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Examining the Influence of Green Finance, FinTech, and Environmental Innovation on Environmental Degradation in G-20 Nations: A Comprehensive Review

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Abstract
The main purpose of this study is to investigate the impacts of green finance, fintech, and environmental innovation on CO_2 emissions of the G-20 countries. This study seeks to determine how these variables play a role in the environment and add to the existing literature on these variables. This study investigated the period comprising the years from 1990 to 2021. The purpose statement of the present study is determined and it develops a comprehensive analysis and integration of the current theoretical and empirical literature regarding previous literature. The purpose of this research is to summarize the association among green finance, fintech, financial inclusion, GDP and environmental innovation on CO_2 emissions for the G-20 countries. In addition, this research aims to discover the existing literature by examining the theoretical frameworks as well as empirical evidence presented in published articles. Besides, the paper analyses the theoretical approaches that make the theoretical background transparent and show how the principles and mechanisms of the methods are interconnected. This research endeavours to be of great importance to the world of green finance, fintech, financial inclusion, GDP, and environmental innovation by means of undertaking an extensive literature review and synthesis utilizing current theories and studies dealing with the influence of green finance, fintech, financial inclusion, GDP, and environmental innovation on CO_2 emissions in G-20 countries.
Keywords: Green finance, Fintech, Financial inclusion, Environmental innovation, CO_2 emission, G-20 countries

1. Introduction

To counter the possible hazard that the climate change may provide to the ecosystem and the social well-being of humanity, Paris Climate Change Agreement was concluded in 2015. To ensure that global warming remains below the pre-industrial level below 2 degrees Celsius and better much below 1.5 degrees Celsius, today almost all the economies in the world as mandated by law, are required to develop greenhouse gas emission reduction strategies (Udeagha & Breitenbach, 2023) Also, with the growing CO_2 emissions of nations that depend on fossil fuel, and which have historically prioritized economic development over environmental hazards (Hao, Chen, & Research, 2023; Udeagha, Breitenbach, & Sustainability, 2023), more countries are also getting alarmed. Furthermore, rising CO_2 emissions have triggered the anxiety of nations depending on oil and gas and having a strong economic growth history at the expense of the environment (Udeagha, Breitenbach, & Research, 2023). The G-20 region's CO_2 emissions have increased as a result of their rapid economic growth and expansion into manufacturing Huang, Rahman, Meo, Ali, & Khan, (2024), Song, Anees, Rahman, & Ali, (2024). As the G-20 nations have different fiscal limitations that provide a higher chance for poor environmental performance, the use of aggressive GFN policies may be necessary. The BRICS governments have autonomy to come up with policies that can be used effectively in promoting the Global Financial Network Zhao, Rahman, Afshan, Ali, Ashfaq, & Idrees, (2023)are heavily dependent on oil imports and national energy production ultimately grow due to high rates of economic development at the cost of the environment in various aspects of their power sector . Nevertheless, modern day economics now can hardly achieve high rates of growth without environmental sustainability, including practices of limitation in CO_2 emissions. Consequently, taking into account various important elements, among which are green finance (GFN) and fintech (financial technologies) (Kanwal, Tayyab, & Idrees, 2023), growth of research interest in modern researchers (Udeagha, Breitenbach, & Finance, 2021) is inevitable (Kanwal, Khalid, & Alam, 2023).
Given the fact that finance and information technology(Kanwal, Hassan, & Butt, 2023) are essentially indistinguishable, fintech may efficiently and effectively be linking surplus financial amounts to their deficit counterpart. fintech lowers trade costs and information asymmetry (Nenavath, 2022; Audi & Ali, 2023). Fintech moreover has the edges of being cheap, convenient and open and transparent. The fintech helps to expand the investor's base, lower the access barrier, and helps uncover hidden financial needs of investors Qadri, Shi, Rahman, Anees, Ali, Brancu, & Nayel, (2023). These countries that are generally described as low-tech economies and. Fintech to a large extent has altered financial services delivery, costing, and at the same time been promoting sustainable development and green financing. But at least in these three areas fintech is a tool that helps us to decrease CO_2 emissions and therefore to become more sustainable.On the one hand, ecologists are currently debating how to eliminate the connection between CO_2 emissions and green finance, a technique known as an environmental investment strategy (Kanwal, Hassan, et al., 2023; Muganyi et al., 2021; Ashiq et al., 2023). Due to budgetary constraints, GFN enables corporations to fund environmentally friendly projects. With their over 4 trillion dollars in foreign currency reserves, over 21% of the world's population, and robust economic progress, these initiatives are crucial for promoting environmentally friendly growth because they contribute to the improvement of ecological integrity, the development of new environmentally sustainable industries, and the acceleration of the growth of credit intermediaries that are supported by the global economy's strategy (Lisha et al., 2023; Audi & Ali, 2023).

1.1. Problem Statement

In the last few decades, people are looking more at the economics of sustainability (Awan, Shahid, Rahman, & Baig, 2023; Younas, Shoukat, Awan, & Arslan, 2023), which layers a new understanding of the financial systems, technological inventions, as well as the systems of laws and policies that govern the environment, on the ways of practicing sustainability. With the emergence of this connection, from Green Finance, Environmental innovation and FinTech, it has been a focal topic of inquiry by policymakers, researchers and industries. Conversely, while a substantial knowledge gap exists in the commencement of the issues related to the collective effects of those factors on the environmental degradation among the G-20 economies, but the differences in the magnitude of those effects are yet to be examined.

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The complexity originates from the shared influence between Green Finance, Environmental Innovation, and FinTech on one hand (Arslan, Kanwal, Kazmi, & Rahman, 2023), and the diversity in socio-economic and environmental settings of G-20 countries on the other. Even though a lot is done to implement sustainable measures, the results can be highly consistent, consequently playing the role of obstacle for the formulation of successful environmental policies (Altaf, Awan, & Rehman, 2023). Hence, a systematic examination is compulsory to elucidate the complex relationship and evaluate the multiple effects of such variables on sustainability within G-20 nations.

1.2. Significance of the study

The study finds the central knowledge gap and answers it by exploring the green finance, FinTech and environmental innovation together on CO_2 emission in G-20 countries Shahzadi et al., (2023). This study is therefore of prime importance since it not merely provides knowledge to the literature but also gives useful information to policy makers, researchers, and industries. The study captures the interconnected nature of the economic, technological, and legal mechanisms, hence making the policy making process easier by providing more insights. What adds to the credibility of the research is the emphasis on the practical aspects of the implementation of the sustainable measures, which makes the development of better strategies for more consistent and effective environmental policies easier Ali, (2022), Dawood et al., (2023), Zahra et al., (2023), Ali et al., (2023).

The G-20 nations' global relevance makes this research noteworthy, particularly through its insights which outrun individual countries' borders and which thus contribute to the global discourse on environmental sustainability. The study is interdisciplinary in nature, which combines economics, technology, and law, ensuring a holistic understanding of the problems, therefore offering a classic integrated strategy. Correspondingly, the study's emphasis on the long-term effects that characterizes the approach of sustainable practices contributes to a platform for activities that ensure environmental stability and deal with the complexities arising out of the dynamic world Ullah et al., (2023).

2. Literature Review

The first section of literature deals with Green Finance and CO_2, the second section deals with Fintech and CO2, the third section deals with Environmental Innovation and CO_2.

2.1. Green Finance and CO_2 emission

Environmental benefits, on the contrary, are still the focus of green finance unlike traditional financial services Hafiza, Rahman, Sadiq, Manzoor, Shoukat, & Ali, (2023).The precise objective of green finance is to deliver monetary resources to eco-friendly business and the restriction of financing to the firms with polluting activities. Ren, Shao, and Zhong (2020) discovered that China's green financing policy had a potent effect on "carbon reduction. Further, the impact was asymmetric with most always mostly short-term. Empirical studies that take individual businesses as a unit of analysis are scarce, and existing works mainly focus on the relationship between green financing and businesses Chaudhary, Nasir, Rahman, & Sheikh, (2023). In the opinion of L. Zhang, Saydaliev, and Ma (2022), there are some assertions that the plan for legally tightening environmental requirements hasn't succeeded yet Eco-green-financing policy goal is elevating environmental level of implementation. The use of green financing has proven to be effective in dealing with environmental crises Khan, Rahman, Fiaz, (2023). The government's green finance plan enjoys the cooperation between both environmental preservation and economic growth so as to have sustainable development, with the bigger role of GFN in that system (S. Zhang, Wu, Wang, & Hao, 2021). By being a driver for the ecological environment, green financial funds showing high potential for growth(Younas et al., 2023).

Further core questions addressed in the study were the degree to which green finance development and ecological preservation are complementary, the impact of green finance on changes in the structure of energy use (L. Zhang et al., 2022), and the advantages of green finance for the economy and environment (Yang, Su, & Yao, 2021). Businesses that pollute excessively also face significant financing costs as a result of the implementation of the green finance strategy Usman, Rahman, Shafique, Sadiq, & Idrees, (2023).In order to comply with rules and get funding, high-risk enterprises participating in the eco-friendly financial transformation pilot program bear a significant financial burden from the payments they generate for negative externalities, such as pollution discharge fees and pollution penalties (Shi, Yu, Li, Wang, & Change, 2022) (Awan, Rahman, Ali, & Zafar, 2023). For the G-20 countries, pollution control is the primary means of combating environmental deterioration and climate change.

2.2. Fintech and CO_2 emission

Fintech affects consumer spending, saving patterns, and renewable energy investment decisions. NRG-coin, crowdsourcing campaigns funding renewable projects, and blockchain-based green energy credits (like Origin from the Energy Web Foundation) are a few examples of cryptocurrencies (Lisha et al., 2023). The goal of the investigation is to quantify how fintech adoption affects the use of green energy Rahman, Bakar, & Idrees, (2019), Rahman, & Bakar, (2018). To do this, a balanced panel of 21 OECD nations using data from 2005 to 2018 can be taken into consideration. You can use the Driscoll-Kraay standard errors to analyse the empirical model. The results indicate a link between the growth of fintech and green energy (Udeagha & Muchapondwa, 2023). A thorough grasp of the environmental impact of contemporary data analytics and artificial intelligence technologies is provided through studies on the connection between fintech and ecological stewardship Shahid, Gurmani, Rahman, & Saif, (2023).Fintech intends to continue searching for green funding opportunities in order to grow its finance business and capture market share in a cutthroat industry. As of the present, environmental protection needs of consumers are met (Nenavath, 2022).

Fintech applications have the potential to prevent environmental deterioration and improve ecological integrity (Tao, Su, Naqvi, Rizvi, & Change, 2022). This investigation was conducted to determine whether the nation's environment is improved by the fintech industry's growth. The likelihood of endogeneity in the fintech industry's development is well known. Nonetheless, results from GMM and 2SLS are trustworthy. Croutzet and Dabbous (2021) critically evaluate the relevance of fintech, which is thought to be one of the factors influencing the OECD countries' adoption of renewable energy Ilyas, Banaras, Javaid, & Rahman, (2023). Increased energy safety concerns, a decline in carbon dioxide emissions, and the volatility of oil prices are some of the factors pushing renewable energy into the spotlight. Chueca Vergara and Ferruz Agudo (2021) have investigated if fintech has a good environmental impact through a review of the literature and case studies. Their focus is on certain fields with advanced technology Ilyas, Awan, Kanwal, Banaras, Rahman, Ali, (2023), Awan, Rahman, Ali, & Zafar, (2023). The

examination of two fintech projects (Pensumo and Clarity AI) through the study of a green investment business operation has improved the assessment as well. The results demonstrate that fintech offers a number of advantages. Additionally, by promoting the expansion of green finance, there may be an impact on improving eco-friendly behaviour, which could ultimately result in the overall sustainable growth of the fintech businesses Fatima, Jamshed, Tariq, & Rahman, (2023).

2.3. Environmental Innovation and CO_2 emission

Prior studies that aimed at the measurement of the impacts of environmental innovation (EEI) used the relationship between environmental innovation and CO2 emissions. As well, Ahmad et al. (2021) showed that for OECD economies, unfavourable shocks to innovation cause the emission of CO_2 to decline, however, a favourable shock to innovation has the opposite effect. The authors of the study not only improved the field but analysed innovation shocks (both the positive and negative ones) and determined how these shocks (positive and negative) affect pollution in OECD countries Shahzadi, Ali, Ghafoor, & Rahman, (2023), Zainab, Qaisra, Hassan, Haris, Rahman, & Ali, (2023) added to the materials in the literature. They found a significant and consistent positive relationship in the long-term context between CO_2 emissions during the recession and economically unfriendly technological innovation to environmental protection. A recovery of economy can also be accompanied by favourable shocks to the environmental outcomes that ultimately reduce CO_2 emissions.

Umar, Ji, Kirikkaleli, and Xu (2020) performed economywide and causal impact evaluation of innovation and financial development on CO_2 emissions across 1971-2018 periods using combined cointegration and wavelet coherence techniques. Economic growth served also as a control factor. To add to this, the model was controlled. Relying on data from 43 countries, the scientists discovered that monetary development, innovation and CO_2 emissions are absolutely affected at various points and frequencies. The results from their study suggested that CO_2 emissions could be predicted using innovation as a primary predictor. The study of Ali, Dogan, Chen, and Khan (2021)on the link between environmental innovation, and the use of renewables was their main objective Mukhtar, Mukhtar, Mukhtar, Shahid, Razzaq, Rahman, (2023). Also, by studying the deviating and reinforcing influences of innovation in ERTI, Ahmad and Zheng (2021). The authors used the cross-sectionally augmented autoregressive distributed lag (CS-ARDL) method to make the assertion that while carbon emissions are linked to environmental integration over the long term, this connection is context-dependent while maintaining consumption-based and area-based emissions Rahman, & Bakar, (2019), Rahman, & Bakar, 2019).Authors opted for studying the factors, which are triggering CO_2 emissions and the extent, by which the informative (environmental) innovation creates environmental sustainability instead of considering the entirety of impact, which environment-related technical innovation has on environmental quality Nawaz, Rahman, Zafar, & Ghaffar, (2023).

3. Methods

This research paper contains systematic review of the literature (Awan, Ali, Rehman, & Idrees, 2023; Awan, Bibi, Bano, & Shoukat, 2023) or meta-analysis (Lacey, Matheson, & Jesson, 2011) in order to explore and critically evaluate resources dealing with the problem. As a part of the comprehensive and critical analysis Ali, Rahman, & Anser, (2020)., I would develop a critical review (Awan, Arslan, & Hussain, 2023)form to do a full review of the following points in the preceding papers: area of focus, bibliographic details, theory used (when relevant), research philosophy (Zikmund, Babin, Carr, & Griffin, 2013), results, methodology, definition of green finance, fintech, Financial inclusion, GDP and environmental innovation on To critical review the study (Awan, ul Hasnain, & Arshad, 2023), author browsed literature that have (Awan, ul Hasnain, et al., 2023) been published since 2016 to 2023. For the purpose of the research of the most suitable papers about green finance, fintech and environmental innovation CO_2 emission, the researcher carried out the thorough search Tabassum, Rahman, Zafar, & Ghaffar, (2023), Li, Bai, Yu, Meo, Anees, &. Rahman, (2022)

This search involved assessing papers attained from two primary sources: (1) The list of financial/economics journals curated by Clarivate analytics, Zhu, Fang, Rahman, & Khan, (2021), Younas, Idrees, & Rahman,(2021) namely the Master Journal List 2017 and Arts and Humanities Citation Index Report 2016. (2) The databases containing papers of different financial resources, including Business Source Premier by Ebsco and Scopus. (3) Google Scholar; (4) bibliography including green finance, fintech, financial inclusion, GDP and environmental innovation, CO_2 emission (listing the many references), Shafique, Rahman, Khizar, Zulfiqar, (2021) published in different journals. The author has specified some criteria which they will use to select the literature as outlined in this literature review. The standard comprises of concentrating on green finance, fintech, financial inclusion, GDP, environmental innovation and carbon dioxide emissions Idrees, Awan, Arslan, Hussain, Razzaq, Haris, & Rahman, (2023).

Furthermore, non-empirical or non-conceptual materials such books, commentary, conference summary summaries, executive abstracts, editorials, literature reviews, and newspaper/magazine pieces have been omitted Hassan, Sheikh, & Rahman, (2022), Khan, Afridi, Shad, Rahman, (2022).After accounting for duplication, the author conducted a comprehensive analysis and identified almost 50 papers. This study carefully examined each paper's abstract, title, and methodology, when needed, to determine its applicability.

4. Conclusion

A study of reviewing literature has led us to the believe that there is a highly likely causal relationship between green finance, fintech, financial inclusion, GDP, environmental innovation, and CO_2 emissions Rahman, Ali, Idrees, Ali, & Zulfiqar, (2022). This review is like a two-sided coin as there exist both positive and negative influences. On the other hand, by the fact that both results are the gaps in other studies on their own), Rahman, Chaudhry, Meo, Sheikh, & Idrees, (2021), it is quite interesting. This paper considers green finance, fintech, financial inclusion, learn about the trends of green finance or benefits environmental innovation drives CO_2 emissions in the G-20 countries, the ongoing topic of discussion and researchSarwar, Ali, Bhatti, & Rahman, (2021). Lots of research have been done to understand more about whether green finance, fintech, and environmental innovation affects the economy as whole.

4.1. Future Direction

Examine the recent literature shows that There is a great need for further research in all three of the justifications.One of the first points to make is that a great deal of research has been done to assess the relationships between the green finance, fintech, financial inclusion, the GDP, and the environmental innovation that most likely influence the CO_2 emissions across the G-20

countries. Several of them have used the RDL model, ARDL model (Awan, Shahid, et al., 2023), ordinary least squares (OLS) regression, and general method of moments (GMM) as the base for their analysis. Eerily, the VCEM (Vector Error Correction Model) and NARDL (Nonlinear Autoregressive Distributed Lag Model)(Awan, Rahman, et al., 2023) is remarkably less used in the area of carrying on such analyses. The imperative of having an appropriately executed VCEM procedure is of significant importance given the purpose of capturing the dynamics of the time series data being studied, while also overcoming the endogeneity and causality problems. Bearing that in mind, the line of reasoning here is that the VECM method is an excellent tool to be able to detect any indirect or feedback effects in the data Khoula, Rahman, Idress, (2022). Whereas, the NARDL model is able to capture the non-linear relationships in time series data. Successfully implementing the NARDL procedures is crucial for uncovering hidden patterns and identifying complex relationships which makes these models effective tools for completing data analysis. Their ability to handle both short-run and long-run concerns is what makes them relevant in examining the dynamics of time series data, Zulfiqar, Ansar, Ali, Hassan, Bilal, & Rahman, (2022).

Secondly, most of the previous researches have mainly focused on the association between host countries' GDP and economic growth and the effects that green finance, fintech, and environmental innovation Shahid, Muhammed, Abbasi, Gurmani, & Rahman, (2022), while CO_2 emission is the main factor that is being studied. Yet, the research gap regarding the G-20 countries is a crucial obstacle on the path towards implementation of the SDGs. Hence, it is recommended Qureshi, Zaman, Rahman, Shahzadi, (2022)that additional inquiry be conducted in order to gain a comprehensive understanding of the intricacies within G-20 nations. This is particularly vital given the magnitude of green finance, fintech, financial inclusion, GDP, and environmental innovation Hafiza, Manzoor, Fatima, Sheikh, Rahman, Qureshi, (2022).Moreover, the comparative measurement of ecological footprint as a proxy measure to CO_2 emission to improve the precision and correctness of assessments.

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