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The Impact of Fintech and Economic Development on Carbon Emissions in Mobile Money Economies

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ABSTRACT

Innovation is essential for accomplishing green and low-carbon objectives, which drives industrial upgrading and transformation. In order to improve the financial services industry's capacity for innovation, numerous countries actively encourage the growth of FinTech. This will surely contribute to the development of industry and technology in the field of a low-carbon, green economy. This research examined the nexus between carbon emissions (CO_2) and fintech in the mobile money economies. Using the variables of fintech, carbon emissions, domestic credit to the private sector, foreign direct investment, GDP, and trade, the study employed statistical tools for the generalized linear model (GLM) and unit root test, over a period of 10 years, from 2013 to 2022. The study's findings confirmed that fintech did have a positive effect on carbon emissions and will aid financial institutions in developing a green economy and encourage the low-carbon economy to meet the objectives of the Paris Agreement. The study concluded that Fintech (Financial Technology) is the best financial strategy for reducing Carbon emissions (CO_2) at the global level.

Keywords: CO_2 Emissions, FinTech, Gross Domestic Product, Economic Development

JEL Classifications: E2, O1, Q40, O31

1. INTRODUCTION

The Fintech of the 21st Century, was established by financial institutions, particularly banking sectors, business owners, corporate sectors and artificial intelligence, etc., Fintech refers to "Financial Technology," that is used to integrate new technology into the use of financial services. It includes all sectors like educational institutions, industries, consumer businesses, start-ups, artificial intelligence (AI), fundraising companies, and investment in financial services of management sectors. Everyone has a part to play in the global economy's decarbonization. The financial technology sector's contribution is greater than most, according to Michael Kent, chairman and co-founder of Azimo. But "pricing the risk and financing the investment for the green revolution, will run to trillions of dollars for consumers, businesses, and governments all over the world."

The sixth report from the UN's Intergovernmental Panel on Climate Change (IPCC), is the first significant assessment of climate change since 2013 and has been dubbed a "code red for humanity." In response, the fintech sector has urged for increased cooperation and widespread investment in clean technologies and natural resources, to realise the climate goals set forth by the Paris Agreement. A world if finance has shifted toward decarbonization may have a significant impact on global warming. Further investments in battery technology, carbon sequestration (the removal, storage, and capture of CO2 from the atmosphere), reforestation, renewable energy, electrification, and energy efficiency are being made as part of the endeavor to lower carbon emissions (Wang and Zhi, 2016).

Fintech is the process of developing new financial products and service models, using information technology, including blockchain, big data and artificial intelligence. Currently, the micro level of businesses is the subject of more Fintech studies. First, Fintech innovation has successfully increased real businesses' total factor productivity, promoting transformation and strengthening the real economy's sustainable growth (Luo et al., 2022; Xu, J., Chen, F., Zhang, W., Liu, Y., and Li, T. (2023). Fintech firms provide innovative technology and innovative strategies to the business climate, creating new opportunities to provide access to businesses and generate in investors who had not previously been present. Additionally, it can lead market participants to change to these more effective and efficient intermediation methods (Bollaert, H., et al. 2021).

Fintech, which is radically changing financial services, is the use of information technologies such as big data, blockchain, and artificial intelligence in the financial industry (Goldstein et al., 2019). Several scientists suggest that developments in finance and technology affect carbon emissions (Jiao et al., 2018; Wang et al., 2019; Tamazian et al., 2009; Shahbaz et al., 2018). Fintech may, therefore, have an impact on carbon emissions. Fintech has the potential to mitigate carbon emissions, by facilitating industrial structure upgrading, as noted by Ren et al. (2021). Fintech has the potential to spur economic expansion and also raise carbon emissions in the process (Liu et al., 2021). Fintech can also advance technology (Cao et al., 2021). In a sense, we are unsure about fintech's effect on carbon emissions—positive or negative.

The Fintech firms have a significant impact on both global warming and the international economy. One of the biggest issues the world has ever faced is preventing global warming by reducing carbon emissions. Due to its involvement in the financing of fossil fuel facilities and the high energy consumption, associated with cryptocurrency mining, the fintech sector might be considered a direct contributor to climate change. Therefore, some argue that it is the industry's responsibility to develop cutting-edge technology, to aid in the reduction of carbon emissions. They use technology to help integrate renewable energy sources into power networks, analyze bank statements to show how people's lifestyles contribute to CO_2 emissions and use artificial intelligence (AI) to determine whether financial institutions are greenwashing. Fintech firms assist others in achieving net-zero emissions. Once a baseline measurement has been made, it is crucial to reassess it every year, to make sure that the GHG and CO_2 emissions do not rise higher. Following accreditations like the Science Based Targets initiative (SBTi), which will validate your reductions to guarantee. We keep global warming to 1.5°C and commit to lowering emissions. Although Carbon Emission (CO_2) reduction strategies are challenging, worthwhile endeavours are never simple.

In this study, an attempt has been made to analyze the relationship between financial technology and the sustainability of carbon emissions in mobile money economies, with the variables of fintech, carbon emission, domestic credit to the private sector, foreign direct investment, GDP and trade over a period of 10 years, from 2013 to 2022. The remainder of this paper is organized as follows: Section 2 provides a review of the literature. Section 3 describes the theoretical analysis and hypothesis. Finally, the results of the findings are discussed in Section 4 and Section 5 provides the conclusion.

2. REVIEW OF LITERATURE

In this study, an attempt has been made to briefly review the literature, related to the previous research work already undertaken by researchers, relating to the topic under study.

In the paper entitled, "Fintech, financial inclusion, and income inequality: A quantile regression approach," by Demir et al. (2020), studied panel data of 140 countries from Global Findex waves. The paper discussed the United Nations 2030 Agenda for Sustainable Development and the G20 High-level Principles for Digital Financial Inclusion, with exploiting the potential of fintech to decrease financial exclusion and income inequality. It is suggested that defects in the financial system, such as information asymmetries and transaction costs, hinder the ability of impoverished individuals to escape poverty by restricting their access to formal financial services. Data were obtained for 140 countries in the years 2011, 2014, and 2017. The finding shows that FinTech has a significantly negative coefficient, implying that it decreases income inequality. Their findings allow us to make three primary conclusions. First, through its impact on financial inclusion, fintech indirectly reduces income inequality. Second, the impacts of financial inclusion are greater at the top quantiles of the inequality distribution and decrease inequality at all quantiles. Finally, financial inclusion significantly increases inequality, with higher-income nations being the main drivers of these impacts.

Coffie et al. (2022), in their paper titled, "FinTech and CO_2 Emission: Evidence from (Top 7) Mobile Money Economies in Africa," estimated the nexus between financial technology and carbon emission, over the period from 2009 to 2020 with the FMOLS model for cross-sectional dependence and cointegration. The FinTech reported a significant negative relationship with CO_2 emission in the 7 countries while DCP showed a statistically insignificant relationship with CO_2. They suggested that FinTech reduces CO_2 emissions in these economies. The study concluded that FinTech reduces CO_2 emissions, and domestic credit to the private sector shows a statistically insignificant relationship with CO_2 in the top 7 mobile money economies in sub-Saharan Africa. Therefore, the study recommended encouraging mass FinTech diffusion and continual usage in sub-Sahara Africa and implementing policies to encourage businesses to invest in ecologically safe machinery and equipment.

In an article entitled, "Impact of Digital Finance on Green Technology Innovation: The Mediating Effect of Financial Constraints" by Decai Tang et al. (2023) examined the effect of fixed and mediating models, to discuss how digital finance enabled corporates to introduce green technology by using the Chinese A-share public businesses data, from 2011 to 2020. The study used three dimensions, that is digital finance, business innovation in green technology, and business located in the regions. According to the empirical results, green technology innovation was positively impacted by digital financing, which also revealed that the digital financial coefficient was significantly positive, confirming the robustness of the findings. The study concluded that digital finance positively impacted the innovation of green technology and policy initiatives would enhance the macroeconomic environment, provide financing avenues for business, and to create fiscal and tax incentives and other support policies and actions.

In the paper entitled, "The Effect of digital financial inclusion on the Green Economy: the case of Egypt," by Salman and Ismael (2023), the relationship between digital finance, renewable energy, and traditional financial inclusion (TFI) was examined, with regard to carbon emissions in Egypt. Together with additional control variables, the study used the autoregressive distributed lag (ARDL) model, to analyze the effects of renewable energy on carbon emissions and traditional bank-based financial inclusion for Egypt, between 1990 and 2020. The findings revealed that over time, digital financial services can reduce CO_2 emissions. According to the study, DFI may have an impact on Egypt's energy structure, by acting as a moderator between CO_2 emissions and renewable energy, and it may also be a crucial instrument for policymakers looking to enhance environmental standards. The study concluded that while digitalization improves environmental quality, reducing CO_2 cannot be accomplished without a digitalized financial system. Inclusive digital finance and environmental sustainability are compatible strategies.

The study entitled, "The Role of green finance in reducing CO_2 emission: An empirical analysis," by Meo and Abd Karim (2021), examined the nexus between carbon emission (CO_2) and green finance in the top ten economies. The study analyzed Quantile on Quantile Regression (QQR) tools, to examine the relationship between green finance and CO_2 emissions, with the negative effect in the United States. They found a positive impact of green finance on CO_2 emissions in the lower quantile of green finance and lower to upper quantiles of CO_2 emissions. The study recommended government fiscal policies and fiscal funding to improve green finance development and to manage the way credit funding and capital go into green credit, green investment, and green securities.

The study, "The Impact of Financial Development on Decarbonization Factors of Carbon Emissions: A Global Perspective," by Thangaiyarkarasi and Vanitha (2021), examined the relationship between the financial performance of ten industrialized and five developing countries, during a 10-year period, from April 1, 2010, to March 31, 2019, and the carbon emissions of decarbonization variables. Applying the NLS panel regression model, the ARMA approach, the unit root test, and the cointegration test, the study examined financial development variables. The results found a positive correlation between financial development and carbon emissions. The probability values were significant at the 5% level, based on a subsample regression. According to the authors, technological developments will increase energy consumption and the transportation sector is responsible for 23% of world emissions.

According to the paper entitled, "The Impact of Carbon Emission and Energy Factors on Climate Change in BRICS Countries," by Vanitha and Thangaiyarkarasi (2024), burning and combustion are the primary human-caused factors which contribute to climate change and global warming. The main objective of this study was to examine the effects of climate change on energy factors and carbon emissions in the BRICS countries over 20 years, from 2003 to 2022. The paper examined Granger causality between all variables and the energy, GDP, and carbon emission components, using applied econometric analysis methodologies. Energy-related variables include energy use, electricity consumption, electricity accessibility, and renewable energy use. A low-carbon economy and a decrease in carbon emissions would contribute to progressive GDP growth, according to the empirical data. According to the results, indicators would increase between 1990 and 2008. In the wake of the global economic crisis, CO_2 emissions began to decline, but GDP per capita continued to increase.

3. MATERIALS AND METHODS

3.1. Materials

The paper proposes to analyze the problem of FinTech and CO_2 emissions and their impact on economic development in Mobile Money Economies during the study period. In recent decades, an estimated 69% of consumers worldwide have changed their products and services to more sustainable alternatives. Climate crisis communication is more relevant than ever, as businesses and consumers grow increasingly concerned about their environmental impact. FinTech has an ongoing responsibility to drive sustainable initiatives for reducing CO_2 emissions and greenhouse gas (GHG) emissions across industry verticals around the world.

The need to achieve net zero will never be more urgent than it is today. "Net zero" is one of the most key challenges for corporate companies, firms, business enterprises, financial institutions, and organizations around the world. Attaining net zero carbon emissions is now on the agenda for many FinTech, with increasing societal and regulatory pressure causing Fintechs to recognize the importance of aligning their operations with sustainability goals. In a world that is quickly shifting to a net zero economy, achieving net zero carbon emissions is high on the agenda for a growing number of FinTech.

The study was based on the objectives is to study the relationship between financial technology (FinTech) and sustainability of carbon emissions (CO_2) during the study period, to study the impact fintech with digital finance on carbon emissions in mobile money economies and to summarise the findings, suggestions, and arrive at conclusions. The present study tested the following hypotheses: H_1: The impact of carbon emission (CO_2) can be reduced by using financial technology (FinTech) during the study period and H_2: Digital finance can develop fintech innovation. In this study, the main objective was to find the impact of Fintech and Digital Finance on the Sustainability of Carbon Emission in Mobile Money Economies. The sample countries were Australia, Brazil, China, France, Germany, India, Indonesia, Japan, Russia, South Korea, UK, and the USA.

The Sources and Collection of the Data This study examined the impact of Financial Technology (FinTech) and digital finance on the sustainability of reducing carbon emissions (CO_2) in mobile money market economies. Table 1 summarizes details of the

Table 1: Details of variable description during 1st January 2013-31st December 2022

S. no.	Variables	Description	Source
1	CO_2	CO_2 emissions (metric tons per capita)	WDI
2	FinTech	Financial Development Index	IMF Fin access
3	DCP	Domestic credit to private sector (% of GDP)	WDI
4	FDI	Foreign direct investment, net inflows (% of GDP)	WDI
5	GDP	GDP (constant 2015 US$)	WDI
6	TOP	Trade (% of GDP)	WDI

Source: Data were collected from www.worldindicators.com and IMF

sources of data employed for the study. Data were gathered from two main sources - World Development Index and International Monetary Fund (IMF) Fin Access. The study depended mainly on secondary data. The data were collected from www.worldbank.org and www.imf.org. Data on CO_2 Emission, Domestic Credit to Private sector (DCP), Foreign Direct Investment (FDI), GDP per capita, and Trade Openness (TO) were sourced from World Bank indicators, and FinTech (Financial Technology) was sourced from the International Monetary Fund Fin Access.

All the variables were transformed into the natural logarithms, except for FinTech and, as they were already dimensionless or ratio indexes. The study covered a period of 10 years, from 1st January 2013 to 31st December 2022.

3.1.2. Reasons behind selecting mobile money economies

The global mobile money industry has seen a compound annual growth rate (CAGR) of 25.9%, rising from $8.86 billion in 2022 to $11.16 billion in 2023. At least temporarily, the chances of a global economic recovery from the COVID-19 pandemic were damaged by the Russia-Ukraine war. Due to the conflict between these two nations, numerous nations are now subject to economic sanctions, commodity prices have spiked and supply chain disruptions have resulted in the inflation of goods and services, impacting numerous global markets. At a compound annual growth rate of 26.6%, the mobile money market is projected to reach $28.67 billion by 2027.

The revenue generated by businesses, offering solutions to manage and save costs through the use of a bank account connected to a mobile phone, to enable safe and convenient transactions, is included in the mobile money market. The electronic transmission of funds between people or organizations through mobile devices is referred to as mobile money. Through the incorporated digital payment technology, users can send, receive and withdraw money, using standard smartphone devices without utilizing the traditional banking system. Australia, Brazil, China, France, Germany, India, Indonesia, Japan, Russia, South Korea, the UK, and the USA are the nations included in the mobile money market research.

3.2. Methodology

3.2.1. Econometric model

The impact of technological development on environmental pollution was examined by Ehrlich and Holdren (1971) for the 1st time. The study proposed the population (P), affluence (A), and technology (T) impact (I) on the environment (IPAT) model, which is in the form of a linear equation. It examines the impact of technology, population growth, and affluence on environmental pollution. An additional variable extended the model of the IPAT equation into a stochastic form known as the "STIRPAT" model.

$$I= \alpha_{it} P^{\beta 1} A^{\beta 2}{}_{it}\ T^{\beta 3} it\ c\varepsilon_{it}$$

Where the I refers to the environmental pollution by human activities, while P, A, and I are the driving force of carbon emission (CO_2), proposed by Ehrlich and Holdren (1971), and finally β_1, β_2 and β_3 represent elasticity variables. This study extends the STIRPAT model to influence the effect of FinTech and CO_2 emission on sustainable development, in addition to including other explanatory and control variables. Thus, the basic model is as follows:

$$CO2 = \beta + \beta_1 FIN\ TECH + \beta_2 DCP + \beta_3 TOP + \beta_4 FDI + \beta_5 GDP$$

Where the dependent variable is CO_2 emissions, and others are independent variables.

The cross-sectional dependence on energy consumption in mobile money economies, or other geographic political, and institutional entities in the globalization era, characterizes the world today both in economic and social and the environmental aspects. Some groups of economies form coalitions such as the European countries, that have chosen to participate in the European Economic Union (EU). This coalition is mainly economic but gradually it has become social and political. Other countries belong to other unions or organizations, partly because they have stipulated certain conditions and promised to comply with rules and behaviors. These behaviors are either the reasons they qualified for participation or they have promised to develop them with certain deadlines. The endorsement of international environmental agreements also drives to unanimous behavior and attitudes toward the reduction of pollution, the increase of energy efficiency, and the replacement of conventional fossil energy sources with renewable energy sources. Of course, each economic structure is different and the level of its development is also different and thus can fulfill these goals with different duties and responsibilities.

The study suffers from the following limitations: The study was based on secondary data and hence, limitations of secondary data are applicable to this study also, this study focused only on Mobile Money Economies and was confined to a period of 10 years.

4. EMPIRICAL RESULTS

The results of descriptive statistics of mobile money economies are shown in Table 2. The mean value at 12.2715 was the difference between the highest GDP and lowest value of FDI respectively, and it revealed the average value of the mean among the variables. The mean value results indicated that foreign direct investment (FDI) can increase growth, by transferring new technology from advanced countries to emerging nations. The maximum value of GDP recorded the highest value and the minimum value of FDI demonstrated the negative impact on overall observations of mobile money economies. The standard deviation of all variables reported positive values and at 0.3084, it recorded the difference between the highest value of FINTECH and the lowest value of Trade Openness. Additionally, looking at the values for the standard deviation, all variables were <1.000, indicating that the values were closer to the mean values of the sample average. On the skewness of the distribution, the variables of TOP and GDP were positively skewed and the other variables were negatively skewed, indicating a long-left tail. The kurtosis values revealed that only GDP was normal or mesokurtic curve and the FDI values were leptokurtic of higher values. The Jarque-Bera test of statistics revealed that 395.1418 was the measure of the difference value of the highest FDI and lowest value of Trade Openness. The findings of the results demonstrated that economic growth of mobile money economies can be increased with the help of FDI. According to the results, the transfer of resources, expertise, and technology between nations increased innovation and productivity during the study period. The descriptive results indicated that CO_2 emissions were reduced by mobile money economies through improving the new innovative technologies and financial services of FINTECH, done by digital transaction and transformation, resulting in a green economy in the future.

The Table 3 presents the results of the correlation matrix. The variables of TOP, FIN TECH, and CO_2 emissions of mobile money economies were positively correlated, and the other variables were negatively correlated. When the variables of FINTECH and CO_2 emissions reported weakly positive correlation with the TOP variable, it indicated that increasing technology reduced carbon emissions. The relationship between FDI and GDP revealed a weakly negative correlation, implying that when one variable increases, the other variable tends to decrease. The FDI recorded negative values with FINTECH, DCP, and CO_2 emissions, revealing the negative correlation between the variables. The findings of negative correlation revealed that when one variable increased, the other variable decreased. The correlation of domestic credit to the private sector and CO_2 was moderately positive with each variable, suggesting that when one variable increases, other variables also increase. The correlation result suggests that the value of CO_2 emissions was positive in relation to all variables, except the FDI variable. In other words, FDI was not associated with CO_2 emission of mobile money economies. When there are more FDI inflows in higher environmental emissions, the effect might be detrimental.

Table 2: Results of descriptive statistics for mobile money economies from 1st January 2013 to 31st December 2022

S. no.	Variables	Mean	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	Jarque-Bera
1	CO_2	0.6408	1.2310	0.0000	0.4413	−0.2840	1.5178	12.4967
2	GDP	12.4493	13.3124	11.8696	0.3810	0.9362	2.9496	17.3967
3	FINTECH	0.6383	1.0000	0.0000	0.4692	−0.5740	1.3918	19.3561
4	FDI	0.1778	1.0803	−2.0595	0.3925	−1.9890	11.0363	398.6937
5	DCP	1.9867	2.3351	1.5242	0.2299	−0.3890	1.7852	10.3229
6	TOP	1.6664	2.0231	1.3689	0.1608	0.2064	2.2611	3.5519

Source: Data were collected from www.worldindicators.com and IMF. Computed from E-Views 7 version

TOP: Denotes trade openness, GDP: Denotes gross domestic product, FIN: TECH denotes financial technology, FDI: denotes foreign direct investment, DCP: denotes domestic credit to private sector and CO_2 denotes carbon emission

Table 3: Results of the correlation matrix for mobile money economies from 1st January 2013 to 31st December 2022

S. no.	Variables	TOP	GDP	FINTECH	FDI	DCP	CO_2
1	TOP	1.0000					
2	GDP	−0.3298	1.0000				
3	FIN TECH	0.2149	0.1490	1.0000			
4	FDI	−0.0726	−0.0874	−0.1531	1.0000		
5	DCP	−0.0538	0.6427	0.6380	−0.2362	1.0000	
6	CO_2	0.1307	0.1846	0.2918	−0.0884	0.3524	1.0000

Source: Data were collected from www.worldindicators.com and IMF. Computed from E-Views 7 version

Table 4: Results of ranking for mobile money economies CO_2 Emission metric Tons for the period from 1st January 2013 to 31st December 2022

S. no.	Country/year	Rankings	2013	2014	2015	2016	2017	2018	2019	2020
1	Australia	16	1.2310	1.2160	1.1995	1.2004	1.2018	1.1993	1.1904	1.1834
2	Brazil	14	0.3563	0.3826	0.4005	0.3739	0.3347	0.3403	0.3149	0.3119
3	China	1	0.8480	0.8648	0.8630	0.8541	0.8522	0.8592	0.8743	0.8812
4	France	21	0.7121	0.7101	0.6643	0.6700	0.6725	0.6767	0.6601	0.6493
5	Germany	8	0.9755	0.9834	0.9585	0.9584	0.9577	0.9474	0.9313	0.8983
6	India	3	0.1756	0.1840	0.2155	0.2125	0.2148	0.2339	0.2531	0.2494
7	Indonesia	6	0.2843	0.2476	0.2761	0.2755	0.2655	0.2913	0.3345	0.3616
8	Japan	5	0.9922	0.9960	0.9806	0.9674	0.9633	0.9590	0.9446	0.9315
9	Korea	9	1.0777	1.0752	1.0640	1.0761	1.0801	1.0864	1.0873	1.0719
10	Russia	4	1.0683	1.0560	1.0495	1.0434	1.0369	1.0428	1.0606	1.0718
11	UK	17	0.8659	0.8498	0.8084	0.7895	0.7637	0.7447	0.7346	0.7177
12	US	2	1.1984	1.2071	1.2052	1.1920	1.1804	1.1709	1.1825	1.1665

Source: www.iea.org

Table 4 presents the carbon emission (CO_2) in metric tons of mobile money economies from 1st April 2013 to 31st March 2022. Australia was ranked sixteenth in CO_2 emissions in metric tons. The biggest and fastest economic transformation since the Industrial Revolution is taking place in Australia and the world. While reducing emissions will help prevent the worst effects of climate change, it will also lead to growth in new industries and jobs. The Australian government continues to take significant steps to realize the opportunities of an efficient, productive, high-wage net-zero economy and Australia is moving towards a renewable energy superpower. Australia released 465.2 million tons of CO_2 equivalent in June 2023, up 0.8% from June 2022, according to the June 2023 report. The main source of carbon emissions in Australia is generating energy. China reports the second-largest economy with the largest population in the world. In addition, it is the world's fifth-largest producer of oil and China is the world's biggest emitter of carbon dioxide (CO_2) and other greenhouse gases. Since it uses more coal than the entire globe combined. China's power generation from solar and wind has increased tenfold in the last 10 years. France is ranked twenty-first, the last ranking in mobile money economies. Just behind China and considerably ahead of Russia, it is the third-largest nuclear power generator in the world. Compared to other G20 nations, France generates minimal electricity from fossil fuels.

Table 5 presents the carbon emission (CO_2) per capita of mobile money economies from 1 April 2013 to 31 March 2022. The US was ranked eleventh in carbon emission per capita. In 2022, the average US emitted 13.8130 carbon emissions per capita, a decrease of more than 30% since 1990. After China, the United States is the world's second-largest carbon emitter. The worldwide increase in greenhouse gases in the atmosphere during the past 150 years is attributable to human activity. Burning fossil fuels for transportation, heating, and power is the main human activity-related source of greenhouse gas emissions in the US. Australia is at the 12th rank in carbon emissions per capita. The process of burning fossil fuels in order to produce energy, accounted for 32.6% of the overall emissions. India at the 98th ranking, has the last ranking position, with low per-capita emissions (1.8 tons of CO_2) when compared to the global average of 4.4 tons. India is the world's third-largest emitter of greenhouse gases (GHG), behind the United States and China.

The decision-making process between first- and second-generation panel unit root testing was made possible by a cross-sectional dependence test. Three tests were used to achieve this: The Pesaran cross-sectional dependence (CD), the Breusch-Pagan Lagrange multiplier (LM), and the Pesaran Scaled Lagrange Multiplier (LM). The data in Table 6 presents the results of the cross-sectional dependence test, for mobile money economies, from 1st April 2013 to 31st March 2022. The null hypothesis that there is no cross-sectional dependence was rejected. Because Breusch-Pagan LM and Pesaran Scaled LM tests revealed cross-sectional dependency, among the regressors, at the 1% significance level. The variable of CO_2 emissions revealed a 0.05 level of significance for Breusch-pagan LM, Pesaran-scaled LM, and Pesaran CD. The domestic credit to private sector (DCP) reported a prob. Value of 0.000 at <5% significant level. The trade openness (TOP) recorded a prob. value of 0.05 at a significance level. But Foreign direct investment (FDI) recorded the prob. Value which was greater than significant value, and it also reported negative statistic values of −0.0105 and −1.1402. In other words, mobile money economies were somewhat

Table 5: Results of ranking mobile money economies CO_2 emissions per capita for the period from 1st January 2013 to 31st December 2022

S. no.	CO_2 emissions per capita in percentage											
	Country/year	Rankings	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
1	Australia	12	16.5840	15.9280	15.8810	15.9480	15.7780	15.4800	15.1580	14.3880	14.0530	13.6380
2	Brazil	94	2.2680	2.3550	2.2230	2.0310	2.0720	1.9540	1.9250	1.8110	2.0490	1.9220
3	China	25	6.7460	6.7090	6.6020	6.5560	6.6590	6.9470	7.0440	7.0900	7.4880	7.5150
4	France	60	5.0110	4.4990	4.5660	4.5830	4.6290	4.4530	4.3360	3.8290	4.2580	4.1330
5	Germany	27	9.4690	8.9290	8.9330	8.9190	8.6960	8.3770	7.7670	7.1320	7.4300	7.3030
6	India	98	1.4330	1.5470	1.5520	1.5510	1.6190	1.6800	1.6540	1.5110	1.6510	1.7760
7	Indonesia	88	1.6690	1.7670	1.7700	1.7200	1.7970	1.9850	2.1120	1.9560	2.0250	2.3650
8	Japan	23	9.7200	9.3360	9.0440	8.9410	8.8410	8.5470	8.2730	7.8500	7.9920	7.7930
9	Russia	15	10.9300	10.7890	10.6390	10.4590	10.6380	11.0200	11.0210	10.5340	11.5660	11.3070
10	South Korea	17	11.7460	11.3740	11.5370	11.5150	11.8390	12.1670	11.6260	10.7730	11.0980	10.6400
11	UK	52	6.9710	6.3130	6.0330	5.6540	5.4470	5.3170	5.0840	4.4880	4.7630	4.5640
12	US	11	15.8890	15.7900	15.3010	14.9060	14.5670	14.9350	14.3560	12.8320	13.6870	13.8130

Source: www.iea.org

Table 6: Results of cross-section dependence test from 1st January 2013 to 31st December 2022

S. no.	Variables	Breusch-Pagan LM		Pesaran scaled LM		Pesaran CD	
		Statistic	Prob.	Statistic	Prob.	Statistic	Prob.
1	CO_2	636.245	0.000	49.6334	0.000	25.2172	0.000
2	FDI	65.8789	0.481	−0.0105	0.9916	−1.1402	0.254
3	DCP	228.113	0.000	14.1102	0.000	9.91911	0.000
4	TOP	147.491	0.000	7.09287	0.000	4.90934	0.000

Source: Data were collected from www.worldindicators.com and IMF. Computed from E-Views 7 version dependent on one another, which supported the suitability of the first-generation panel unit root tests for this research.

Table 7 shows the results of the panel unit root test, based on Augmented Dickey-Fuller test (ADF) and Phillips-Perron test (PP). The statistics values of all variables were negative and the prob. values of significant levels were 0.0009 and 0.000 at 1% level respectively. Phillips-Perron Test, revealed negative effect, and the prob. values were at 1%, 5%, and 10% significant levels. The P-value was <0.05 level of significance. All variables were not static at 5% significance, according to the test results, except FDI and CO_2 emission in the ADF test. As per the results of both panel unit root tests of the Augmented Dickey-Fuller test (ADF), and Phillips-Perron test (PP), the variable of foreign direct investment (FDI) was recorded at 0.0009 and 0.000 respectively and the prob. value was less than the significant level of 0.05. In other words, the variable was stationary and did not have a unit root. In short, FDI was not associated with CO_2 emission of mobile money economies. In short, more FDI inflows may result in higher environmental emissions, the effect might be detrimental.

Table 7: Results of unit root test for mobile money economies from 1st January 2013 to 31st December 2022

S. no.	Variables	Augmented Dickey-Fuller test statistic		Phillips-Perron test statistic	
		Statistic	Prob.	Statistic	Prob.
1	TOP	−2.5859	0.0987*	−2.7245	0.0729*
2	GDP	−2.8565	0.0537*	−3.0269	0.0353**
3	FIN TECH	−2.7974	0.0617*	−2.9022	0.0481**
4	FDI	−4.2283	0.0009***	−7.6077	0.000***
5	DCP	−2.6391	0.0881*	−2.7086	0.0755*
6	CO_2	−3.1901	0.0232**	−4.9961	0.0001***

Source: Data were collected from www.worldindicators.com and IMF. Computed from E-Views. *** and ** represent statistical significance at 1% and 5% respectively

The results of cointegration test are presented in Table 8. Individual cross-sections were combined in the cointegration test. The maximum eigenvalue test and the trace test were the two ratio tests, used in this method. Using the results of the separate, independent tests, Fisher created a composite test. Maddala and Wu combined tests, from individual cross-sections, to obtain a test statistic for the entire panel. This builds on Fisher's findings to suggest an alternative method of testing cointegration in panel data. The results of co-integration relationship, among the panel data series were rejected among the variables, which implied cointegration relationship. The study was continued by establishing the panel data model. The CO_2 emissions indicated a prob. value of 0.0001 at 1% significant level, which gives strong evidence that the variables experienced long-run relationship. The Trace statistic value of 7.4887, the difference value of CO_2 emissions and TOP recorded the highest and lowest value among the variables. The results also revealed that an increase in trade openness could increase CO_2 emissions.

Table 9 shows the results of panel regression with a generalized linear model. The coefficient of CO_2 and DCP value at −0.0699, was the different values of negative impact. The prob. values of DCP, GDP, and TOP were 0.000 at 1% significant level. In other words, the fintech will reduce carbon emissions by using innovative technologies, and improving financial and business transactions, with the help of mobile banking apps, modern technology, etc. The Table shows that the coefficients of foreign direct investment, fintech, GDP, and trade openness, for the full regressions, were 0.0010, 0.0102, 0.0807, and 0.0835 respectively and were they significant at the 1% level. The theoretical analysis raised the question whether FinTech's financial development would impact carbon emissions. Financial development could support the innovative efforts of businesses, industries and green projects, that enhance output while cutting down on energy use,

Table 8: Results of the cointegration test for mobile money economies from 1st January 2013 to 31st December 2022

S. no.	Variables	Eigenvalue	(Trace) statistic	Critical value	Prob.**
1	CO_2	0.1210	14.8362	3.8415	0.0001
2	FinTech	0.0710	8.4670	3.8415	0.0036
3	DCP	0.0620	7.3570	3.8415	0.0067
4	GDP	0.0863	10.3782	3.8415	0.0013
5	FDI	0.0667	7.5265	3.8415	0.0061
6	TOP	0.0619	7.3475	3.8415	0.0067

Source: Data were collected from www.worldindicators.com and IMF. Computed from E-Views
*** and ** represent statistical significance at 1% and 5% respectively

Table 9: Results of full regression generalised linear model (GLM) for mobile money economies from 1st January 2013 to 31st December 2022

S. no.	Variable	Coefficient	Std. error	t-statistic	Prob.
1	CO_2	−0.0047	0.0050	−0.9256	0.3566
2	DCP	−0.0746	0.0158	−4.7275	0.0000***
3	FDI	0.0010	0.0054	0.1761	0.8605
4	FIN TECH	0.0102	0.0064	1.5934	0.1139
5	GDP	0.0807	0.0031	25.7188	0.0000***
6	TOP	0.0835	0.0119	6.9999	0.0000***
7	S.E. of regression	----	----	----	0.0223
8	Sum squared resid	----	----	----	0.0563
9	Durbin-Watson stat	----	----	----	0.1476

*** and ** represent statistical significance at 1% and 5% respectively thereby reducing carbon emissions. This could be referred to as the "negative effect" of fintech's financial development on carbon emissions. From another perspective, the growth of the financial sector can encourage trade openness, domestic credit to the private sector and energy use, all of which could increase carbon emissions. This is referred to as the "positive effect" of fintech's financial development on carbon emissions. The inversely related dimensions of positive and negative impacts determine the overall impact. But empirical findings demonstrated that in the mobile money economies of our sample nations, the positive impact exceeded the negative effect. Lin, B., and Ma, R. (2022) state that real GDP per capita measures the economic development level.

The major findings of the study were the mean values for the series revealed that GDP recorded the highest value compared to TOP, FDI, DCP CO_2, and FinTech respectively. Further, looking at the values for the Jarque Bera, the value of 388.3718 was the highest difference value between FDI and DCP. The prob. value of trade openness was not significant and other variables like GDP, FinTech, FDI, DCP, and CO_2 emissions were significant at 0.005 level respectively. In other words, there was positive effect of relationship between all variables. The correlation matrix, revealed that FinTech values reported positive relationship with TOP and GDP, indicating that trade and country growth of GDP increased with the help of financial technology. When the FinTech value was 0.2149 and the CO_2 emissions was at 0.1307, it established positive relationship between variables.

The panel unit root tests commonly used Augmented Dickey-Fuller Fisher (ADF) and Phillips-Perron Fisher test (PP-Fisher). The results found that variables were non-stationary at their level forms. Cointegration statistics, from the Pedroni cointegration test, was used to examine the long-run relation between Fintech and carbon emission, in the mobile money economies, over a period of 10 years from 2013 to 2022. There was 0.001 significant level of relationship between DCP, GDP, and TOP, and other values were more than the significant level of 1%. According to results of the GLM regression method, the coefficient value at 0.0825 was the difference between the highest and the lowest values of FDI and trade openness.

The study suggests that optimal structure of emerging FinTech goods and services could be so structured to cut down on investment activities that release carbon emissions. The expanding FinTech landscape of mobile money economies should be expanded to harness the power of technology and finance, towards the support of environmentally sustainable projects, like the growth of green finance and green environment activities in all countries. ElMassah, S., and Mohieldin, M. (2020) focus on how the Sustainable Development Goals (SDGs) might be customized and accomplished using the use of technological change.

4.1. The Outcome of Research

- Climate change mitigation offers a unique chance to enhance public health and the environment. In addition to reducing carbon and greenhouse gas emissions, the measures that must be implemented, are expected to significantly reduce air pollution, heart disease, cancer, obesity, diabetes and transport-related causes of death and injury.
- From a different viewpoint, fintech can effectively decrease national carbon emissions and prevent environmental pollution.
- Fintech drives the global green transition, fosters green and low-carbon economic development, and benefits the environment through low-carbon consumption practices.
- Fintech has developed an application programming interface (API), that helps businesses to launch carbon-neutral products and services, that offset carbon emissions with sustainability tracking.
- Fintech allows consumers and businesses, to transfer some of their proceeds to reduce carbon footprints and focus on clean energy through online investment apps. It will also increase the employment growth rate.

5. CONCLUSION

This study wanted to find out how fintech and digital finance could affect the sustainability of carbon emissions in mobile money economies. Australia, Brazil, China, France, Germany, India, Indonesia, Japan, Russia, South Korea, the UK, and the USA were the nations, covered under the mobile money market research. The unit root test and GLM regression model were employed, to examine the asymmetric impact of fintech on carbon emission. The overall findings revealed the possibility of reducing carbon emissions, using fintech in mobile money economies. However, the relationship between fintech and sustainability of carbon emissions varied in different countries, depending upon the development of modern innovative technology.

With a compound annual growth rate (CAGR) of 25.9%, the global mobile money industry increased from $8.86 billion in 2022 to $11.16 billion in 2023. At a CAGR of 26.6%, the mobile money industry is expected to reach $28.67 billion in 2027. The digital transmission of financial resources from one person or business to another, through a mobile device, is referred to as "mobile money Economy." The digital payment technology is integrated into standard smartphones to receive, withdraw, and transmit money without utilizing the traditional banking system. We recommend the following policies to promote financial technology (FinTech) and to achieve decarbonization.

1. The government should use fiscal policies to advance the cause of using fintech and finance to enable the development of green funding and a green environment.
2. The government should provide a green finance or climate fund, for developing fintech development policies.

The scope for further research lies in analyzing the FinTech's effect on carbon emissions in both developed and developing nations. The use of econometric instruments may facilitate analysis in subsequent research. Lastly, measurements of FinTech from different databases may be used in subsequent research to ascertain whether the relationship between FinTech and CO_2 emissions was true, as asserted by this study.

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