand, the Organization for Economic Cooperation and Development (OECD, 2011) defines green growth as “fostering economic growth and development while ensuring that natural assets continue to provide resources and environmental services on which the intergenerational well-being of humankind relies”.

How to reduce the “black footprint” during the process of achieving rapid economic growth and accomplishing the goal of green growth is an issue that most nations are facing these days (Capasso et al. 2019; Vargas-Hernández 2020; Sun et al. 2020). In 2012, a “Rio +20” conference was organized by United Nations under the title of Sustainable Development, which gave the new direction and asked the world community to focus on the development of a green economy instead of the traditional resource-intensive of growth model. Further, OECD (2017) also warned that if the current pattern of economic growth continues at the same pace it may jeopardize the fundamentals of our economic growth and development. Therefore, the need of the hour is to adopt such a development policy that is sustainable, green, and inclusive OECD (2017). Hence, it is pertinent to find the factors that can help us to attain green growth through the complete decoupling of economic growth from CO_2 emissions.

Among many factors, the technological transformation of society is critical in pushing the economy towards the path of sustainable economic development (OECD, 2011). Particularly, the role of green technologies is crucial that can efficiently utilize natural resources and reduce pollution emissions during the production and manufacturing process. In this regard, information and communication technologies (ICTs) have completely transformed societies and changed the way of looking at things. For instance, the books, compact disks, snapshots, and checkbooks are replaced by bytes, MP3s, JPGs, and clicks respectively. The revolution that ICT has brought in human society has allowed people to save, time, money, and resources through means of online shopping, e-commencing, videoconferencing, and online working (Usman et al., 2021). This transformation of the economic structure from physical to information resources has significantly helped to mitigate the effects of CO_2 emissions which represent a weightless economy with a low capital requirement (Toffel and Horvath, 2004). Due to this transformation, economic growth is anticipated to be less resource-intensive and as a result, produce fewer emissions.

Some of the benefits attached to online shopping, video conferencing, and teleworking can be seen in the form of reduced fuel consumption due to less traveling and gathering at the shopping places, which ultimately mitigate CO_2 emissions (Wei & Ullah, 2022). According to Coroama et al. (2015), the biggest benefit of e-commerce is that it produces less waste due to its reliance on pixels-based printing catalogs instead of papers. Although smart devices such as laptops, LCDs, and tablets with increased efficiency consume less energy but the rising demand for these devices also pushes the energy demand upward due to increased production of the allied products (Van Heddeghem et al., 2014). According to an estimate, due to the production of ICT-related devices, the demand for energy consumption is rising at 7% per annum, whereas the ICT industry contributes to 1-3 percent of worldwide CO_2 emissions (Peng, 2013).

Alongside the ICT sector, the financial sector has also grown rapidly in the last 20 years. Several studies have observed that the financial sector, particularly, the banking sector development help to promote economic growth rate (Petkovski and Kjosevski, 2014 and Li et al. 2022). However, the relationship between banking credit, environmental quality, and green growth is not extensively studied. Nevertheless, the easy access to banking credits may enable firms and businesses to take advantage of this opportunity and to invest in green technologies that would help them to completely decouple economic growth and CO_2 emission. Similarly, due to the easy availability of banking credits, the cost of producing green and environmentally-friendly products significantly reduces (IPA, 2017), which can play an important role in attaining the target of green growth. On the other hand, the easy availability of banking credit may lure the firms to increase their profits by producing more energy-intensive products without worrying about environmental sustainability (Frankel and Romer, 1999). Likewise, the consumer may be able to get financing facilities for more energy-intensive products such as automobiles, refrigerators, air conditioners, and microwaves, which further pollute the environment.

Although the literature on the determinants of environmental quality is growing but without focus much on the factors such as human capital. Human capital is a by-product of education, which is widely recognized as a promoter of economic growth (Barro and Lee, 2001; Jian et al. 2021). Therefore, it can be anticipated that human capital can also significantly affect environmental quality. Human capital can be used as an input in the production function that helps the economy to move on the path of sustainable development swiftly because human capital intensive production techniques are more eco-friendly and exert less burden on the capital resources, thereby improving the environmental quality (Li & Ullah, 2022). Further, human capital is an effective way to influence human behavior and to persuade them to use renewable energy products (Chankrajang and Muttarak, 2017). Likewise, to understand the phenomenon of global climate change and its harmful effects on human lives and the ecosystem the significance of education can't be ignored.

The primary objective of this study is to explore the effect of ICT-trade on CO2 emissions and green growth. The study also explores the role of bank credit in determining CO2 emissions and green growth. The study empirically investigates the impact of ICT-trade and bank credit on CO2 emissions and green growth for BRICS economies over the period 1996 to 2019. The study employed a cross-sectional ARDL approach for empirical exploration. The findings of this study will help in evolving policies related to green growth and carbon neutrality in BRICS economies. The findings of this study not only expand the awareness but also highlight determinants to reinforce green growth in the globe.

Footnote:

[1] UNESCAP 2011, "Green Growth Approach: Experiences in mainstreaming Disaster Risk Reduction and Climate Change Adaptation" Published by United Nation ESCAP. http://www.unescap.org/sites/default/files/CDR2-INF6.pdf

Model And Methods

Modern growth theories have also pointed out the various channels such as ICT-trade and financial development which help to attain sustainable economic development and protect the environment. Hence, we can confer that ICT-trade and banking sector development can significantly help to decouple economic growth and CO2 emissions (Ullah et al., 2021). Therefore, to capture the impact of ICT-trade and banking sector development on green growth and CO2 emissions, we have followed Murshed et al. (2020) and Yu et al. (2021) and constructed the following models:

$$GG_{it} = \eta_0 + \eta_1 ICT.trade_{it} + \eta_2 BC_{it} + \eta_3 Education_{it} + \eta_4 SM_{it} + \eta_5 RD_{it} + \varepsilon_{it} \quad \text{-------} \; (1)$$

$$CO_{2,it} = \eta_0 + \eta_1 ICT.trade_{it} + \eta_2 BC_{it} + \eta_3 Education_{it} + \eta_4 SM_{it} + \eta_5 RD_{it} + \varepsilon_{it} \quad \text{-------} \; (2)$$

Where green growth (GG) and CO2 emissions (CO2) in equations (1 & 2) are dependent on ICT-trade openness (ICT-trade), bank credit (BC), educational attainment (Education), stock market development (SM), research and development (R&D), and is randomly distributed error term. Equations (1 & 2) reflect the long-run effects of green growth and CO2 emissions. To suppose the short-run effects, we re-write equations (1 & 2) in an error-correction format. The study uses the following linear CS-ARDL regression equation.

$$\Delta GG_{it} = \varphi_i + \lambda_i (GG_{it-1} - \beta_i X_{it-1} - \Upsilon_i C_{it-1} - \phi_{1i} \overline{GG}_{t-1} - \delta_2 \bar{X}_{t-1} - \pi_2 \bar{C}_{t-1}) + \sum_{j=1}^{p-1} \theta_{ij} \Delta GG_{it-j} + \sum_{j=0}^{q-1} \eta_{ij} \Delta X_{it-j} + \sum_{j=0}^{q-1} \tau_{ij} \Delta C_{it-j} + \eta_{1i} \Delta \overline{GG}_t + \eta_{2i} \Delta \bar{X}_t + \eta_{3i} \Delta \bar{C}_t + \varepsilon_{it} \quad \text{---------} \; (3)$$

$$\Delta CO_{2,it} = \varphi_i + \lambda_i \left(CO_{2,it-1} - \beta_i X_{it-1} - \Upsilon_i C_{it-1} - \phi_{1i} \overline{CO}_{2,t-1} - \delta_2 \bar{X}_{t-1} - \pi_2 \bar{C}_{t-1} \right) + \sum_{j=1}^{p-1} \theta_{ij} \Delta CO_{2,it-j} + \sum_{j=0}^{q-1} \eta_{ij} \Delta X_{it-j} + \sum_{j=0}^{q-1} \tau_{ij} \Delta C_{it-j} + \eta_{1i} \Delta \overline{CO}_{2,t} + \eta_{2i} \Delta \bar{X}_t + \eta_{3i} \Delta \bar{C}_t + \varepsilon_{it} \quad \text{---------} \; (4)$$

Where, and are set of the independent and control variables in equations (3 & 4). The first step in the empirical estimation of the model is to confirm the stationarity of the variables. To that end, we have applied two unit root tests known as the Levin–Lin–Chu (2002) and Im–Pesaran–Shin (2003). After the application of the unit root test and confirmation of the order of integration of the variables, we move to our main model.

For getting short and long-run estimates of the variables, we have relied on the cross-sectional augmented autoregressive distributive lag order (CS-ARDL) model proposed by Chudik and Pesaran (2013). This method has various benefits over other methods. The first-generation estimation techniques such as FMOLS, DOLS, etc can't address the issue of cross-sectional dependence and provide biased and inefficient estimates (Chen et al., 2022). Whereas, due to the inclusion of lagged dependent variable and cross-sectional averages, the CS-ARDL can deal with the most celebrated problems of the cross-sectional dependence and also deal with an additional issue of slope heterogeneity; hence, providing efficient results (Chudik and Pesaran, 2013). Another benefit of this method is that it can provide both short and long-run estimates simultaneously. Further, pre-unit root testing is not mandatory during the application of this method because it can also account for the variables that are integrated at different orders. Lastly, this method can provide efficient results even in the case of a limited number of observations across time.

To check the robustness of our results, we have applied PMG-ARDL and the quantile regression model. As compared to ordinary least square (OLS), which defines the variation in the dependent variables with the averages of the explanatory variables. Nevertheless, in the case of panel data analysis, some of the basic assumptions of OLS (zero mean, homoscedasticity, and normal distribution) are violated resulting in biased estimates. Therefore, quantile regression analysis is appropriate because in this method dependent variable is the conditional quantile of all independent variables and thereby providing regression for all quantiles. Therefore, quantile regression is better as compared to the OLS in the case of panel data due to its ability to analyze the impact of explanatory variables on the range of variation and conditional diffusion of the dependent variable.

Data

This study is exploring the effects of ICT-trade and bank credit on green growth and carbon neutrality in BRICS economies for the period 1990 to 2020. Table 1 provides the details about the description and abbreviations of variables and descriptive statistics of data. The green growth variable is determined through pollution-adjusted GDP growth. The carbon neutrality variable is measured by CO_2 emissions in kilotons. Trade of ICT goods as a percent of total trade is taken to measure the ICT-trade. Bank credit is determined by domestic credit to private sector by bank as percent of GDP. Human capital is determined through education that is measured as average years of schooling. The study has used stock market development and research and development as control variables. Stock market development is measured as stock market capitalization to percent of GDP. Research and development expenditure are taken in percent of GDP. Data for these variables have been extracted from various sources such as OECD, WDI, and IMF.

Table 1: Definitions and data description

Variables	Definitions	Mean	Median	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	Sources
GG	Pollution-adjusted GDP growth	5.178	4.983	13.13	-4.730	3.045	-0.457	3.602	OECD
CO2	CO2 emissions (kt)	13.94	14.13	16.21	12.48	1.096	0.487	2.210	WDI
BC	Domestic credit to private sector by banks (% of GDP)	3.805	3.966	5.108	-6.725	1.355	-5.565	40.32	IMF
ICT-trade	ICT goods trade(% total trade)	17.13	10.00	56.78	3.128	15.41	1.506	3.640	WDI
Education	Average years of schooling	12.38	12.90	15.50	8.200	1.964	-0.680	2.518	WDI
SM	Stock market capitalization to GDP (%)	4.049	4.027	5.794	1.807	0.794	0.266	2.804	IMF
RD	Research and development expenditure (% of GDP)	1.026	0.970	2.192	0.555	0.368	1.531	5.163	WDI

Empirical results

The cross-sectional ARDL technique is based on four steps such as cross-sectional dependence test, stationarity test, cointegration test, and long-run and short-run coefficient estimation. As a first step, the study is testing the cross-sectional dependence properties of data. For this purpose, the study adopted the cross-sectional dependence technique developed by Pesaran et al. (2004). Table 2 reports the findings for the cross-sectional dependence test. The findings clarify that all the variables in the model are cross-sectionally dependent. It infers that any change in one of the BRICS economies will affect other BRICS economies as well. The second step is to check the stationarity of variables. In the current study, LLC, IPS, and ADF tests are used to check the panel stationarity of data. Table 3 displays the results of all unit root tests. The findings of LLC unit root test clarify that GG, BC, ICT-Trade, and R&D possess level stationary properties while CO_2, Education, and SM variable possess first difference stationary properties. The findings of IPS unit root approach declare that GG and BC are level stationary variables and the remaining variables are first difference stationary. The ADF approach clarifies that GG, BC, and SM variables hold level stationary properties while CO2, ICT-trade, education, and RD hold first difference stationary properties.

Table 2: Cross-sectional dependence tests

	GG	BC	ICT-trade	Education	SM	RD
Pesaran's test	4.527***	0.689	-1.200	4.791***	5.326***	-1.655*
Off-diagonal elements	0.313	0.289	0.412	0.402	0.382	0.474
	CO2	**BC**	**ICT-trade**	**Education**	**SM**	**RD**
Pesaran's test	6.186***	0.898	-1.631*	2.422**	5.099***	-1.180
Off-diagonal elements	0.472	0.165	0.375	0.374	0.354	0.437

Note: ***p<0.01; **p<0.05; *p<0.1

Table 3: Panel unit root tests

	LLC			IPS			ADF		
	I(0)	I(1)		I(0)	I(1)		I(0)	I(1)	
GG	-3.750***		I(0)	-3.626***		I(0)	-5.659***		I(0)
CO2	-0.790	-2.001*	I(1)	-1.051	-4.142***	I(1)	1.321	-6.926***	I(1)
BC	-5.472***		I(0)	-2.898*		I(0)	-3.256***		I(0)
ICT-trade	-2.296**		I(0)	-1.971	-4.905***	I(1)	-1.157	-8.708***	I(1)
Education	-0.422	-1.289*	I(1)	-0.019	-3.421***	I(1)	1.702	-5.126***	I(1)
SM	-1.005	-5.919***	I(1)	-2.023	-4.505***	I(1)	-1.313*		I(0)
RD	-1.528*		I(0)	-1.812	-3.870***	I(1)	-0.726	-6.285***	I(1)

Note: ***p<0.01; **p<0.05; *p<0.1

Table 4: Panel cointegration tests

	Green growth			CO2		
Statistic	**Value**	**Z-value**	**P-value**	**Value**	**Z-value**	**P-value**
Gt	-3.690***	3.090	0.001	-8.170***	-13.08	0.000
Ga	-6.349	2.222	0.987	-0.197	4.440	1.000
Pt	-6.470*	1.502	0.067	-3.241***	-2.408	0.008
Pa	-4.351	2.030	0.979	-0.277	3.535	1.000

Note: ***p<0.01; **p<0.05; *p<0.1

In the third step, the long-run relationship between the variables has been examined by employing a cointegration test. The outcomes of panel cointegration tests are given in Table 4. The long-run cointegration association is found among the variables of the models. After confirmation of long-run association among variables, the study employed a cross-section ARDL approach for deducing short-run and long-run coefficient estimates of models. The long-run and short-run coefficient estimates of the green growth model and carbon neutrality model are given in Table 5. In the green growth model, the long-run findings demonstrate that bank credit reports a significant and positive effects on green growth confirming that increase in bank credit results in enhancing green growth in BRICS economies. The finding exhibits that a 1 percent rise in bank credit brings 1.097 percent upsurge in green growth in the long-run. The impact of ICT-trade on green growth is significant and positive in the long-run confirming the increasing pattern of green growth due to an increase in ICT-trade. It infers that a 1 percent increment in ICT-trade intensifies green growth by 0.302 percent in the long-run. The impact of education, stock market development, and research and development is statistically insignificant in the long-run. In the short-run, ICT-trade reports a significant and positive effects on green growth. In contrast, bank credit, education, stock market development, and research and development report statistically insignificant effects on green growth in the short-run. The coefficient estimate of the error correction term is statistically significant and negative confirming the tangency of achieving equilibrium in the long-run. In the quantile regression model in Table 6, the estimates of only ICT-trade are significantly positive in the green growth model at higher quantiles; while, the estimates of bank credit and education are insignificant in most quantiles.

In the carbon emissions model, the long-run findings display that bank credit reports significant and negative effects on CO2 emissions in the long-run confirming that an increase in bank credit results in improving environmental quality. It implies that a 1 percent increase in bank credit reduces CO2 emissions by 1.198 percent in the long-run. ICT-trade and education both variables have a significant and negative effects on CO2 emissions in the long-run. The coefficient estimates display that a 1 percent increase in ICT-trade and education tends to mitigate CO2 emissions by 0.102 percent and 0.289 percent, respectively. Stock market development and research and development have a statistically insignificant influence on CO2 emissions in the long-run. In the long-run, the findings of all independent variables are consistent in terms of direction and magnitude in the robust model. However, control variables report a significant positive effect on CO2 emissions in the robust model.

In the CS-ARDL model, the impact of all the variables on CO2 emissions is statistically insignificant in the short run. However, bank credit and ICT-trade produce a significant effects on CO2 emissions in the robust model in short-run. The findings of the robust model display that Bank credit reports a significant positive effect on CO2 emissions revealing that increase in bank credit results in intensification of CO2 emissions in the short-run. In contrast, ICT-trade reports significant and negative effects on CO2 emissions in a robust model revealing the increase in ICT-trade leads to a significant reduction in CO2 emissions in the short-run. Lastly, the error correction term reports a significant and negative coefficient estimate that confirms the possibility of convergence towards stability in the long-run. However, in Table 6, the estimates of bank credit, ICT-trade, and education are significant and negative in the CO2 emissions model only at higher quantiles.

Table 5: Short and long-run estimates of green growth and CO2 emissions

	GG		CO2		GG		CO2	
	CS-ARDL		CS-ARDL		PMG-ARDL		PMG-ARDL	
	Coefficient	Z-Stat	Coefficient	z-Stat	Coefficient	t-Stat	Coefficient	t-Stat
Long-run								
BC	1.097***	2.890	-1.198***	3.030	1.054***	5.744	-1.190***	2.850
ICT-trade	0.302*	1.840	-0.102*	1.760	0.125***	7.348	-0.150***	3.476
Education	0.108	0.950	-0.289*	1.750	0.145	0.774	-0.281***	9.193
SM	0.254	1.000	-0.145	1.250	0.109	0.430	-0.159**	1.963
RD	0.842	0.840	0.689	0.170	0.621**	2.459	-0.486***	2.849
Short-run								
D(BC)	1.655	0.840	0.195	1.490	1.739	0.430	0.097**	2.556
D(BC(-1))					0.769	0.260		
D(ICT-trade)	0.785**	2.540	0.105	1.320	0.038	0.209	-0.003*	1.857
D(ICT-trade(-1))					0.507	1.358		
D(Education)	0.154	0.050	0.265	1.360	1.288***	2.739	-0.061	1.493
D(Education(-1))					-1.169	0.844		
D(SM)	1.534	0.930	0.162	1.310	1.811***	4.662	-0.014	0.736
D(SM(-1))					0.596**	2.463		
D(RD)	1.026	0.050	0.178	0.390	1.411	1.492	-0.034	0.309
D(RD(-1))					0.698	1.132		
C					1.206***	3.741	0.394	0.531
ECM(-1)	-0.565	2.012	-0.501	2.987	-0.455***	6.076	-0.442*	1.732

Note: ***p<0.01; **p<0.05; *p<0.1

Results Discussion

In our study, it is found that ICT-trade is positively associated with green growth and negatively associated with CO2 emissions. These findings are supported by various studies such as Higon et al., (2017), Murshed (2020). Azam et al. (2021) argued that ICT-trade contributes significantly in providing technological support for green growth. The progress of ICT-trade positively influences green growth and improves the effectiveness of growth and energy efficiency by improving technological diffusion and innovation, enlarging demand, and decreasing production costs. Meanwhile, Higon et al. (2017) claimed that ICT-trade influences environmental performance through the channels of industrial process, transportation, and electrical grids. The overall findings of the study indicate that ICT-trade influences green growth through the channel of clean energy consumption. Secondly, ICT-trade influences CO2 emissions through the enlargement of green technologies. The negative impact of ICT-trade on CO2 emissions is supported by Wang and Han (2016) in the case of China and Samargandi (2019) in the case of OPEC economies. The positive linkage between green growth and ICT-trade corroborates with the studies of Murshed (2020) and Zhao et al. (2022). The positive linkage between ICT-trade and green growth infers that the use of imported ICT-based technologies and commodities is capable of influencing the technology adoption behavior of users.

Our study reports that bank credit tends to increase green growth and reduce CO2 emissions significantly. These findings are backed by the following studies (He et al., 2019; Ahmed et al. 2021; Chien et al. 2021). Guo et al. (2022) reported that bank credits indirectly affect environmental performance, degradation, and social instability through the channel of financial activities. Findings infer that bank credit directs investment towards green production that contributes to the attainment of green growth. This also means that green credit increases the provision of funds for environmental performance and thus improves green growth. While Yang et al (2020) study disclosed that green bank credit is the most imperative financial determinant that can be used to achieve green development. Similarly, Hu et al. (2011) and Maeda et al. (2001) qualitatively confirmed that green growth can be promoted through green bank credit.

Table 6
Panel quantile regression

	0.05	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	0.95
Green growth											
BC	2.065	1.558	1.129	0.713	0.377*	0.371*	0.494**	0.504*	0.448*	0.079	0.169
	(1.543)	(0.834)	(0.453)	(0.287)	(1.682)	(1.897)	(2.250)	(1.872)	(1.940)	(0.272)	(0.636)
ICT-trade	0.067	0.083	0.090	0.103	0.111***	0.101***	0.101***	0.078***	0.079***	0.099***	0.105***
	(0.935)	(0.999)	(0.880)	(1.031)	(3.703)	(3.244)	(3.588)	(2.753)	(3.178)	(2.948)	(3.586)
Education	0.661	0.703	0.507	0.194	0.035	0.048	0.107	0.072	0.051	0.170	0.060
	(1.201)	(1.593)	(1.306)	(0.437)	(0.186)	(0.246)	(0.619)	(0.349)	(0.310)	(0.714)	(0.333)
SM	0.520	0.617	0.636	0.416	0.281	0.521*	0.167**	0.842*	1.458**	1.781***	1.689***
	(0.502)	(0.631)	(0.589)	(0.451)	(0.661)	(1.727)	(2.424)	(1.806)	(2.491)	(3.816)	(3.621)
RD	1.448	1.212	0.968	0.142	0.356	0.198	-0.180	-0.869	-0.907	1.069	0.940
	1.522	1.321	0.913	0.115	0.267	0.140	-0.137	-0.708	-0.775	0.348	0.452
CO2 emissions											
BC	0.772	0.706	0.961	1.294	1.509	1.824	-2.111*	-0.285***	-0.273**	-0.362*	-0.279
	(0.283)	(0.161)	(0.245)	(0.504)	(0.670)	(0.862)	(1.712)	(2.807)	(2.030)	(1.724)	(1.031)
ICT-trade	0.062	0.057	0.057	0.074	0.076	-0.057	-0.005	-0.087***	-0.077**	-0.091***	-0.087***
	(0.995)	(1.153)	(0.679)	(0.817)	(0.800)	(0.601)	(0.052)	(2.755)	(2.158)	(2.676)	(3.800)
Education	0.422	0.491	0.522	0.507	-0.502	-0.457	0.199	-0.443**	-0.427	-0.413	-0.930***
	(1.313)	(1.274)	(1.132)	(1.287)	(1.229)	(1.131)	(0.798)	(2.278)	(1.406)	(0.925)	(2.614)
SM	0.563	0.453	0.238	0.093	0.001	-0.113	-0.862	-2.183***	-2.145***	-2.294***	-2.674**
	(0.543)	(0.246)	(0.161)	(0.108)	(0.002)	(0.183)	(0.659)	(4.223)	(4.506)	(3.460)	(2.535)
RD	0.443	0.496	0.239	-0.336	-0.676	-0.404	-0.073	0.412	1.322	2.592	2.843
	(0.291)	(0.122)	(0.098)	(0.366)	(0.676)	(0.378)	(0.055)	(0.217)	(0.366)	(0.477)	(1.304)
Note: ***p < 0.01; **p < 0.05; *p < 0.1											

Conclusion And Implications

Since the Rio + 20 conference, the idea of green growth has become the central focus of environmentalists, professionals, policymakers, and empirics. The idea of green growth revolves around the theme that how to completely decouple economic growth and CO2 emissions. Therefore, most nations have adopted the idea of green growth as a policy to achieve sustainable economic development. However, not enough empirical studies are available that have tried to find the determinants of green growth. To fill this lacuna, this analysis tries to investigate the various determinants of green growth and environmental quality. For getting short and long-run estimates we have applied the CS-ARDL model as a baseline model and the PMG-ARDL model as a robust model. Then, we have also applied a quantile regression model to further strengthen our analysis.

The long-run estimates of bank credit and ICT trade are significantly positive in the green growth model with both CS-ARDL and ARDL-PMG estimation techniques. These estimates imply banking credit and ICT-trade are beneficial for improving green growth. On the other side, the estimates of Education are positive but insignificant, confirming that education does not have any noticeable role in increasing and decreasing green growth. Conversely, the estimates of the bank credit, ICT-trade, and Education are negatively significant in the CO2 emissions model with both CS-ARDL and PMG-ARDL estimation techniques, suggesting that all these factors improve environmental quality in BRICS economies. In the quantile regression model, the estimates of only ICT-trade are significantly positive in the green growth model at higher quantiles; whereas, the estimates of bank credit and education are insignificant in most quantiles. However, the estimates of bank credit, ICT-trade, and education are significant and negative only at higher quantiles.

Our results have some important implications for the concerned stakeholders. Firstly, the policymakers should lower the interest rates on banking credit because that would make the availability of funds easier. Due to soft conditions and lower interest rates on bank credits, investment in green technology become more affordable, a crucial factor in decoupling economic growth and CO2 emissions. Secondly, the role of ICT-related products should be increased in every sector because that would pave the way for an economy to become weightless and less capital-intensive and move towards the path of sustainability. Lastly, the formal literacy rate should also be increased to develop human capital and to make production techniques more human capital-oriented and less resource-intensive.

Although our results are important and the study adds to the existing literature but the study has a few shortcomings as well. The data set only include BRICS economies which only represent the emerging economies; however, future studies can analyze the same relationship in the context of developing and advanced economies. Further, the future study can also focus on a comparative analysis, where the results of underdeveloped, emerging, and advanced economies should be compared.

Declarations

Acknowledgement: Research on the mechanism and path of mass entrepreneurship and Innovation Incubation Base promoting employment and entrepreneurship in Colleges and universities in the new era Grant No. XJK21CGD035, project No. ND213254

Authors Contributions: This idea was given by Li Bo. Li Bo, Tan Chao, Xu Yunbao, and Dai Chengbo analyzed the data and wrote the complete paper. While Tahira Yameen, Zhao Guangde and Li Bo read and approved the final version.

Availability of data and materials: The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Ethical Approval: Not applicable

Consent to Participate: I am free to contact any of the people involved in the research to seek further clarification and information

Consent to Publish: Not applicable

Competing interests: The authors declare that they have no conflict of interest.

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