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A Review of Green Innovation and Environmental Performance in BRICS Nations

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ABSTRACT

This research aims to assess the literature on green innovations towards environmental performance within the framework of the BRICS economies. Innovation is now associated with both sustainable development on the environment and long-term economic success. The influence of technical advancements or inventions with an environmental focus on the quality of the environment is crucial in this regard. The literature and empirical data on the topic are reviewed and summarized in this work. First an overview of Green Innovations and Environmental performance in BRICS countries is given. Second, using concepts and theoretical stances from the published literature, the articles will be indexed. Along with explaining how and why these processes work, this article also discusses their theoretical foundations. Third, three product categories are suggested for more investigation in this paper. Through a critical analysis and synthesis of existing theory and research on green innovation and the environment, this study makes a contribution to the field of innovations and the environment.

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1. Introduction

Ecological degradation is a significant problematic issue in the realm of economics that has drawn a lot of attention from economists and scholars over the years. Countries are confronted with serious issues related to warming the planet as a result of a persistent increase in emissions of carbon. The last several decades have seen a sharp rise in greenhouse gas (GHG) emissions worldwide due to human activities, which has degraded the ecosystem in ways never seen before Hammed and Arawomo (2022). The fight against climate change requires reducing emissions of global warming greenhouse gases (GHG), such as methane and carbon dioxide. Global greenhouse gas emissions are predicted to increase to 53.8 billion cubic meters of carbon dioxide (GtCO2e) by 2022, although the rate of climate change is accelerating. Global fossil fuel emissions are expected to reach a record high by 2023, with global CO2 levels 50% higher than pre-industrial levels (Statista 2024.). Growth that results from decreased threats to ecological and environmental security and increased human well-being is referred to as "green growth" (Jänicke, 2012). It has been hotly contested among economists that green growth is mostly propelled by green innovation. The association between economic growth and technological innovation was originally examined by Schumpeter (1934), who suggested that the former feeds the latter's evolutionary process. Green innovation, as a concept to encourage green economic growth, has gained relevance in recent years. The notion of "green innovation" is still up for debate in academia. Right now, "green innovation" is defined as any innovative, one-of-a-kind method or product that accomplishes resource conservation and environmental betterment. Green innovation is defined by the Organization for Economic Cooperation and Development

(OECD) (2010) as the deliberate or inadvertent development or significant enhancement of a business's procedures, advertising strategies, institutional frameworks, organizational arrangements, and products (which includes services and goods) that lower risk to the environment and pollutant emissions, and the adverse consequences of energy and resource usage (Arundel & Kemp, 2009). The global economy has turned its attention to environmental safety testing due to the growing pollution issue. To stop environmental contamination, the global society additionally worked extensively and put environmental safety tests into place.

There are many environmentalists who contend that modern technologies might help reduce greenhouse gas emissions as it can increase energy efficiency without obstructing economic growth. Greenhouse gas emissions are related to environmental technology policies. The tax is imposed that significantly reduces the use of electricity and the emission of harmful substances, which affects the price of fossil fuels. In addition, these laws provide incentives for businesses to innovate in technology. However, there is an argument that the result of technological improvements is the consumption of resources and damage to the environment. The industrial sector uses technology to increase productivity, which reduces environmental impacts and requires more energy and raw materials (Zhu, Fang, Rahman, & Khan, 2023). The link between environmental quality and new technology, in brief for different areas has been documented in previous studies, which also used some traditional economic methods. The BRICS nations were chosen for this analysis based on their GDP, which in 2020 accounted for almost 23% of global GDP, 19.851 trillion dollars, and 41.50% of global population. The BRICS economies are may be assumed as the backbone of the global economy, contributing 20% of world trade and 45% of global economic growth (New Development Bank, 2018). According to assessment of the World Bank from 2019, the economy of the BRICS countries grows by 5.1% and 5.3% in 2019 and 2021. As previously presented statistical data explains, the BRICS nations' economic development, energy efficiency, trade openness and financial openness are important study markers. Since the manufacturing and construction industries in the BRICS countries are the main drivers of economic expansion and modernization, the environmental damage that these nations face cannot be ignored. The BRICS nations, however, are working hard to advance the quality and worth of the atmosphere and environment. At September 2017 BRICS leaders' meeting in Xiamen, they emphasized the need for improving environmentally-friendly technology, sustainable urban environments, and the collaboration of member and associate countries to program on eco-friendly and environmental concerns (Declaration, 2017). Green investments can promote green growth, but organizations can lower their GHG emissions by developing environmentally friendly technologies. In addition, the reuse of manufacturing waste is facilitated by innovation and technology.

1.1. Research Objective

The research objectives are:

1. To provide an overview of green innovations and its effect on ecological and environmental efficiency within BRICS economies.
2. To review and summarize existing literature and empirical data on the association among environmental/ecological quality and green innovations in BRICS countries.

2. Literature Review

The literature that has been written about how green innovations affect environmental performance is included in this section. Furthermore, evaluated in this section is the literature that used green innovation as an independent variable. Geng et al.'s study from 2023 examined how the quality of environment in BRICS nations was impacted by Green Innovation between 1992 and 2021. Research's findings have shown that when green innovation reaches a certain threshold, the quality of the environment improves. This suggests that a smaller ecological footprint is the way to go. Moreover, Ali et al. (2022) looked at how green innovation and FDI impacted the environmental and ecological quality of the BRICS economies between 1990 and 2014. The results show that there is a bilateral link between CO2 emissions and energy consumption, CO2 emissions and urbanization, CO2 emissions and trade openness, and CO2 emissions and green innovation. Furthermore, the findings demonstrate a unidirectional underlying connection between urbanization, CO2 emissions and GDP. In view of the importance that financial stability plays in fostering green development, Huang (2024) explored the relationship between mineral resources, creativity and innovation, the process of globalization and green development in the BRICS nations from 1990 to 2021. The results have verified that

globalization and the green development of the BRICS nations are inversely related. The main recommendation was that in order to alleviate the adverse effects of process of globalization and internationalization on green development, the BRICS realms should squeeze their ecological and ecological regulations. Similarly, Chiou, Chan, Lettice, and Chung (2011) investigated the association between green innovation and rejuvenation suppliers and Taiwan's competitive advantage and ecological or environmental performance. Using a questionnaire-based survey, data were collected for the study from 124 Taiwanese businesses that represented eight distinct industry sectors. Based on the outcomes of the final measurement model, the structural model that verifies the importance of the suggested relationships is assessed. The analysis of the data is done by structural equation modeling. One of the research's key conclusions is that green innovation, or "greening the supplier," improves the supplier's competitive advantage and environmental performance.

Furthermore, consumption-based CO2 emissions and the effects of income, energy usage, and green innovation were examined by Jiang, Rahman, Zhang, and Islam (2022). Data from developing countries (BRICS)that are empirical. Three econometric methods were employed to examine the properties of the data: the second-generation panel unit root test, the slope heterogeneity test, and the cross-sectional dependency test. DCCEMG (Driscoll and Kraay and a dynamic common correlated effect mean group) were used to examine the available balance data for the years 1985 to 2018. Empirical results over an extended period of time indicate that environment-related technologies (ERT) have a negative effect on CCO2e, but CC and per capita GDP have a favorable effect. Based on empirical facts, environment-related technologies (ERT) are critical to the long-term viability of the BRICS nations. Policymakers are advised to support environment-related technologies (ERT) programs that assist in reducing emissions of greenhouse gases. In another study, the link between environmental performance and green innovation in major industrial enterprises was examined by (Rehman, Kraus, Shah, Khanin, & Mahto, 2021). This study argues that there is more depth than previously thought in the association between green human resource management, green innovation, environmental performance, and green intellectual capital. It was suggested that there is no direct correlation between environmental performance and either GHRM or Green Intellectual Capital. Rather, it was said, Green Innovation performances as a intermediary in the connections among Green Intellectual Capital, Green House Resource Management, and environmental performance. Furthermore, it was suggested that environmental approaches help to manage the link between Green Innovation and environmental performance, and they are strongly related to environmental performance. In study there was used a sample of 244 major manufacturing companies to evaluate our suggested approach. The majority of the theories are supported by the findings of the structural equation modeling investigation.

Furthermore, the study conducted by Chaudhry, Ali, Bhatti, Anser, Khan, and Nazar (2021) aims to inspect the dynamic, common linked impacts of institutional performance and technical breakthroughs on environmental quality. The research draws on data from nations in East Asia and the Pacific. By panel data from Pacific nations and East Asian during the years 1995–2018, the study examines the dynamically common linked impacts of institutional performance and technology developments on environmental quality. Environmental quality is assessed using many greenhouse gas emission proxies in addition to a recently developed metric called "ecological footprint." The index of technical innovations is also derived from six distinct inventive indicators. The problems of heterogeneity and cross-sectional dependency are ignored by traditional approaches, which provide false results. The aforementioned problems are addressed by a distinctive econometric method called "dynamic common correlated effects (DCCE)". Technological advancements show a substantial and in lower-income and overall East Asia, long-run estimate shows a negative association with ecological footprint, CH4 and N2O has positive relationship with CO2 emissions. On the other hand, in good and best-income Pacific nations and East Asian, all environmental measures show a favorable link with advances in high technology. In general, in Pacific nations and higher-income East Asian, institutional performance has been shown to take the substantial and detrimental long-standing influence on ecological and environmental indicators. Lastly, it is proposed that East Asian and Pacific nations may guarantee environmental sustainability if they reinforce their institutions, encourage creative activities, and promote free trade policies.

Moreover,Chen, Ramzan, Hafeez, and Ullah (2023) looks into how green innovation financial and globalization impact green growth in the economies of the BRICS (Brazil, Russia, India, China, and South Africa). In the analysis of study, the CS-ARDL model is employed. The results demonstrate the positive significance of long-term guesstimates of environmental and ecological inventions and rights, suggesting that ecological and eco-friendly technologies in the BRICS countries' economy support green growth. Furthermore, the financial globalization estimates are very positive, meaning that the green development of the BRICS nations would expand in step with the level of financial globalization. According to the findings, policy experts and representatives should keep their concentration projects of R & D that in order to adoptive green growth might inspire the expansion of green innovations in the BRICS economies.

Anyhow, combined impact of economic globalization, green productivity, eco-innovation and eco- friendly growth in attaining ecological sustainability aimed at OECD economies was the focus of Ahmad and Wu (2022) research. The study does not take into account the joint contributions of ecology, economics, and green growth to the achievement of ecological sustainability. Therefore, using a set of 20 Organization for Economic Co-operation and Development (OECD) countries, the influence of these qualities was examined from 1990 to 2017 in the context of financial development, human capital and gross domestic product on the basis of per capita ecological footprint. The application of quantitative regression yields dependable results at different ecological footprint levels of OECD countries. The first findings are as follows: First, increasing green production on the line and non-line reduces the ecological degradation, and the greater the amount shows the strength of radiation protection than medium and small quantities. Second, the effects of the economic world are conflicting: when it comes to eco-innovation, there is an influence on ecological degradation, but when it comes to ecological protection, there is an interaction effect. Third, eco-innovation shows that it has an impact on ecological conservation across all sectors, but it has the greatest impact on nations with large per capita ecological footprints, then on medium and small footprints more.

Furthermore, in the study of Waheed, Chang, Sarwar, and Chen (2018) that how Pakistan's use of forestry, agriculture, and renewable energy impacted the nation's carbon emissions (CO2) by. Using yearly data for the years 1990–2014, the Autoregressive Distributed Lag model was employed to observe the long- and short-term impacts on CO2 emissions. It was discovered that there are major long-standing undesirable and inverse impacts on emissions of CO2 associated with the renewable energy usage and forest area. It showed that increasing the area covered by trees and the quantity of renewable energy used might help reduce CO2 emissions. However, over time, agricultural output significantly and favorably affects CO2 emissions. Over time, the renewable energy consumption and forest area have an undesirable, inverse and considerable influence on emissions of carbon dioxide. This suggests that reducing CO2 emissions might be attained by growing the amount of use of renewable energy and expansion of forest area. Furthermore, the forests and the extensive usage and practice of renewable energy have demonstrated comparable outcomes in the near term, whereas the impacts of agriculture cease to be statistically significant.

3. Methodology

The systematic literature review technique bordered by Lacey, Matheson, and Jesson (2011) was employed by the author of this study to gather and critically evaluate the pertinent literature. In order to conduct a comprehensive and critical study, the author has created a critical and serious review form that examines several important factors of prior studies, including concentration of the research, information of the bibliographic, applied theory and model when suitable, Research philosophy (Zikmund, Babin, Carr, & Griffin, 2000), green innovation’s definition, methodology, key findings, green growth, environmental performance, research context, study setting, examination of the theory and practice, further conclusion, and reported limits. For the purpose of this work's critical assessment, the author studied the literature from November 2017 to April 2018. Following the identification of the papers, the researcher conducted an exhaustive search to locate the most relevant Green Innovation papers. To do this, they evaluated the pertinent papers that they had downloaded from two sources: (1) comprehensive databases (Scopus); (2) The Master Journal List 2017 and JCR report 2016 are two examples of Clarivate Analytics' listings for economics journals. (3) MDPI; (4) Google Scholar. The selection criteria for the literature were shaped by the author based on the following features: commentaries, books, conference summaries, executive abstracts, abstracts with keywords, editorials, literature reviews, articles, and newspaper/magazine are examples of

papers that were excluded because they did not deal with green innovation and environmental performances or were not empirical or conceptual.

4. Conclusion

It is concluded from a detailed analysis of the literature that green innovation has both advantages or positive and disadvantages or negative results. In actuality, each of the two studies independently closes a gap in the literature. Thus, there is ongoing debate about how environmental performance is affected by green innovation, and numerous articles have been conducted to determine how green innovation affects the economy and the environment as a whole. While some studies have shown a strong positive relationship with environmental degradation, others have found a strong negative relationship with environmental degradation in relation to specific economic, financial and technological conditions. This study examines the industrial sector's response to green innovation, the environment, and factor productivity. It will also add to the research on environmental performance and green innovation. This research endeavor aimed to establish a connection between relevant contributions and literary ideas. In addition, the variables' analysis in this study is not established. Determining a clear and systematic and detailed overview and summary of previous research on Green innovation, with contextual and relative practice and methodologies, is the prime goal of the research.

4.1. Recommendations for Future

For more enquiry in this review of the literature three motives are given. Initially, Granger causality, FOLS regression, the ARDL model, and the G.M.M. approach are the methods most study utilize to examine the variables. Non-Linear Auto Regressive Distributed Lag Model (NARDL) has been applied in a limited number of research to conduct the study throughout the literature review. In order to account for asymmetry about both positive and negative changes in the explanatory variable or variables, the NARDL model is a single-equation error correction model (nonlinear autoregressive distributed lag) is examined for estimation and inference. Additionally, using the NARDL approach, any possible indirect effects and feedback are also noted. Second, research on green innovation has been done in the past, but it has mostly focused on green growth. As a result, it is recommended that additional research be done to determine how well green innovation has changed the environment. Third, the investigations only include the bare minimum of variables, allowing for the selection of more environmental indicators.

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