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Climate Change and Sustainable Green Banking in BRICS Countries

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Abstract

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The effects of climate change and related risks on the economies and financial systems are attracting the governments and financial sector regulators' attention globally. Climate change is associated with physical degradation and economic losses which influence the financial system stability. This study investigates the causal relationship between climatic variables and green banking development in Brazil, Russia, India, China and South Africa, with secondary data from 1990 to 2018, employing unit root test, co-integration tests with the FMOLS, DOLS and Granger causality for long run relationship analysis. The results illustrate that carbon dioxide emission and renewable energy significantly and positively affect green banking development in both dynamic and fully modified ordinary least squares estimations methods. Government effectiveness significantly and positively affects green banking development. Also, causality flows from bank credit to carbon dioxide, renewable energy and government effectiveness. BRICS countries' banks should focus on promoting green banking practices by establishing regulatory systems which motivates banks to fully embrace green banking activities. Specifically, banks should moderate charges in financing green projects and exploit the green investments opportunities by designing green products and services. Monetary authorities should treat climate change culture as an attribute of financial operations, which necessitates that certain proportions of bank credit are allocated to green financing in soft loan format. The study reveals a long run relationship between the climate change variables and green banking development.

Key words: Climate change, green banking, carbon dioxide, renewable energy, DOLS, FMOLS

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1. INTRODUCTION

The effects of climate change and related risks on the economies and financial systems are progressively attracting the governments and financial sector regulators' attention globally. Climate change is associated with physical degradation and economic losses which influence the financial system stability (Damianova, Guttierez, Levitanskaya, Minasyan, & Nemova, 2018). A speedy structural change to reduce carbon emissions could shrink some assets values of oil, gas and coal reserves affecting the transportation, infrastructure and other carbon concentrated industries. This could result to economic losses, unemployment and affects the financial situation of the companies that own these assets. Therefore, negatively impacts creditors and investors with triggering effects in the interrelated financial system (Campiglio, Dafermos, Monnin, Ryan C, Schotten & Tanaka, 2018). Brazil, Russia, India, China and South Africa (BRICS), being carbon concentrated economies producing huge fossil fuels could have considerable financial sector carbon risks exposure. Currently, regulators in many countries worldwide are evaluating the impact of climate related risks and low carbon transition in the financial sector. In the BRICS, only Russian regulators and financial institutions are not yet entirely focused on the climate change risks evaluation due to recent banking crisis (Damianova, Guttierez, Levitanskaya, Minasyan, & Nemova, 2018).

According to (Rajesh & Dileep, 2015), green banking is an approach to address climate change by sustaining economic growth and creating a financial world model. The approach considers the social, environmental and economic impacts to protect and preserve the environment. With the banking sector being the driving force in an economy, the financial impacts of diversity, climate change, human right, and social equality should be evaluated (Finacle, 2016). Rajesh & Dileep (2015) examined that banks contribute to sustainable growth by transforming internal operations and corporate social responsibility into green financing. Pinter, Deutsch & Ottmar, (2005) maintain that sustainable development is achieved through green bank innovations in products and services without environmental pollution. Individual banks have devised various strategies to operate green products and services. Ethical banking contributes to meet human needs without compromising future generational needs. All is about cautious nature conservation and biodiversity for future generations in natural resources use relative to climate in banking operations (Gelder, 2006).

In a milestone climate change accord at UN negotiations in 2015 in Paris, governments agreed to reduce global temperature to below 2°C, with the aim of further decreasing it to1.5°C and provide funds consistently with low carbon emissions and climate resilient development (UNFCCC, 2015). Banks play a critical role in this agenda realization. For temperatures to be below 2°C verge, financial provision has to align with the global economic decarbonization by mid-century and avoid activities that could destabilize a successful low carbon transition (Rogelj, Joeri, Schaeffer, Michiel, Hare, & Bill, 2015). Forward oriented banks play positive roles in injecting the required capital to fund technologies, infrastructure and traditional industrial transition with adaptation costs. According to the international energy agency (IEA, 2019), the world has to spend US$359 trillion by 2050 to avoid climate change disasters. For global warming to remain below 2 degrees Celsius requires a change in financial and economic operation and behavior. There is need to dramatically transfer resources, develop and adopt cleaner efficient technologies (Compere, 2017). The financial requirements for these undertakings are enormous with much determination, investors' power, huge asset owners, public and private banks.

Presently, with a growing population, excessive natural resources use and the greenhouse gas emissions, the interaction between climate and humans is changing. Human activities are influencing the atmosphere resulting to climate change evolution. Climate change activities are speedily altering companies and investors risks and return preferences. Investors' analysis of climatic risks is limited to the sectors which are directly link to fossil fuels and carbon emissions like energy and utilities sectors. For instance, Boston Common investment assessments recognize the climate-related exposures and potential opportunities in all sectors including banking and finance (Gemma, 2011). The emergence of climate change financing is to provide adequate, predictable and sustainable banking services to address climate change activities especially in emerging nations.

From 2002, over 20 global funds emerged to finance climate change to tune of US$30 billion as resolved at the Copenhagen conferences of parties (COP21) for 2011-2013 and US$ 100 billion yearly by 2020 for long-term finance to reduce greenhouse gas emissions (Intergovernmental Panel on Climate Change,[IPCC] 2019). As climate risk is critical to banks, investors are eager to know if the risk is properly managed at the organizational top level. For instance, do banks incorporate top level assessments of the climate change effects on loan portfolios? Do the banks adopt policies and governance mechanisms which comprehensively handle climate-related risks? Do the banks products and services support transition to a low carbon economy?

Boston Common's report (2015) examined the practices and long run management of 45 global banks using ten climate performance measures. The study revealed a huge gap between the global financial sector's current practices and its catalyzing potentials to transit to a low carbon future. In 2017 report, banks and climate change highlights that with progress in the adoption of some sector specific restrictions alongside the use of carbon assessment tools like carbon footprint, environmental stress tests and economic scenarios, the whole sector does not keep pace in this fast changing environment. Share Action's investors guide banking on a low carbon future stipulates practical guidelines on investors' expectations for banks to alleviate climate risk, search green financing opportunities, leverage public-private partnerships (PPP) with industrial collaborations to hasten climate change action (Compere, 2017).

The guide provides investors engagement questions on climate risk assessment, management and defines low carbon products and services, leverages collaboration, realization and supervision. This is complementary to the action call for the banking sector to initiate practices that reduce climate change vulnerability and accelerate evolution to a low carbon society. Currently, the world is around the turning-point where environmental degradation and climate change effects on the vulnerable populations could become irreversible due limited climate change actions. To address the challenges requires urgent action, huge private capital mobilization and a significant business behavioral change. Investors exert much transformative power through the investors climate risk arrangements, pension schemes and being banking sector customers should assist to redirect capital flows to attain the below 2 degrees Celsius future (Compere, 2017).

In Qatar 2012, the Kyoto Protocol was amended and a second commitment period of 2013 to 2020 applied. The greenhouse gas emission reduction rate adopted was 18% relative to the 1990 base values (Zavras et al, 2012). The IPCC adopted at the Paris Agreement (COP 21), that global temperature rise should be below 2 degrees Celsius. Over 175 developed countries and 10 developing countries ratified it in 2018 with national adaptation plans for climate change (United Nation Framework Convention on Climate Change,[UNFCCC] 2018). All world nations are urged to ratify these climate change conventions, geared towards reducing greenhouse gas emissions from economic activity to minimize climate change impacts. Countries like India and China signed the protocol without commitment to reduce gas emissions. The countries that pledged to reduce greenhouse gas emissions for the second period only value between 14% and 15% of the global emissions. Russia and Japan were not committed to the obligations while Canada officially withdrew from the Protocol. The Kyoto Protocol provides three financial instruments: emissions trading (ET), joint implementation (JI) and clean development mechanism (CDM), (Cirman, Domadenik , Koman, & Redek, 2009).

Recently, due to rapid growth of BRICS economies and greenhouse gas emission levels, this basic group is internationally pressurized to mitigate the greenhouse gas (GHG) emissions. It is as stated that mitigating climate change is futile if the industrialized countries are involved. This argument holds true, in 2007 China led the US as the world's highest emitter. India's emission rate was leading her to second highest emitter in the near future. India, China and Brazil, alongside other developing countries introduced mitigation pledges for the first time in 2009. India and China promised to limit the amount emitted per unit of GDP between 20 & 25% and 40 & 45% respectively by 2020 compared to 2005 levels. Brazil opted to decrease its GHG emissions between 36.1 and 38.9% below target by 2020.

India is taking measures to tackle poverty, manage natural resources and mitigate climate change. Progress is made in renewable energy which puts the country as global leader. The government has encouraged operation Clean Development Mechanism (CDM) which distinguishes the country globally. The implementation of a carbon tax on coal provides revenues for renewable energy projects. No plans exist to stop fossil fuels use in 20 years time. Climate change assessments are performed with results indicating significant risks to food security, water supply and livelihoods. This signals that much is required towards making India climate resilient.

Equally, China is significantly addressing climate change nationally which shows commitment to its international mitigation pledge. Climate change action has been embedded in China's Five-Year Plan (FYP) policy. This FYP addresses sustainability issues like pollution, energy efficiency and the non-fossil fuel sourced energy. China is leading in the global renewable energy sector for years now. Despite efforts on sustainability management, the payback is still minimal due to the negative environmental impacts of rapid industrialization. China's national climate change policy program identifies areas of vulnerability like challenges of food security and water supply (Park H, & Kim J.D, 2020).

In Brazil, confronting deforestation is the determining factor to achieve its ambitious mitigation target since it controls over 70% Amazon Rainforest. Brazil is leading the world in low carbon agriculture and bio-fuels. With a boom in Brazil's oil and gas sector, GHG emissions from fossil fuels are expected to rapidly increase. India and Brazil possess national funds to finance climate change projects and policies to promote renewable energy. The BRICS countries consider renewable energy as an economic opportunity which fosters growth in the sector. The implementation and realization of these climate change projects require finance (Griffith-Jones, 2014).

Russia committed itself to limit greenhouse gas emission by 2030 to between 70 & 75% of the 1990 levels which is based on the maximum forests absorbing capacity in the intended nationally determined contribution (INDC) established in the framework of the Paris Agreement (COP21). Russia also officially named 2017, the year of ecology which attracted attention among stakeholders' on environmental conservation, green economy and finance. Conversely, various challenges are hindering many economic sectors from picking up the green investment impetus. Russia requires a strong and coherent policy signal with stricter environmental regulations enforcement to encourage the development of green financial instruments (Damianova, Guttierez, Levitanskaya, Minasyan, & Nemova 2018).

Green banking policy ensures environmentally conscientious banking which contributes to the economic systems involving production and distribution services using reactive financial services, process and capacity building thereby promoting pollution free environment (Rahman, 2014). Banks are glued to each market sector via the lending intermediation practices which uniquely make the banks exposed to climate-related risk. Investors are extremely concerned that climate change activities due to weather variability heat up the overall atmosphere producing adverse impacts on banking models. This potentially harms the future share value of major banks and that of several interrelated sectors of the financial market. Affirmatively, the financial sector and banks in particular can potentially propel the society to a reduced carbon emission economy given its global market capitalization size (Boston Common Asset Management,[BCAM] 2015). Green banking policy set out the essential components for achievement.

Green banking requires an innovative thinking in economics, business and finance. This is achievable if world leaders revise the economic models from monetary economics to include environmental economics and transform the accounting principles from financial to involve ecological and operational energy accounting (Rajesh & Dileep, 2015). Green banking is a broad term which covers many areas from a bank being environmentally friendly to investment strategies. Green banking includes all the social and environmental factors to shelter the environment and preserve natural resources. Ethical banking or Sustainable banking activities are regulated by the same authority with additional policies towards ecological care. Green banking is a proactive concept with smart innovative thinking visualizing Earth's future sustainability which contributes to better and safe living standards (Rahman, 2014).

Banks are operating in a complex environment which is vulnerable to human activities like natural resources exploitation. Pressure on the available natural resources for sustainable development usually results to negative effects on human existence. Gelder, (2006) stated that banks and other financial institutions perform certain operations which harm the environment, human rights and social equality. Additionally, (Pinter, Deutsch, & Ottmar, 2006) hold that these effects are low relative to other economic sectors, evidenced by water usage, energy and waste management in serving the customers. For example, wastes papers from forest resources and crude oil fuel emit carbon monoxide (CO) into the atmosphere which leads to climate change, water scarcity and natural resources depletion etc. As such, banks are aware that their reputations are affected, exposing them to environmental and social risks, due to their activities and those of the customers (KPMG Advisory NV, & WWF Schweiz, 2012). The remaining research portion is organized as follows: literature review in section two; methodology in section three, section four gives results and discussions while five ends up with conclusion.

2. LITERATURE REVIEW

2.1 Social Responsibility Investment Theory (SRI) This theory focuses on integrating individual firm's value and societal wellbeing as essential elements which are considered in evaluating investment choices (Junkus, & Berry, 2015; Van Dooren, & Galema,2018). The SRI theory is motivated by the need to ethically invest and was practiced since the ancient days of Christianity, Islam, and Judaism (Renneboog, Horst, & Zhang, 2008). The SRI theory seems to have no consensual definition given that terms like ethical, sustainability, social, environmental, green investment are interchangeably used for SRI (Junkus, & Berry, 2015). Additionally, community and impact investments are frequently used phrases that are swapped for each other in referring to SRI theory. Similar studies showed SRI as a social impact investment which significantly enhances the investors' social benefits alongside that of the community (Hernandez, & Hugger, 2016).

Social responsibility investment theory encourages finance in the actualizations of both financial and other life goals. Socially motivated financial firms like micro finance institutions are being used solve environmental challenges, job creation and rural development. Furthermore, SRI theory is empirically seen from the social, environmental and sustainability dimensions, with the social dimension using finance to achieve financial and social values. The environmental dimension explores financial benefits by adopting environmental investments while the sustainability aspect includes businesses in financial, social, and environmental benefits (Bennett, & Iqbal, 2013, Michelson, Wailes,Van Der Laan, & Frost, 2004). The SRI theory is a blueprint used to enhance the relationship between green banking and climate change variables basing on financial investment to improve sustainability growth which essential both policy makers and managers (Dorfleitner, & Nguyen, 2016).

2.2 Empirical Review Olaoluwa, Adepoju, & Aladejebi, (2016) examine the role of banks in sustainable development via green innovative 3Ps (products, paths & processes), using cross-sectional survey of deposit money banks' customers in Akure metropolis, Nigeria. The Relative effective index (REI) and Pearson correlation captured the effectiveness, link between the 3P's and sustainable development. The results show that automated teller machine (ATM), mobile banking, mobile/SMS banking, point of sales (POS), email, social banking and online banking are significant green innovative 3P's banking. You & Huang (2014), examine the determinants of green growth and future sustenance in the OECD framework using 30 provinces from 1998 to 2011 applying the dynamic panel model. The findings revealed that China experienced a slow green growth rate, implying that financing innovations through government funds stimulate greater green growth benefits.

Li, Liu, Hou, Xu, & Chao, (2019) studied the impact of carbon finance on carbon (CO2) emissions in Beijing-Tianjin-Hebei Region using the logarithmic mean divisia index model to decompose carbon emission increment. The findings indicated a reduction in carbon emission value is caused by green credit from 2010 to 2016 in the Beijing-Tianjin-Hebei region and carbon trading increases the value of carbon emission. It was concluded that green credit reduces carbon emissions while carbon trading increases carbon emissions.

Smulders & Withagen (2012), investigated the lessons learnt from the green growth theory using a dynamic general equilibrium and the Ramsey model to relate the interaction between economic growth and environmental variations. The study showed that green growth is the lone substitution in endogenous technical change alongside a clean back-up technology. Smulders et al. (2014), postulate that longer term investment balancing in a sustainable environment could be extended through income to reduce poverty and that green growth is based on technical change of initial resource depletion. The study revealed that poverty reduction highly depends on green growth.

Hynes & Wang (2012) examined relationship between poverty reduction, improved wellbeing, managing scarce resources and climate change in an inclusive growth of developing nations. The study analyzed the needs, conditions and mechanism of green growth with accompanied policy benefits. The study concluded that green growth is vital for sustainable wellbeing and poverty alleviation. Kaggwa, (2013) studied South African green growth transition in the mix challenges and opportunities of the socio-economic problems of the nation using empirical literature. The study indicated that the policy makers maintain that green industries are a panacea to reducing unemployment and carbon dioxide emission.

Uwazie, (2015) investigated the green growth implications on economic performance in Nigeria employing the political economy method to explain the core sustainable development in the environment. The study used few sampled sectors to determine the existence of economic benefits from green growth different from the present growth path if transited. The results showed that enormous benefits and opportunities exist if Nigeria incorporates environmental policies in the present economic program. Oyebanji, Adeniyi, Khobai, & Le Roux, (2017) examined the long-run equilibrium between green growth and environmental factors like deforestation, energy depletion and carbon dioxide (CO_2) emissions in Nigeria from 1980 to 2015. The study used the autoregressive distributed lag (ARDL) and bound testing co-integration. The bound test co-integration shows a negative long-run relationship between carbon dioxide emission and renewable energy with green growth. Conversely, deforestation has a positive long-run relationship with green growth.

Kahn, M.E, Mohaddes K, Ryan N.C, Pesaran M.H, Mehdi R, & Yang J.C, (2019) studied the long-run impact of climate change on economic activity within countries, applying a stochastic growth model with panel data from 1960 to 2014. Labor productivity is positively affected by country climate change measured by temperature and precipitation deviations from the historical norms. The findings revealed that real output growth per-capita is negatively affected by temperature changes but precipitation changes has no statistical significant effects on real output growth per-capita. Morssy (2012) research on green growth, innovation and sustainable development in Austria, using regression showed that a balance mechanism between the consumers' demands and protection of earthly resources via advance technology is needed. The study added that green growth policy serves as an analytical and macroeconomic policy framework changing from archaic growth to a sustainable growth path using innovations by countries.

Literature is limited on green banking nexus climate change factors in BRICS countries, which is attributable to limited significant policies formulation and implementation on green banking strategies. Also, studies provide debated results on the relationship between climate change variables and green banking development (Kahn, et al., 2019; Olaoluwa, et al., 2016; Oyebanji, et al., 2017). Green banking strategies are being implemented in Brazil, India, Russia, China and South Africa to address greenhouse gas emissions and other environmental hazards (Abdullah et al., 2017; Akinyemi et al., 2017; Dudin et al., 2016; Jupesta et al., 2011). This study investigates the causal relationship between climatic variables and green banking development in BRICS states.

3. METHODOLOGY

The research employs quantitative *ex–post facto* method with secondary panel data from 1990 to 2018 retrieved from world development indicators (WDIs) and world governance indicators (WGI) databases. The 1990 starting year stems from the period climate change accords started by the United Nations systems (Gupta, 2010). The data is sourced and mined with Microsoft excel before transferring into the electronic view software (E-Views 9).

3.1 Material and Methods The study utilizes the unit root test, co-integration tests using the fully modified ordinary least squares (FMOLS), dynamic ordinary least squares (DOLS) and Granger causality for long run relationship analysis. Like other studies, the Cobb-Douglas production function is adopted for model estimates (Bashir, et al, 2010; Saleem, & Jan, 2011). Usually, growth analysis applies Cobb-Douglas production function with two inputs considered to be fixed on output scale. According to (Echevarria, 1998), other variables are integrated in the function stated as:

$$Y_{it} = AK_{it}^{\alpha} L_{it}^{\beta} e^{\mu_{it}} \qquad (1)$$

Here Y is green banking development, A is the intercept, K is physical capital and L is labor force. α and β are capital and labour coefficients on green banking development respectively which range between 0 and 1, i.e. $0 < \alpha, \beta < 1$. i represents the countries, t is time span and μ is stochastic error term. This study examines the causation between green banking development and climate change variables, considering that green banking development is vital for climate change mitigation. Integrating climate change indicators in the model, equation (1) becomes:

$GBD_{it} = ACO2_{it}^{\alpha} REGY_{it}^{\beta}\ GEF_{it}^{\gamma} e^{\mu_{it}}$ …………………………………………….. (2)

Where α and β becomes the respective coefficients of carbon dioxide and renewable energy while γ is the coefficient of government effectiveness which lies between 0 and 1, i.e. $0 < \gamma < 1$. Introducing logarithm to equation (2) gives:

$lnGBD_{it} = \beta_0 + \alpha lnCO2_{it} + \beta lnREGY_{it} + \gamma lnGEF_{it} + \pi_{it} + \mu_{it}$…………………… (3)

Where:

$lnGBD_{it}$ represents green banking development, proxied by bank credit to the private sector.

$lnCO2_{it}$ represents carbon dioxide emission,

$lnREGY_{it}$ is renewable energy,

$lnGEF_{it}$ stands for government effectiveness,

π_{it} captures the specific effects in the panel

μ_{it} is the random error term

Theoretically, the variables are explained as follows: Green banking development is proxied by domestic credit to private sector by banks which are the financial resources given to the private sector by deposit taking institutions excluding central banks which are repayable. Green banking is expected to be expanding in order to have the required societal impact. Carbon dioxide emissions are emissions from the fossil fuels combustion and cement manufacture. This includes carbon dioxide emitted during solid, liquid and gas fuels consumption together with gas evaporation. Carbon dioxide emission is expected to have both positive and negative influence on green banking development. Renewable energy consumed is the renewable energy proportion in total energy consumed per year. It is believed to have positive effects on green banking development. Government effectiveness refers to the perceptions of public services quality and the degree of independence from political pressures, policy formulation and realization and government credibility to policy commitment. Estimated values range from between -2.5 for weak and 2.5 for strong government effectiveness. In controlling factors that influence green banking expansion across the BRICS countries besides the climatic factors, government effectiveness is used as a control variable. These variables used in the model are in ratios form which equalizes differences in scales and the countries' economic uniqueness.

4. RESULTS AND DISCUSSION

4.1. Panel Unit Root Test In accordance with (Hossfeld, 2016), panel unit root test is categorized into "first or second generation". The prominent first generation unit root tests are the Levin-Lin-Chu (LLC, 2002) and the Im-Pesaran-Shin (IPS, 2003). Essentially, these are extensions of the habitual augmented Dickey-Fuller (ADF) unit root test for time series models, assuming cross-sectional independence. Univariate ADF unit root test of the random process y_t estimates the equation:

$\Delta y_t = \rho y_{t-1} + \sum_{p=1}^{p} \varphi_p \Delta y_{t-p} + \gamma_l D_l + \varepsilon_t$, t = 1,...,T……………………………. (4)

where D_l, l = {1, 2, 3} is a deterministic terms vector, which shows if the method has none, an intercept and no time trend or both intercept and time trend. The ADF statistics tests the null hypothesis that series has the unit root and the alternative that it is stationary. That is H_0: ρ = 0, H_1: ρ < 0. For panel analysis the ADF estimates the equation:

$\Delta y_{i,t} = \rho_i y_{i,t-1} + \sum_{p=1}^{pi} \varphi_{pi} \Delta y_{it-p} + \gamma_{il} D_{il} + \varepsilon_{it}$, t = 1,...,T, i = 1,...,N……………… (5)

Panel Unit Root Test Summary, Table 1

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1.1.1.1. Method	*1.1.1.2. CPSB*	*1.1.1.3. CO_2*	*1.1.1.4. REGY*	*1.1.1.5. GEF*
1.1.1.6. Levin, Lin & Chu	*1.1.1.7. -7.99896******	*1.1.1.8. -5.09441******	*1.1.1.9. -5.79837******	*1.1.1.10. -7.40383******
1.1.1.11. Im, Pesaran and Shin W-stat	*1.1.1.12. -7.07397******	*1.1.1.13. -5.38396******	*1.1.1.14. -6.53355******	*1.1.1.15. -6.02521******
1.1.1.16. ADF - Fisher Chi-square	*1.1.1.17. 63.9145******	*1.1.1.18. 47.3086******	*1.1.1.19. 55.8161******	*1.1.1.20. 48.6205******
1.1.1.21. PP - Fisher Chi-square	*1.1.1.22. 67.9301******	*1.1.1.23. 47.6137******	*1.1.1.24. 59.2851******	*1.1.1.25. 57.6955******
1.1.1.26. Integration level	*1.1.1.27. I(1)*	*1.1.1.28. I(1)*	*1.1.1.29. I(1)*	*1.1.1.30. I(1)*

Source: Author's compilation from E-views 9, (***), (**) and (*) represents 1%, 5% and 10% significance level respectively. Projected values are t-statistics.

From table 1, the panel stationarity check of the variables using Levin,Lin &Chu (LLC), Im, Pesaran & Shin, Augmented Dickey Fuller (ADF)- Fisher Chi-square and Philip Peron (PP), Fisher Chi-square tests used by (Choi 2001) and proposed by (Levin, Lin & Chu 2002). With Schwarz Information Criteria (SIC) automatic lag selection using intercept and no trend show that the variables are I(1) integrated. These results expect a long-run association between the variables and green banking development since they are same order integrated.

4.2 Correlation Table 2

	CPSB	**CO2**	**REGY**	**GEF**
CPSB	1.000000			
CO2	0.083415	1.000000		
REGY	-0.330345	-0.937046	1.000000	
GEF	0.295052	0.113469	-0.070222	1.000000

Source: Author's compilation from E-views 9

From the correlation results in table 2, carbon dioxide (CO2) and government effectiveness are positively correlated to CPSB, while REGY negatively correlates CPSB in the BRICS basic group.

Hausman Test With panel data employed in this study, the five countries fixed and random effects are considered. The Hausman test is used to determine if fixed or random effects is more appropriate. This test checks for exogeneity in the unobserved error variables. The test verification shows that the fixed effects model is more appropriate than the random effects model.

4.3 Johansen Fisher Panel Co-integration Test, Table 3

1.1.1.31. Hypothesized No. of CE(s)	1.1.1.32. Fisher Stat.* (from Trace test)	1.1.1.33. Fisher Stat.* (from Max-Eigen test)
1.1.1.34. None	1.1.1.35. 6.931	1.1.1.36. 6.931
1.1.1.37. At most 1	1.1.1.38. 58.03***	1.1.1.39. 58.03***
1.1.1.40. At most 2	1.1.1.41. 1317***	1.1.1.42. 92.10***
1.1.1.43. At most 3	1.1.1.44. 32.47***	1.1.1.45. 32.47***

Source: Author's compilation from E-views 9, (***), (**) and (*) represents 1%, 5% and 10% significance level respectively. Projected values are t-statistics.

Following table 3, the results of Johansen Fisher panel co-integration test indicate that there are three co-integrated equations out of four tests in the series at 5%. Since the co-integrated equations form the majority of the tests, it implies that there is co-integration in the series. This indicates a long run relationship among the variables. The results signal a long term covariance between carbon dioxide, renewable energy and green banking development within the BRICS basic group.

4.4 Fully Modified OLS (FMOLS) and Dynamic OLS (DOLS) Estimations, Table 4

1.1.1.46. Variables	1.1.1.47. DOLS	1.1.1.48. FMOLS
1.1.1.49. CO2	1.1.1.50. 4.626212*** 1.1.1.51. (8.154070)	1.1.1.52. 4.402092*** 1.1.1.53. (25.23483)
1.1.1.54. REGY	1.1.1.55. 1.008202*** 1.1.1.56. (4.909821)	1.1.1.57. 1.129700*** 1.1.1.58. (7.543605)
1.1.1.59. GEF	1.1.1.60. 33.64624*** 1.1.1.61. (2.722570)	1.1.1.62. 3.614740*** 1.1.1.63. (23.85053)
1.1.1.64. R-squared	1.1.1.65. 0.708170	1.1.1.66. 0.977219
1.1.1.67. Adjusted R-squared	1.1.1.68. 0.590049	1.1.1.69. 0.971402
1.1.1.70. S.E. of regression	1.1.1.71. 20.46887	1.1.1.72. 5.406234
1.1.1.73. Long-run variance	1.1.1.74. 423.4783	1.1.1.75. 17.96817

Source: Author's compilation from E-view 9, *** and ** represent 1% and 5% significance levels respectively;
T-statistics in parentheses

Table 4 presents estimated results of dynamic OLS (DOLS) and fully modified OLS (FMOLS) techniques. The DOLS is regressed using the pooled estimates with no constant and trend, while the FMOLS is estimated using the pooled weighted method with trend. The results illustrate that carbon dioxide (CO2) emission is statistically and significantly affect bank credit to the private sector which the proxy for green banking development in both DOLS and FMOLS estimations methods. Carbon dioxide (CO2) emission has a positive coefficient, which implies that carbon dioxide (CO2) emission increases green banking development in the BRICS countries. The coefficient value indicates that 1% rise in carbon dioxide (CO2) emission increases green banking development by 4.62% in DOLS and 4.40% in the FMOLS estimation techniques. This is probably an indication that investment opportunities for banks are created due to carbon dioxide emissions into the atmosphere. This portrays a long run relationship between carbon dioxide emissions and green banking development in the BRICS states. This finding contradicts the economic expectation and agrees with (Li, Liu, Hou, Xu, & Chao, 2019).

Renewable energy (REGY) has a significantly positive impact on green banking development in BRICS states. This demonstrates that a 1% increase in renewable energy increases green banking by 1.01% in the DOLS and 1.13% in the FMOLS method. The strong positive significant coefficients in the two estimation techniques signify a long term relationship between renewable energy and green banking development in the BRICS countries. This result endorses the social responsibility investment (SRI) theory which requires individuals and entities to do ethical investments. The findings also respect the expectations but oppose (Oyebanji, Adeniyi, Khobai, & Le Roux, (2017).

Government effectiveness (GEF) which served as moderating variable also has a significantly positive effect on green banking development in the BRICS. The results reveal that a 1% rise in government effectiveness improves green banking process by 33.64% in the DOLS and 3.62% in the FMOLS techniques. This implies that governments' participation in promoting and encouraging green banking is very essential in the BRICS states. R-square is 70.82% in the DOLS and 97.73% in the FMOLS, which implies that the explanatory variables have explained the variations in the dependent variable at 70.82% and 97.73% in the DOLS and FMOLS methods respectively.

4.5 Pairwise Granger Causality Tests, Table 5

1.1.1.76. Causality Flow	***1.1.1.77. F-statistic***	***1.1.1.78. Remark***	***1.1.1.79. Direction***
1.1.1.80. CO_2 to CPSB	*1.1.1.81. 0.20602*	*1.1.1.82. No Causality*	*1.1.1.83. None*
1.1.1.84. CPSB to CO_2	*1.1.1.85. 4.86656***	*1.1.1.86. Causality*	*1.1.1.87. Unidirectional*
1.1.1.88. REGY to CPSB	*1.1.1.89. 0.83908*	*1.1.1.90. No Causality*	*1.1.1.91. None*
1.1.1.92. CPSB to REGY	*1.1.1.93. 7.83153****	*1.1.1.94. Causality*	*1.1.1.95. Unidirectional*
1.1.1.96. GEF to CPSB	*1.1.1.97. 0.07859*	*1.1.1.98. No Causality*	*1.1.1.99. None*
1.1.1.100. CPSB to GEF	*1.1.1.101. 4.03715***	*1.1.1.102. Causality*	*1.1.1.103. Unidirectional*

Source: Author's compilation from E-views 9, (***), (**) and (*) represents 1%, 5% and 10% significance level respectively.

Table 5 presents the causation between the independent variables and the dependent variable. There is causation between the variables as illustrated on the table by the causality flow, f-statistic significance with accompanied remark and direction. The findings show causality flow from bank credit to carbon dioxide, renewable energy and government effectiveness. This reveals that bank credit to the private sector is crucial in reducing carbon dioxide emissions, promoting the production of renewable energy sources and medium of government policies implementation.

5.0 CONCLUSION

This study examines the sustained relationship between climate change variables and green banking development in the BRICS countries. The variables employed are bank credit to the private sector, carbon dioxide emission, renewable energy consumption and government effectiveness in the dynamic and fully modified ordinary least squares techniques. The results indicate that carbon dioxide emission, renewable energy consumption and government effectiveness significantly and positively affect green banking development. This implies that green banking development increases with the increase in carbon dioxide emission, renewable energy used and government effectiveness. The findings demonstrate causality flow from bank credit to carbon dioxide, renewable energy and government effectiveness.

Banks in the BRICS countries should focus on promoting green banking practices. It is vital to establish a regulatory system which motivates banks to fully embrace green banking activities. Specifically, banks should moderate charges in financing green projects and exploit the green investments opportunities by designing green products and services towards clean environment. Government should be fully committed to create awareness towards environmental conservation. Monetary authorities should understand that climate change culture is an attribute of financial operations, which necessitates that certain proportions of bank credit should be allocated to green financing in soft loan format. The study reveals a long run relationship between the climate change variables and green banking development.

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