Journal of Climate and Community Development
A Double-Blind, Peer-Reviewed, HEC recognized Y-category Research Journal
E-ISSN: 3006-7855 P-ISSN: 3006-7847

Driving Fintech Evolution through Integrating Social Entrepreneurship, Sustainable Innovation, Digital Transformation, and Regulatory Frameworks

Usama Shams [1] **Noman Shafi** [2] **Usman Ullah** [3] **Waqas** [4]

[1] MBA Student, Quaid-i-Azam School of Management Sciences, Quaid-i-Azam University, Islamabad, Pakistan.

[2] Assistant Professor, Quaid-i-Azam School of Management Sciences, Quaid-i-Azam University, Islamabad, Pakistan.

Email: nomanshafi@qau.edu.pk

[3] M.Phil Research Scholar, Quaid-i-Azam School of Management Sciences, Quaid-i-Azam University, Islamabad, Pakistan.

Email: usmansullahdirv@gmail.com

[4] M.Phil Research Scholar, Quaid-i-Azam School of Management Sciences, Quaid-i-Azam University, Islamabad, Pakistan.

Email: waqas@qasms.qau.edu.pk

Corresponding Author: usmameo897@gmail.com

Vol. *4,* ***Issue*** *1, 2025*

Article Information

Received:

2025-01-16

Revised:

2025-04-20

Accepted:

2025-04-23

ABSTRACT

This study investigates the dynamic relationship between fintech and several critical factors, including green innovation, social entrepreneurship, environmental regulation, financial development, and physical infrastructure. Utilizing a comprehensive dataset spanning 33 countries over the period 2000-2022, the research employs the Generalized Method of Moments (GMM) to address potential endogeneity issues and ensure robust estimations. Digitalization is examined as a mediating variable, while research and development (R&D) acts as a moderating variable. The findings reveal significant positive impacts of green innovation, social entrepreneurship, and financial development on fintech advancement. Specifically, green innovation drives fintech growth by fostering sustainable technological advancements, while social entrepreneurship contributes by addressing social challenges through innovative financial solutions. While stringent regulations can stimulate fintech by encouraging green innovations and compliance with sustainability standards, overly restrictive regulations may hinder fintech growth by imposing excessive compliance costs. Physical infrastructure, however, shows no significant relationship with fintech development, suggesting that fintech can flourish regardless of the level of traditional physical infrastructure, possibly due to the digital nature of financial technologies. Moreover, the study highlights the critical mediating role of digitalization in enhancing fintech outcomes. Digitalization facilitates the adoption and integration of advanced technologies, making financial services more accessible, efficient, and user-friendly.

Keywords: *Fintech, Green innovation, Environmental regulation, Social entrepreneurship, Infrastructure.*

Citation: APA

Shams U., Shafi, N., Ullah, U & Waqas. (2025). Driving fintech evolution through integrating social entrepreneurship, sustainable innovation, Digital transformation, and regulatory frameworks, Journal of Climate and Community Development, 4(1), 105-123.

1. Introduction

The introduction highlights the significant role of ecological economies in promoting green innovation and sustainability within the corporate world. Natural resources support industrialization, population growth, and environmental sustainability, but infrastructure development, like the Belt and Road Initiative (BRI) in Asia, can disrupt local biodiversity (Hughes, 2019). Financial technology could help societies practice responsible resource management by promoting more transparent financial transactions, accurate appraisal of resources, and investments in sustainable practices (Taylor, 2023). This exponential growth underscores the transformative impact of fintech on global financial markets, driving innovation, enhancing financial inclusion, and reshaping traditional financial services.

This dynamic expansion makes fintech a crucial variable for analyzing its interplay with green innovation, social entrepreneurship, and other factors in the context of sustainable economic development (Ul-Durar et al., 2024) As a result, social entrepreneurship has been seen as a viable solution to these problems, as it allows for the use of entrepreneurial efforts to create beneficial social and environmental effects (Chaudry, 2023). Entrepreneurs can achieve both financial success and social good through the practice of social entrepreneurship, which comprises starting businesses with a social purpose (Lall & Park, 2022). Physical infrastructure faces challenges to its capacity, defined as its ability to provide essential goods or services, due to potential direct damage to its components (Ellis, 2011) Moreover, given their interconnected nature, infrastructure systems must also contend with cascading effects resulting from dependencies among them (Giesekam et al., 2014). Some studies posit that environmental regulation acts as a catalyst for corporate green investment. For instance, (Hu et al., 2018) observed a positive correlation between environmental regulation and corporate green investment in the European manufacturing industry, suggesting that firms tend to increase green investment in response to heightened regulatory requirements. This study recognizes that fintech expansion is expected to support financial development through the promotion of financial inclusion and accessibility, a perspective endorsed by scholars such as (Jagtiani & Lemieux, 2019; Muthukannan et al., 2017). To this end, surrogate variables are utilized in this study to represent three dimensions of financial development.

The purpose of this study is to look at how the acceptance and use of FinTech are affected by innovative green technology, social enterprise, physical structures, regulation of the environment, and financial development. By examining the intricate connections between FinTech adoption and sustainability dimensions such as financial development, social enterprise, infrastructure development, environmental regulation, and green innovation the study aims to provide comprehensive insights. These insights will enable policymakers to craft regulations that responsibly integrate FinTech into sustainable development agendas, fostering economic growth while mitigating environmental impacts. For financial institutions, understanding digitalization's mediating role and the moderating impact of R&D investment will inform strategies that align with sustainability goals. This includes optimizing investments and services to promote innovations in social entrepreneurship and green technologies. Businesses in sectors like renewable energy and environmental services will benefit by leveraging these findings to enhance their sustainability performance through effective FinTech adoption strategies. Ultimately, this research contributes to realizing a future that is both ecologically sustainable and socially equitable, ensuring that FinTech innovations drive positive societal impacts and contribute to global sustainability objectives.This study examines fintech's dual role in advancing sustainability and economic growth, with a focus on how it fosters innovation in medium and small enterprises. It explores the varied impacts of environmental regulations on corporate green investments and highlights the role of social entrepreneurship in driving societal change. The research fills gap by providing empirical insights from China's fintech landscape. Examine the Connections Between FinTech Acceptance and Sustainability Dimensions: This study's main goal is to investigate the connections between different aspects of sustainability, such as financial development, social enterprise, infrastructure development, regulation of the

environment, and green innovation, and the adoption of technology for finance (FinTech). The study aims to ascertain the degree to which the adoption of FinTech impacts these sustainability parameters through the analysis of actual data. To Evaluate Digitalization's Mediating Function: Evaluating the function of digitalization as a mediator in the link between adoption of financial technology and sustainability characteristics is a secondary goal. The 2nd section is about previous literature. 3rd is methodology of the study and section 4 covers the basic and specific analysis of research. The 5th section has concluding remarks with implications and limitations of the study.

2. Literature Review

According to (Roper & Cheney, 2006), green innovation encompasses advancements in hardware and software that are linked to environmentally friendly products or processes. This includes innovations in technologies that help save energy, prevent pollution, recycle waste, create environmentally friendly designs for products, or manage the environmental impact of corporations. To meet global environmental protection standards, businesses can implement green innovations to boost their environmental performance (Roper & Cheney, 2006). Green innovation performance would be favorably affected by an organization's environmental identity, according to our hypothesis. According to (Keogh & Polonsky, 1998) corporations can't win over society without first committing to environmental causes. Technological, managerial, product design, and manufacturing process components are the four main areas into which green innovations fall. Modifying an existing product's design to lessen its adverse effects on the environment is one example of a green innovation that can be incorporated into a product's life cycle evaluation (Klassen & Whybark, 1999). Green innovation also helps businesses get an edge in the market. Theoretically, the model lays forth the requirements for green innovation in action. Defining "green innovation" in production is the first step in understanding the practices' motivating factors. Academic research on social entrepreneurship has only been around for a short while. Various groups participate in a wide range of economic, academic, research, welfare, social, and spiritual activities as an expression of social entrepreneurship (Leadbeater, 1997). In the realm of private non-profits, there are several strategies for social entrepreneurship. Some community groups have found that social entrepreneurship helps improve the lives of the poor and disadvantaged (Cornwall, 1998) and aids in the growth of the community (Wallace, 1999). To address social and other needs, some scholars have proposed social entrepreneurship as an approach that might help alleviate the burden of comprehensive welfare reform (Leadbeater, 1997; Thompson, 2002). A major shortcoming of literature, as pointed out above, is the lack of a unified approach to social entrepreneurship, which has its roots in several fields. Environmental changes brought about by globalization, government "reinvention" programs, and for-profit organizations' growing presence in areas once dominated by charities provide the backdrop for social entrepreneurship, according to (Sullivan Mort et al., 2003). A major shortcoming of literature, as pointed out above, is the lack of a unified approach to social entrepreneurship, which has its roots in several fields. The most critical thing we found was that the way social companies are envisioned does not correspond to the real world of competition. For instance, it is difficult to understand the behavioral traits of entrepreneurship, such as how social entrepreneurs accomplish their organization's goals by carrying out their social mission, and how they respond to changes in their environment by aiming for operational efficiency. This is because these entrepreneurs are often seen as a "one special breed of leaders" (Dees, 1998) or as reflecting personal characteristics (Prabhu, 1998; Shaw et al., 2002). It is not a coincidence, according to (Hodgkin, 2002), that social enterprise is getting more attention at a time when the competitive landscape is changing fast and the lines between the for-profit and non-profit sectors are blurring. In a market that values organizational capacity, performance, and discipline more than just not-for-profit status and mission, (Ryan, 1999) found a new competitive environment for non-profits. Environmental changes brought about by globalization, government "reinvention" programs, and for-profit organizations' growing presence in areas once dominated by charities provide the backdrop for social entrepreneurship, according to (Sullivan Mort et al., 2003). Additionally, the participation of women in

economic activities has been linked to increased foreign direct investment (FDI), as empirical evidence suggests that industries with a higher concentration of female labor attract greater FDI (Shaheen et al., 2024). Similarly, Hussain et al. (2024) find that while some economies effectively manage health-oriented outputs, such as quality of life and mortality rates, others demonstrate strong economic performance. Bilal and Shaheen (2024) highlight that technological innovation, and natural resources contribute to the adoption of energy efficiency strategies and environmental regulations, while green financial indicators significantly promote the transition to renewable energy sources.

In an urban setting, the construction of buildings and physical infrastructure, such as roads and highways, increases the need for energy by both residents and companies. People who travel by train or other forms of transportation are the ones who use fossil fuels. Also, more vehicles on the road and rails means more demand for coal, oil, and other non-renewable energy sources (Achour & Belloumi, 2016). In Tunisia, the transportation sector accounts for 33% of the country's energy consumption is a physical infrastructure (Shahbaz et al., 2015), while commuters utilize 13% (Jafri et al., 2021). Results showed that ACCs and road infrastructure in Pakistan increase energy consumption, according to the tested model. According to (Azam et al., 2021a), institutional quality plays a part in the creation and execution of policies that dictate how non-renewable fuels are distributed and used by both consumers and enterprises. Furthermore, they stated that the widespread adoption of new technologies is an essential tool for boosting energy consumption within any economy. Energy usage is significantly influenced by political regime & institutional quality, according to research (Azam et al., 2021b; Warner, 2014). A study conducted by (Godil et al., 2021) investigated the significant impact of institutional quality on energy consumption in India. The researchers looked at 66 developing economies and found that oil and other fossil fuel energy sources were positively impacted by democratic accountability, administrative performance, and political stability. Additionally, Shaheen et al. (2025) address a gap in the literature by analyzing how demographic trends impact the environmental consequences of international trade. Finally, Shaheen et al. (2025) investigate sustainability considerations, including environmental, social, and governance (ESG) factors, as well as governmental policies and regulations that influence capital budgeting decisions. Norin et al. (2024) analyze the effects of advertising on children's attitudes, behaviors, and lifestyles. In response to the growing threat of global warming, scholars and policymakers have been paying closer attention to the relationship between economic growth and environmental protection (Mehroush et al., 2024). The distribution of commodities is associated with an economy's physical infrastructure (Kirchgeorg & Winn, 2006). Investigated the role of physical infrastructure in Palestine's power generation from renewable sources (Mediavilla et al., 2013) and found that, on a worldwide scale, physical constraints are to blame for the generation of electricity from renewable resources. On the other hand, the role of institutions is highlighted in overseeing technological advancements, such as the use of renewable energy sources, and energy efficiency. The goal is to develop and execute sustainable programs and processes that limit the careless consumption of non-renewable resources to promote economic growth. Along these lines, research on 22 developing markets (Wu & Broadstock, 2015) and 38 nations (Uzar, 2020) found that institutional quality was a positive factor for the influence of renewable energy use.

According to several studies, the relationship between environmental regulation as well as green technology innovation follows a U-shaped pattern. In the short run, the relationship is negative (Du et al., 2021) because of the increase in installation cost. The alternative viewpoint on this matter is that environmental regulations promote green technology innovation. There is a greater crowding impact on investing nations caused by pollution of the command and control or market-oriented varieties, which often inflict more harm compared to other forms. No one has been able to draw a firm conclusion from the available research about the connection between environmental regulation & the development of environmentally friendly technologies. This data suggests that one obstacle to implementing effective environmental regulations is the "free rider" effect, which allows pollutants to easily transit international borders (Song et al., 2021). Knowledge spillover &

pollution transfer occur in the short term because of enterprises' preference to move pollutants to areas with weak control environment regulations; however, this strategy may impede efforts to promote innovation in environmentally friendly technologies (Min, 2021). Instead, local bodies push businesses to improve their technology and meet the twin constraints of expansion and pollution reduction through increased pollution abatement pressure. This promotes green technology. To reduce pollution emissions and increase growth, effective environmental regulation must compensate for the cost of environmental compliance through technological innovation (Min, 2021).

Fintech can play an instrumental role in promoting financial and social inclusion in developing countries by reducing inefficiencies in resource allocation within the banking sector and creating economic opportunities that increase financial access and social development (Ding et al., 2018; Salampasis & Mention, 2018). Fintech also provides access to financial services for market segments that do not meet the financing threshold of large commercial banks (Makina, 2019). In China, FinTech enhances credit supply to small and medium enterprises and provides an alternative to small banks (Sheng, 2021). By leveraging advanced technologies such as big data, artificial intelligence, biometrics, and blockchain, FinTech companies aim to provide financial services that are more personalized, convenient, and consumer centric than what traditional providers offer (Ansari & Krop, 2012; Christensen, 2015; Drasch et al., 2018). The availability of venture capital has made it possible for fintech service providers to expand the scope of their services and grow at a remarkable pace (Haddad & Hornuf, 2019). The rapid rise of fintech has expedited the digitalization of traditional banks. By working with fintech companies, traditional banks can offer greater convenience to their consumers (Drummer et al., 2016). Traditional banks are widely adopting fintech technologies, such as biometrics for customer authentication to enhance efficiency and security (Goode, 2018). According to (Anagnostopoulos, 2018), fintech innovations help to maintain banking system stability, and regulatory fintech (reteach) applications can lead to a more efficient, stable, and secure financial service environment. Rotech helps to improve stability in financial systems by reducing risks associated with digital financial services. The emergence of reteach also accelerates the transition to a new regulatory system for financial services (Zhou et al., 2018). While fintech does present several risks to financial systems, it can also be used to mitigate these risks (Lee & Shin, 2018). This presents a trade of for regulators who seek to promote fintech sector growth without negatively impacting consumer confidence (Mahoney, 2019). The growth of the fintech industry depends on how the actors within the ecosystem interact (Diemers et al., 2015). The fintech ecosystem can be split into five main stakeholder groups: fintech start-ups, tech developers, financial consumers, incumbent financial institutions, and regulators. How these stakeholders interact is critical to the growth and stability of the fintech industry. Table 1 highlights these key drivers of fintech growth in China. The research fills gap in understanding how green innovation, social entrepreneurship, infrastructure, regulation, and financial development impact FinTech adoption. It explores how these factors shape FinTech strategies, with a focus on R&D investment and digitalization as mediators and moderators. The study aims to help policymakers and businesses optimize FinTech for sustainable development and economic inclusivity.

3. Research Methodology

To solve the problems of traceability in resource extraction and use, FinTech is using blockchain technology to offer supply chain transparency like never before. Stakeholder accountability may be enhanced, and the dangers of unlawful and unsustainable resource exploitation can be mitigated (Ni et al., 2023). Various indicators, such as the FIN indicator index utilized by (Lisha et al., 2023), are employed to measure fintech. The same indicator (Baidu.com search advanced phrase frequency plus one) was utilized in another study by (Xu & Li, 2023). This research re-uses data from (Ul-Durar et al., 2024) by calculating the fintech index using internet use and cell subscriptions. Environmental regulation, green innovation, social enterprise, physical structures, and financial development are the five independent variables in this study. Indexes such as (Research Development and Research % of GDP) were formerly used to quantify green

innovation. According to (Ahakwa et al., 2024) The total amount of green patents awarded plus one is used to quantify green innovation in this study (Liu et al., 2023). Social entrepreneurship, which has been measured in primary research before, is the second independent variable, (Ayoungman et al., 2023) found that yearly increase percentages, nonetheless. Air and train travel, electricity and gas use, telephone service, spending on elementary and secondary schools, and healthcare are all indicators of a well-developed physical infrastructure (Kumari & Sharma, 2017; Wang & Shen, 2016) state that the GML index, which includes both global benchmark technologies and contemporaneous benchmark technologies, is used to assess environmental control. According to (Lu et al., 2023), this study also takes Index (Environmental policy stringency) into account. (Madsen et al., 2018) state that financial development (Credit) is a measure of financial development. Additionally, this analysis utilizes broad money as a percentage of GDP (Ahmad et al., 2023). The study's mediating variable is digitization. Broadband subscriptions per 100 persons will be used as a measure of digitalization (Iddrisu & Chen, 2022). The number of mobile cellular subscribers per 100 persons is also measured in this study (Edquist & Bergmark, 2024). R&D is the moderating variable in this study as presented in Table-1.

Table 1: *Variable description*

Dependent variable	**Proxies**	**Data source**
Fintech	Mobile cellular subscriptions (per 100 people), Individuals using Internet	WDI
Independent Variables		
Green Innovation	Research and development expenditure (% of GDP)	WDI
Social entrepreneurship	GDP growth (annual %), Railways, goods transported (million ton-km), Access to electricity (% of population)	WDI
Environmental regulation	Environmental Policy Stringency	WDI
Financial Development	Broad money (% of GDP)	WDI
Other Variables		
Digitalization	Mobile cellular subscriptions (per 100 people)	WDI
Research & Development	Patent applications, nonresidents	WDI
Control Variables		
Trade openness	Trade (% of GDP)	WDI
Economic Growth	GDP per capita (current US$)	WDI

3.1. Econometric Model

The purpose of this study is to analyze the chosen panel on fintech and its connections to green innovation, social enterprise, physical infrastructure, regulation of the environment, as well as financial development by applying the following statistical function, which is in line with the literature and the hypothesis relationship.

A financial technology equation may look like this:

FINTECH=f (GF, TI, TO, INF, EG, FDI *Interaction term DIG_R&D) (1)

The theoretical underpinnings of the project are laid forth in the conceptual framework. A logically created, recorded, and developed network of links among the variables uncovered through processes like observing, conducting interviews & literature surveys that are decided to be important to the issue situation.

$$FINTECH_{it} = \beta_0 + \beta_1 GI_{it} + \beta_2 SE_{it} + \beta_3 PI_{it} + \beta_4 EG_{it} + \beta_5 FD_{it} + \mu_i + \epsilon_{it} \quad (2)$$

GI is green innovation, SE is social entrepreneurship, PI is physical infrastructure,

ER is environmental regulation and FD is financial development.

$$FINTECH_{it} = \beta_0 + \beta_1 GI_{it} + \beta_2 SE_{it} + \beta_3 PI_{it} + \beta_4 EG_{it} + \beta 5 FD_{it} + \beta_6 MDIG_{it} + \beta_7 MOR\&D_{it} + \mu_i + \epsilon_{it} \quad (3)$$

GI is green innovation, SE is social entrepreneurship, PI is physical infrastructure,

ER is environmental regulation and FD is financial development. Mediation is Digitalization (DIG) and Moderation is Research and Development(R&D).

$$FINTECH_{it} = \beta_0 + \beta_1 GI_{it} + \beta_2 SE_{it} + \beta_3 PI_{it} + \beta_4 EG_{it} + \beta_5 FD_{it} + \beta_6 MDIG_{it} + \beta_7 MOR\&D_{it} + C1TO + C2EG + \mu_i + \epsilon_{it} \quad (4)$$

GI is green innovation, SE is social entrepreneurship, PI is physical infrastructure, ER is environmental regulation and FD is financial development. Mediation is Digitalization (DIG) and Moderation is Research and Development(R&D) and Control variable is Trade Openness (TO), Economic Growth (EG). Fintech is influenced by physical infrastructure, environmental regulations, social entrepreneurship, green innovation, and financial development, according to this paradigm. By incorporating the roles of mediator and moderator, Equation 3.2 expands upon Equation 3.3. With the addition of the control variables, Equation 3.3 expands upon Equation 3.2. I want to know what the letters "I" and "t" signify in terms of various nations and times. It is incorrect to say (μit). The vector ϋ represents the dependent variable FINTECH and the independent variables GI, SE, PI, EG, FD, and so on. Control variables are TO (Trade Openness), EG (Economic Growth), and LL (Literacy Level), whereas DIG (Digitalization) mediates, and R&D (Research and development) modifies. The meaning of the letters "I" and "t" in relation to certain nations and time periods, respectively. It is incorrect to say (μit). The independent variables are represented by the vector β. C stands for the variables that are under control.

4. Data Analysis

4.1. Descriptive Statistics

Data descriptive statistics for variables are mentioned in table-2, with an emphasis on those that are relevant to the adoption of fintech. There is a large amount of variation in the adoption of fintech among observations, as indicated by the standard error of the variance of 0.545 and mean value of 0.838.

Table 2: *Descriptive Statistics*

Variable	Obs	Mean	Std. Dev.	Min	Max
Fintech	759	.838	.545	.002	2.274
GI	759	1.808	.941	.048	4.93
SE	759	3.492	2.536	.005	24.475
PI	759	.442	.897	0	5.882
ER	759	2.327	1.031	.167	4.889
FD	759	4.361	.468	3.174	5.651
DIG	759	4.507	.631	-1.086	5.148
RD	758	7.33	2.634	1.792	12.726

Financial development (FD) looks to be somewhat consistent across observations with a mean of 4.361 and a comparatively small standard deviation of 0.468 when we look at the independent variables. With a mean of about 1.808 & an average deviation of 0.941, green innovation (GI) distinguishes compared to its values showing a broader dispersion. The significantly higher prevalence of social entrepreneurship (SE) compared to other characteristics is reflected in its higher mean score of 3.492. In comparison to environmental regulation (ER), physical infrastructure (PI) has a larger standard deviation, indicating more variability, with a mean value of 0.442. Additionally, there is a great deal of variation in digitalization (DIG) & research and development (RD), with RD showing a standard deviation of 2.634 and DIG a mean of 4.507. RD's

large range, from 1.792 to 12.726, is especially noticeable. Taken together, these numbers shed light on the dispersion of fintech adoption-related variables, revealing the complex web of forces at work in this area.

4.2. Correlation

Table 3: *Correlation Results*

Variable	VIF	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1) Fintech	1.814	1.000							
(2) GI	1.755	-0.186	1.000						
(3) SE	1.428	0.276	-0.290	1.000					
(4) PI	1.379	-0.131	0.184	-0.024	1.000				
(5) ER	1.324	-0.360	0.495	-0.362	-0.038	1.000			
(6) FD	1.183	-0.139	0.497	-0.131	0.084	0.222	1.000		
(7) DIG	1.145	-0.552	0.281	-0.246	-0.016	0.457	0.124	1.000	
(8) RD	1.432	0.148	0.128	0.084	0.308	-0.239	0.272	-0.238	1.000

The VIF for Green Innovation (GI) is 1.814, with 1/VIF at 0.551, indicating a low to moderate level of multicollinearity with other variables. Environmental Regulation (ER) has a VIF of 1.755 and 1/VIF at 0.570, suggesting a similar, acceptable level of multicollinearity as shown in Table 3. Financial Development (FD) shows a VIF of 1.428 with 1/VIF at 0.700, reflecting a low level of multicollinearity. Research and Development (R&D) has a VIF of 1.379 and 1/VIF at 0.725, which is also low. Digitalization (DIG) has a VIF of 1.324 with 1/VIF at 0.755, indicating low multicollinearity. Social Entrepreneurship (SE) has a VIF of 1.183 with 1/VIF at 0.846, showing a low level of multicollinearity. Physical Infrastructure (PI) has the lowest VIF at 1.145 with 1/VIF at 0.874, indicating the lowest level of multicollinearity among the variables. Overall, the VIF values for all independent variables are below the commonly used threshold of 5, indicating that multicollinearity is not a significant concern in this model. Multicollinearity, which occurs when independent variables are highly correlated, can complicate the assessment of individual variable effects. However, the mean VIF in this analysis is 1.432, suggesting that the overall level of multicollinearity is low. This implies that the regression model should provide reliable estimates of the effects of these variables on fintech development without the distortions typically caused by high multicollinearity.

Table-3 also shows the results of correlation as Fintech exhibits a notable positive correlation with Social Entrepreneurship (0.276) and Research and Development (0.148). This suggests that increases in social entrepreneurship and research and development activities are associated with higher levels of fintech development. Conversely, Fintech shows negative correlations with several other variables, indicating inverse relationships. The strongest negative correlation is with Digitalization (-0.552), implying that as digitalization increases, fintech development tends to decrease. This may seem counterintuitive and could warrant further investigation to understand the underlying factors. Environmental Regulation (-0.360) and Green Innovation (-0.186) also negatively correlate with fintech, though to a lesser extent, indicating that stricter environmental regulations and greater focus on green innovation might be associated with lower fintech activity. Examining the interrelationships among the independent variables provides additional insights. Green Innovation (GI) and Environmental Regulation (ER) have a positive correlation

(0.495), suggesting that more stringent environmental regulations might foster green innovation. Similarly, Financial Development (FD) is positively correlated with both Environmental Regulation (0.222) and Green Innovation (0.497), hinting at a potential synergistic effect where financial development and green policies reinforce each other. Digitalization (DIG) is negatively correlated with several variables: Environmental Regulation (-0.457), Financial Development (-0.124), Green Innovation (-0.281), and Social Entrepreneurship (-0.246).

4.3. Brusch Pagan test

Table 4: *Brusch Pagan Test*

Variable	Var	SD = sqrt (Var)
Fintech	0.297107	0.545075
E	0.20687	0.454829
U	0.040136	0.20034

Fintech (which is the dependent variable), the residual error term e, and the variance component particular of the Breusch-Pagan test are all included in the findings, together with their standard deviations (SD). The fintech variable has a mean of 0.297107 and a standard deviation (SD) of 0.545075. Because of this, we can see that the fintech data is generally inconsistent. The standard deviation and variance for the residual term for error are 0.454829 and 0.20687, respectively. Here we can see the residual variability following regression model fitting; it's a measure of the dispersion between the anticipated and observed fintech values. There is a standard deviation for 0.20034 and a variance component of 0.040136 for the Breusch-Pagan test. Here we can see how much of the total variation is due to heteroscedasticity shown in Table-4.

4.4. Slope Homogeneity Test

Table 5: *Slope Homogeneity Test*

Delta value	p-
19.309	0.000
adj. 23.151	0.000

Delta has a test statistic of 19.309 and a corresponding p-value of 0.000. Similarly, the p-value for the corrected Delta test is 0.000, and the statistic is 23.151. Significantly different slopes of the coefficients of regression across groups are shown by the big Delta & adjusted Delta values. Strong statistical evidence opposing the null expectation of slopes homogeneity is provided by the p-values for both tests, which are substantially below the standard significance level of 0.05 presented in Table-5.

4.5. Cross sectional dependency Test

Table 6: *Cross sectional dependency Test*

Variable	*CD-test*	*p-value*	*average joint T*	*mean ρ*	*mean abs(ρ)*
Fintech	13.11	0	23	0.12	0.58
GI	32.252	0	23	0.29	0.58
SE	30.267	0	23	0.27	0.35
PI	10.035	0	23	0.09	0.42
ER	76.193	0	23	0.69	0.71
FD	23.366	0	23	0.21	0.49
DIG	101.074	0	23	0.92	0.92
RD	-0.416	0.677	22.94	0	0.53

In table-6 the p-value of 0.000 and a CD-test value of 13.11, fintech strongly indicates cross-sectional dependency. The industry also has a median absolute correlation for 0.58 and a correlation coefficient (ρ) of 0.12. With an average correlation of 0.29 and an average absolute correlation of 0.58, Green Innovation (GI) demonstrates strong cross-sectional dependency with a CD-test value of 32.252 & a p-value of 0.000. The CD-test value for social entrepreneurship (SE) is 30.267, the p-value is 0.000, the mean correlation is 0.27, and the mean absolute correlation is 0.35, all of which indicate a strong cross-sectional dependency. With an average correlation of 0.09 and an absolute correlation of 0.42, Physical Infrastructure (PI) shows a significant CD-test of 10.035 & a p-value of 0.000. A high CD-test value of 76.193 & a p-value of 0.000 indicate considerable cross-sectional dependency, which is borne out by a mean correlation of 0.69 & an average absolute correlation of 0.71, making Environmental Regulation (ER) figure out. Given a CD-test score of 23.366, a significant level of 0.000, and an average correlation of 0.21 and an average absolute correlation of 0.49, Financial Development (FD) demonstrates a strong cross-sectional dependency. With the CD-test value of 101.074 as well as a p-value of 0.000, the mean as well as mean absolute correlations for digitalization (DIG) are extraordinarily high at 0.92, indicating the largest cross-sectional dependency among the variables. The CD-test result for Research and Development (the RD) is -0.416, the p-value is 0.677, and the mean correlation is 0, indicating that there is no significant cross-sectional reliance. Despite a mean absolute correlation of 0.53 (a non-significant CD-test score), this does not indicate dependency.

4.6. 2nd Generation unit root test

Table 7: *2nd Generation unit root test*

Variable	*Level*	*1st diff*	*Level*	*1st diff*
FINTECH	-2.44		-2.44	
SE	-3.186		-3.186	
PI	/	-4.258	/	-4.258
ER	/	-4.53	/	-4.53
FD	-3.422		-3.422	
GI	-2.592		-2.592	

The stationarity of variables is checked in the table-7, the values remain constant and do not vary noticeably after differencing, the test statistic for fintech is -2.44 at both levels with the first differences, indicating that fintech is probably stationary at its level. At all levels and initial differences, the test statistic for social entrepreneurship (SE) is -3.186, suggesting that SE is stationary above its level. Physical Infrastructure (PI) may not be stationary at its level but becomes stationary after differencing, according to a test statistic of -4.258 for the first difference level. This suggests that PI becomes non-stationary at its level. At the first difference level, Environmental Regulation (ER) also has a test statistic of -4.53, suggesting that it's the case

stationary before first differencing but probably non-stationary at that level. At both levels and initial differences, Financial Development (FD) has a test statistical of -3.422, indicating that FD is static at the level of it. Green Innovation (GI) is stationary across its level, as shown by its test statistic for -2.592 with both levels with initial differences.

4.7. Cointegration Pedroni Test

Table 8: *Cointegration Pedroni Test*

Modified Phillips Perron t	*6.8137*	*0*
Phillips Perron t	2.2827	0.0112
Augmented Dickey Fuller t	0.6089	0.2713

Strong evidence against a null hypothesis of not having cointegration is indicated by the test statistic of 6.8137 using a p-value of 0. Because of this, we can infer that the variables under consideration have a lasting connection. At the standard significance threshold of 0.05, the test statistic exists 2.2827 and the p-value is 0.0112, which indicates that there is evidence opposing the null hypothesis. A p-value of 0.2713 is associated with the test statistic of 0.6089. This test is typically administered alongside other tests since it does not offer robust evidence for cointegration when performed independently as the results are shown in table-8.

4.8. Kao test of cointegration

Table 9: *Kao test of cointegration*

Modified Dickey Fuller t	*-2.4745*	*0.0067*
Dickey Fuller t	-3.7913	0.0001
Augmented Dickey Fuller t	-3.6167	0.0001
Unadjusted modified Dickey Fuller t	-0.1767	0.4299
Unadjusted Dickey Fuller t	-2.7083	0.0034

The test statistic is -2.4745 with a p-value of 0.0067. This indicates evidence against the null hypothesis of no cointegration, suggesting the presence of a long-term relationship among the variables as presented in Table-9. The test statistic is -3.7913 with a p-value of 0.0001, providing strong evidence against the null hypothesis at conventional significance levels. This supports the existence of cointegration among the variables. The test statistic is -3.6167 with a p-value of 0.0001. Like the Dickey–Fuller test, this provides significant evidence against the null hypothesis and supports the presence of cointegration. The test statistic is -0.1767 with a p-value of 0.4299, suggesting weak evidence against the null hypothesis. However, this test may not be as powerful as the others for detecting cointegration. The test statistic is -2.7083 with a p-value of 0.0034.

4.9. Hausman Test

The table shows the outcomes from the Hausman test, a test that finds out if a random effects or fixed effects model is better suited to a certain dataset.

Table 10: *Hausman Test Coef*

	Coef.
Chi-square test value	27.318
P-value	.001

This test determines if the model's regressors are linked with the unique mistakes (random effects). There is a p-value of 0.001 and a chi-square test score of 27.318. The fixed effect is suggested according to Hausman results as shown in table-10 of this study.

4.10: GMM without Mediation

Table 11: *GMM without Mediation*

Fintech	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
L	.888	.042	21.40	0	.807	.969	***
GI	.248	.06	4.16	0	.131	.365	***
SE	.15	.03	0.5	0.000	.006	.06	***
PI	.114	.091	1.25	.21	-.064	.293	
ER	.024	.008	2.93	.003	.008	.04	***
FD	.168	.125	1.35	0.000	.413	.077	***

Mean dependent var	0.788	SD dependent var	0.504
Number of obs	693	Chi-square	.

*** *p<.01, ** p<.05, * p<.1*

The lagged value of fintech (L) shows a highly significant and strong positive relationship, with a coefficient of 0.888, a standard error of 0.042, a t-value of 21.40, and a p-value of 0.000. This indicates that past values of fintech significantly influence its current value. Green innovation (GI) also has a significant positive effect on fintech, with a coefficient of 0.248, a standard error of 0.060, a t-value of 4.16, and a p-value of 0.000, highlighting the importance of green innovation in promoting fintech. Social entrepreneurship (SE) shows a positive and significant influence on fintech, with a coefficient of 0.150, a standard error of 0.030, a t-value of 5.00, and a p-value of 0.000, suggesting that social entrepreneurship activities contribute positively to fintech development. Physical infrastructure (PI) has a positive coefficient of 0.114 but is not statistically significant, with a standard error of 0.091, a t-value of 1.25, and a p-value of 0.210. Environmental regulation (ER) has a significant positive effect on fintech, with a coefficient of 0.024, a standard error of 0.008, a t-value of 2.93, and a p-value of 0.003, indicating that stronger environmental regulations are associated with increased fintech activities. Financial development (FD) also shows a significant positive relationship with fintech, with a coefficient of 0.168, a standard error of 0.125, a t-value of 1.35, and a p-value of 0.000 as shown in above table-11.

4.11. GMM with Mediation

Table 12: *GMM with Mediation*

Fintech	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
L	.92	.029	31.65	0.000	.863	.977	***
GI	.252	.059	4.26	0.000	.136	.368	***
SE	.007	.003	2.20	.028	.001	.014	**
PI	.136	.104	1.30	.192	-.068	.34	
ER	.038	.008	5.02	0.000	.023	.053	***
FD	.032	.107	0.30	0.000	.242	.177	***
DIG	.07	.049	1.42	.05	.167	.27	**

Mean dependent var	0.788	SD dependent var	0.504
Number of obs	693	Chi-square	.

*** *p<.01, ** p<.05, * p<.1*

Table-12 shows the results of GMM without mediation, lagged value of fintech (L) shows a strong positive relationship with a coefficient of 0.92, a standard error of 0.029, a t-value of 31.65, and a p-value of 0.000, indicating a highly significant impact at the 1% level. Green innovation (GI) also exhibits a significant positive effect on fintech, with a coefficient of 0.252, a standard error of 0.059, a t-value of 4.26, and a p-value of 0.000. Social entrepreneurship (SE) demonstrates a positive and significant influence on fintech, with a coefficient of 0.007,

a standard error of 0.003, a t-value of 2.20, and a p-value of 0.028, significant at the 5% level. Physical infrastructure (PI) has a positive coefficient of 0.136, but it is not statistically significant, with a standard error of 0.104, a t-value of 1.30, and a p-value of 0.192. Environmental regulation (ER) positively impacts fintech significantly, with a coefficient of 0.038, a standard error of 0.008, a t-value of 5.02, and a p-value of 0.000. Financial development (FD) shows a positive but non-significant relationship, with a coefficient of 0.032, a standard error of 0.107, a t-value of 0.30, and a p-value of 0.000. The mediating variable, digitalization (DIG), exhibits a coefficient of 0.07, a standard error of 0.049, a t-value of 1.42, and a p-value of 0.050, indicating a significant impact at the 5% level. The mean of the dependent variable fintech is 0.788, with a standard deviation of 0.504.

4.12. Moderation Results

Table-13 displays the outcomes of a GMM regression model that investigated the influence of several variables on fintech; the model zeroed down on the R&D-DIG interaction is a moderating variable.

Table 13: *Moderation Results*

Fintech	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
L	.899	.006	155.36	0	.888	.911	***
rd_dig	.002	.001	2.16	.03	0	.005	**
Mean dependent var	0.788		SD dependent var		0.504		
Number of obs	693		Chi-square		.		

*** $p<.01$, ** $p<.05$, * $p<.1$

With a coefficient of 0.899 and a standard error of 0.006, the data demonstrate that the levels of fintech now are significantly and substantially influenced by their prior values. A t-value for 155.36 & a p-value of 0.000 are the results, indicating that there is a considerable persistent impact in the growth of fintech. As a result, the way fintech has performed in the past has a significant impact on how it is doing now. The coefficient of the interaction term (rd_dig) between R&D & digitalization is 0.002, and the standard error is 0.001. Therefore, the t-value is 2.16, and the p-value is 0.030. Research and development (R&D) and digitalization (digitization) have a favorable & statistically significant effect on fintech growth. Despite the tiny impact size, fintech increases by 0.002 units with every unit rise in the interaction term. Taken together, the GMM regression findings highlight the significance of prior fintech success as well as the complementary impacts of R&D and digitization. The substantial interaction term suggests that when R&D activities are also included, the favorable effects of digitalization on fintech are much more pronounced. To propel fintech growth successfully, our findings emphasize the critical necessity of encouraging both technology breakthroughs and innovative R&D efforts.

4.17. Discussion

The paper also explores the interconnected nature of environmental rules, financial technology, and efforts to reduce the effects of climate change. Fintech has the potential to make a significant contribution to environmental sustainability, but it can only do so with well-designed regulatory frameworks. More sustainable economy may be achieved by increasing the use of green financial technology options, which can be encouraged by enacting policies that are supportive of the environment (Lu et al., 2023). The research done in China shows that fintech and the growth of the banking industry go hand in hand. Innovations in financial technology (fintech) broaden the availability of financial services, strengthen financial markets, and encourage savings among financial institutions. According to (Muganyi et al., 2022), lawmakers should take a comprehensive strategy to fintech regulation to promote sustainable financial development by promoting balanced growth in the industry and reducing risks. Investigating how digitization and fintech have affected the use of natural resources in BRI nations has shown mixed results. Finally,

there are complex consequences when looking at fintech & innovation efficiency in China. Although fintech has a noticeable favorable effect on innovation and launch efficiency, its influence on research and development efficiency is not as strong. Furthermore, at the launch stage, fintech has negative geographical spillover effects on neighboring regions. Based on these results, regional development policies should be designed to take advantage of fintech while limiting its negative effects; a holistic strategy is necessary to promote innovation and long-term sustainability (Gao et al., 2024).

5. Conclusion and Recommendation

5.1. Conclusion

The complex interplay between fintech growth and a wide range of socio-economic and environmental variables in a variety of settings and countries is thoroughly examined in this paper. The results highlight the substantial influence of fintech on R&D, digitization, physical infrastructure, environmental legislation, green innovation, and social entrepreneurship.

First, the study shows that green innovation may help with fintech's environmental sustainability efforts. Sustainable practices may be driven by green innovations and improved financial technology, which can help achieve global environmental goals. This shows that sustainable practices must be included into fintech projects for the sake of the environment in the long run, especially in economies where the equilibrium between technical progress and environmental preservation is critical. The study sheds light on the revolutionary possibilities of fintech in tackling socio-economic issues, particularly in developing nations, and how this may impact the field of social entrepreneurship. Fintech has the potential to enable social entrepreneurs to make a good difference in society and the environment by expanding access to financial services and making digital payments easier. When looking at the importance of physical infrastructure in the growth of fintech, it becomes clear that strong infrastructure is crucial for creating an environment where entrepreneurs may thrive in the financial industry. Economic growth and innovation in fintech may be greatly boosted by investments in physical infrastructure, since there is a favorable association between the two in many different places. In addition, the examination of environmental regulations and financial technology highlights the need for efficient regulatory frameworks for enhancing the beneficial influence of financial technology on the reduction of greenhouse gas emissions. Findings from the study show that environmental rules have a greater impact on climate change than financial technology (fintech). With digitization on the rise, this double impact emphasizes the need of using fintech toward sustainable resource management. Lastly, the study on R&D & fintech highlights the complex ways in which fintech impacts innovation efficiency. Although fintech has a beneficial influence on innovation and launch efficiency, it has a less noticeable effect on R&D efficiency and has negative geographical spillover effects. Our research indicates that to promote innovation and long-term sustainability, specific regional development strategies are needed to make the most of fintech's advantages while limiting its negative effects.

Finally, this research shows how fintech is involved in many ways that affect societal, economic, and environmental results. To fully realize fintech's potential, it is crucial to combine sustainable principles with strong infrastructure, efficient regulatory frameworks, and sound business practices. Sustainable expansion, creativity, and development may be achieved through the strategic use of fintech, but only if policymakers as well as stakeholders embrace this opportunity in all its varied settings and geographies.

5.2. Recommendations

Based on the findings of this study, several key recommendations emerge to harness the potential of fintech for promoting sustainable development, innovation, and economic growth. Investing in strong physical infrastructure, such as dependable internet and transportation, is essential for the development of fintech ecosystems. It is imperative for governments to enforce efficient environmental policies that foster sustainability and cooperate with fintech businesses and environmental organizations to establish supportive guidelines. To promote innovation and sustainable growth, institutions should establish partnerships with fintech firms, research institutes, and regional governments. Implementing well-

balanced regulatory rules will improve both financial access and market depth. Researchers should prioritize comprehending the influence of fintech on innovation and sustainable development, aiding in the formulation of efficacious regional policies.

Conflict of Interest

The authors showed no conflict of interest.

Funding

Funding

The authors did not mention any funding for this research.

References

Achour, H., & Belloumi, M. (2016). Investigating the causal relationship between transport infrastructure, transport energy consumption and economic growth in Tunisia. *Renewable and Sustainable Energy Reviews*, *56*, 988-998.

Ahakwa, I., Tackie, E. A., Tackie, F. K., Mangudhla, T., Baig, J., ul Islam, S., & Sarpong, F. A. (2024). Greening the path to carbon neutrality in the post-COP26 era: Embracing green energy, green innovation, and green human capital. *Innovation and Green Development*, *3*(3), 100134.

Ahmad, N., Youjin, L., Žiković, S., & Belyaeva, Z. (2023). The effects of technological innovation on sustainable development and environmental degradation: Evidence from China. *Technology in Society*, 72, 102184.

Anagnostopoulos, I. (2018). Fintech and regtech: Impact on regulators and banks. *Journal of Economics and Business*, *100*, 7-25.

Ansari, S. S., & Krop, P. (2012). Incumbent performance in the face of a radical innovation: Towards a framework for incumbent challenger dynamics. *Research Policy*, *41*(8), 1357-1374.

Ayoungman, F. Z., Shawon, A. H., Ahmed, R. R., Khan, M. K., & Islam, M. S. (2023). Exploring the economic impact of institutional entrepreneurship, social Innovation, and poverty reduction on carbon footprint in Brics countries: what is the role of social enterprise? *Environmental Science and Pollution Research*, *30*(58), 122791-122807.

Azam, M., Liu, L., & Ahmad, N. (2021a). Impact of institutional quality on environment and energy consumption: evidence from developing world. *Environment, Development and Sustainability*, *23*, 1646–1667.

Azam, M., Liu, L., & Ahmad, N. (2021b). Impact of institutional quality on environment and energy consumption: evidence from developing world. *Environment, Development and Sustainability*, *23*, 1646–1667.

Chaudry, K. (2023). The role of social entrepreneurship in promoting sustainable development and addressing environmental challenges.

Christensen, C. M. (2015). The innovator's dilemma: when new technologies cause great firms to fail. *Harvard Business Review Press*.

Cornwall, J. R. (1998). The entrepreneur as a building block for community. *Journal of Developmental Entrepreneurship*, *3*(2), 141.

Dees, J. G. (1998). Enterprising nonprofits: What do you do when traditional sources of funding fall short. *Harvard Business Review*, *76*(1), 55–67.

Diemers, D., Lamaa, A., Salamat, J., & Steffens, T. (2015). Developing a FinTech ecosystem in the GCC. Dubai: *Strategy*, 1-16.

Ding, D., Chong, G., Chuen, D. L. K., & Cheng, T. L. (2018). From ant financial to Alibaba's rural Taobao strategy–how Fintech is transforming social inclusion. In Handbook of blockchain, digital finance, and inclusion, volume *1* (pp. 19-35). *Elsevier*.

Drasch, B. J., Schweizer, A., & Urbach, N. (2018). Integrating the 'Troublemakers': A taxonomy for cooperation between banks and fintechs. *Journal of Economics and Business*, 100, 26-42.

Drummer, D., Jerenz, A., Siebelt, P., & Thaten, M. (2016). FinTech: Challenges and Opportunities-How digitization is transforming the financial sector. McKinsey & Company.

Du, K., Cheng, Y., & Yao, X. (2021). Environmental regulation, green technology innovation, and industrial structure upgrading: The road to the green transformation of Chinese cities. *Energy Economics*, *98*, 105247.

Edquist, H., & Bergmark, P. (2024). How is mobile broadband intensity affecting CO2 emissions? –A macro analysis. *Telecommunications Policy*, *48*(2), 102668.

Ellis, E. C. (2011). Anthropogenic transformation of the terrestrial biosphere. Philosophical Transactions of the Royal Society A: *Mathematical, Physical and Engineering Sciences*, *369*(1938), 1010-1035.

Gao, T., Wang, S., Chen, B., & Yang, L. (2024). The impact of big tech corporate venture capital investments on innovation: Evidence from the equity investment market. *China Economic Review*, *83*, 102111.

Giesekam, J., Barrett, J., Taylor, P., & Owen, A. (2014). The greenhouse gas emissions and mitigation options for materials used in UK construction. *Energy and Buildings*, *78*, 202-214.

Godil, D. I., Sharif, A., Ali, M. I., Ozturk, I., & Usman, R. (2021). The role of financial development, R&D expenditure, globalization and institutional quality in energy consumption in India: New evidence from the Qardl approach. *Journal of Environmental Management*, *285*, 112208.

Goode, A. (2018). Biometrics for banking: best practices and barriers to adoption. *Biometric Technology Today*, 2018(10), 5-7.

Haddad, C., & Hornuf, L. (2019). The emergence of the global fintech market: Economic and technological determinants. *Small Business Economics*, *53*(1), 81-105.

Hodgkin, S. V. (2002). Business Social Entrepreneurs. *Citeseer*.

Hu, J., Wang, Z., Lian, Y., & Huang, Q. (2018). Environmental regulation, foreign direct investment and green technological progress—Evidence from Chinese manufacturing industries. International *Journal of Environmental Research and Public Health*, *15*(2), 221.

Hughes, A. C. (2019). Understanding and minimizing environmental impacts of the Belt and Road Initiative. *Conservation Biology*, *33*(4), 883-894.

Hussain, Z., Huo, C., Ahmad, A. Shaheen, W.A. (2024) An assessment of economy- and transport-oriented health performance. *Health Economics Review 14*, 80. https://doi.org/10.1186/s13561-024-00544-0 .

Iddrisu, A. G., & Chen, B. (2022). Economic growth through digitalization in Africa: does financial sector development play a mediating role? *International Journal of Emerging Markets*.

Jafri, M. A. H., Liu, H., Majeed, M. T., Ahmad, W., Ullah, S., & Xue, R. (2021). Physical infrastructure, energy consumption, economic growth, and environmental pollution in Pakistan: an asymmetry analysis. *Environmental Science and Pollution Research*, *28*, 16129–16139.

Jagtiani, J., & Lemieux, C. (2019). The roles of alternative data and machine learning in fintech lending: evidence from the LendingClub consumer platform. *Financial Management*, *48*(4), 1009-1029.

Keogh, P. D., & Polonsky, M. J. (1998). Environmental commitment: a basis for environmental entrepreneurship? *Journal of Organizational Change Management*, *11*(1), 38-49.

Kirchgeorg, M., & Winn, M. I. (2006). Sustainability marketing for the poorest of the poor. *Business Strategy and the Environment*, *15*(3), 171-184.

Klassen, R. D., & Whybark, D. C. (1999). Environmental management in operations: the selection of environmental technologies. *Decision Sciences*, *30*(3), 601-631.

Kumari, A., & Sharma, A. K. (2017). Physical & social infrastructure in India & its relationship with economic development. *World Development Perspectives*, *5*, 30–33.

Lall, S. A., & Park, J. (2022). How social ventures grow: Understanding the role of philanthropic grants in scaling social entrepreneurship. *Business & Society*, *61*(1), 3-44.

Leadbeater, C. (1997). The rise of the social entrepreneur (Issue 25). Demos.

Lee, I., & Shin, Y. J. (2018). Fintech: Ecosystem, business models, investment decisions, and challenges. *Business Horizons*, *61*(1), 35-46.

Lisha, L., Mousa, S., Arnone, G., Muda, I., Huerta-Soto, R., & Shiming, Z. (2023). Natural resources, green innovation, fintech, and sustainability: A fresh insight from Brics. *Resources Policy*, *80*, 103119.

Liu, J., Zhang, Y., & Kuang, J. (2023). Fintech development and green innovation: Evidence from China. *Energy Policy*, *183*, 113827.

Lu, Y., Tian, T., & Ge, C. (2023). Asymmetric effects of renewable energy, fintech development, natural resources, and environmental regulations on the climate change in the post-covid era. *Resources Policy*, *85*, 103902.

Madsen, J. B., Islam, M. R., & Doucouliagos, H. (2018). Inequality, financial development and economic growth in the Oecd, 1870-2011. *European Economic Review*, *101*, 605-624.

Mahoney, J. (2019). The rise of Chinese fintech: lessons for the United States. Colombia Business School, *New York*.

Makina, D. (2019). The potential of FinTech in enabling financial inclusion. In Extending financial inclusion in Africa (pp. 299-318). *Elsevier*.

Mediavilla, M., de Castro, C., Capellán, I., Miguel, L. J., Arto, I., & Frechoso, F. (2013). The transition towards renewable energies: Physical limits and temporal conditions. *Energy Policy*, 52, 297-311.

Mehroush, I., Shaheen, W.A., Shabir, M. *et al.* (2024), "Pathways to ecological resilience: exploring green energy and finance for sustainable development." *Environment Development Sustainability* (2024). https://doi.org/10.1007/s10668-024-04662-x

Min, W. (2021). An empirical study on the impact of environmental regulation on the efficiency of green technology innovation. E3S Web of Conferences, 248, 02029.

Muganyi, T., Yan, L., Yin, Y., Sun, H., Gong, X., & Taghizadeh-Hesary, F. (2022). Fintech, regtech, and financial development: evidence from China. *Financial Innovation*, *8*(1), 1-20.

Muthukannan, P., Tan, B., Tan, F. T. C., & Leong, C. (2017). The concentric development of the financial technology (Fintech) ecosystem in Indonesia.

Ni, L., Yu, Y., & Wen, H. (2023). Impact of fintech and environmental regulation on green innovation: inspiration from prefecture-level cities in China. *Frontiers in Ecology and Evolution*, *11*, 1265531.

Norin, A., Ishfaq, H., Shaheen, W. A., & Abbas, Z. (2024), "Advertising Effects on Young Minds: Probing into Environmental Awareness, Purchasing Patterns, and Attitudinal Shifts in Children." *Research Journal for Societal Issues, 6*(1), 272-292. https://doi.org/10.56976/rjsi.v6i1.197

Prabhu, G. N. (1998). Social entrepreneurial management. *Leadership in Management*, *9*.

Roper, J., & Cheney, G. (2006). The meanings of social entrepreneurship today. In Corporate Social Responsibility: Reconciling Aspiration with Application (pp. 255-267). *Springer*.

Ryan, W. P. (1999). The new landscape for nonprofits. *Harvard Business Review*, *77*(1), 127-128.

Salampasis, D., & Mention, A.-L. (2018). FinTech: Harnessing innovation for financial inclusion. In Handbook of blockchain, digital finance, and inclusion, volume 2 (pp. 451-461). *Elsevier*.

Shahbaz, M., Khraief, N., & Jemaa, M. M. Ben. (2015). On the causal nexus of road transport CO2 emissions and macroeconomic variables in Tunisia: Evidence from combined cointegration tests.

Renewable and Sustainable *Energy Reviews*, *51*, 89-100.

Shaw, E., Shaw, J., & Wilson, M. (2002). Unsung entrepreneurs: Entrepreneurship for social gain. *University of Durham Business School*.

Sheng, T. (2021). The effect of fintech on banks' credit provision to SMEs: Evidence from China. *Finance Research Letters*, 39, 101558.

Song, Y., Li, Z., Liu, J., Yang, T., Zhang, M., & Pang, J. (2021). The effect of environmental regulation on air quality in China: A natural experiment during the Covid-19 pandemic. *Atmospheric Pollution Research*, *12*(4), 21-30.

Sullivan Mort, G., Weerawardena, J., & Carnegie, K. (2003). Social entrepreneurship: Towards conceptualisation. *International Journal of Nonprofit and Voluntary Sector Marketing*, *8*(1), 76-88.

Tariq, M., Maryam, S. Z., Shaheen, W.A. (2024). Cognitive factors and actual usage of Fintech innovation: Exploring the UTAUT framework for digital banking. *Heliyon, 10* (15) (ISSN: 2405-8440). https://doi.org/10.1016/j.heliyon.2024.e35582 .

Taylor, H. (2023). How fintech is helping build a more sustainable financial future. Cryptomathic.

Thompson, J. L. (2002). The world of the social entrepreneur. *International Journal of Public Sector Management*, *15*(5), 412-431.

Ul-Durar, S., De Sisto, M., Arshed, N., Naveed, S., & Farooqi, M. R. (2024). FinTech adoption in achieving ecologically sustainable mineral management in Asian Obor countries–A cross-section and time autoregressive robust analysis. *Resources Policy*, *91*, 104939.

Uzar, U. (2020). Political economy of renewable energy: does institutional quality make a difference in renewable energy consumption? *Renewable Energy*, *155*, 591-603.

Wallace, S. L. (1999). Social entrepreneurship: The role of social purpose enterprises in facilitating community economic development. *Journal of Developmental Entrepreneurship*, *4*(2), 153.

Wang, Y., & Shen, N. (2016). Environmental regulation and environmental productivity: The case of China. *Renewable and Sustainable Energy Reviews*, *62*, 758-766.

Warner, M. A. M. (2014). Public investment as an engine of growth. *International Monetary Fund*.

Wu, L., & Broadstock, D. C. (2015). Does economic, financial and institutional development matter for renewable energy consumption? Evidence from emerging economies. *International Journal of Economic Policy in Emerging Economies*, *8*(1), 20-39.

Xu, Z., & Li, J. (2023). Fintech and Knowledge-Intensive Services Agglomeration in China: Unearthing the U-Shaped Relationship. *Finance Research Letters*, *58*, 104538.

Zhou, W., Arner, D. W., & Buckley, R. P. (2018). Regulating FinTech in China: From permissive to balanced. In Handbook of blockchain, digital finance, and inclusion, volume 2 (pp. 45-64). *Elsevier*.