

-RESEARCH ARTICLE-

## FINTECH AND GREEN ENTREPRENEURSHIP DERIVED ECONOMIC, SOCIAL AND ENVIRONMENTAL (ESE) SUSTAINABILITY IN DEVELOPED ECONOMIES

**Dao Quang Thang**

Vinh University, Vietnam.

Email: [daoquangthang@vinhuni.edu.vn](mailto:daoquangthang@vinhuni.edu.vn)

**Nguyen Huu Trinh\* (Corresponding Author)**

Ho Chi Minh City University of Industry and Trade, Vietnam.

Email: [trinhnh@huit.edu.vn](mailto:trinhnh@huit.edu.vn)

**Nguyen Van Tuan**

Foreign Trade and Technology College, Vietnam.

PhD. Candidate, Vinh University, Vietnam.

Email: [nguyentuaneducation@gmail.com](mailto:nguyentuaneducation@gmail.com)

**Nguyen Hong Anh**

Foreign Trade and Technology College, Vietnam.

Email: [masteranhnguyen@gmail.com](mailto:masteranhnguyen@gmail.com)

### —Abstract—

This study advances the existing body of knowledge by empirically evaluating the influence of financial technology (fintech) and green entrepreneurship on sustainable development. Specifically, it examines the interrelationship between green entrepreneurship, fintech, and the economic, social, and environmental dimensions of sustainability. To achieve this, panel data from 23 developed nations spanning the period 2000–2021 is analysed using the Driscoll-Kraay standard error method. The results indicate that while fintech positively contributes to environmental and social sustainability, it exerts a detrimental effect on economic sustainability. Conversely,

Citation (APA): Thang, D. Q., Trinh, N. H., Tuan, N. V., Anh, N. H. (2024). Fintech and Green Entrepreneurship Derived Economic, Social and Environmental (Ese) Sustainability in Developed Economies. *International Journal of Economics and Finance Studies*, 16(03), 59-78. doi: 10.34109/ijefs.202416304

green entrepreneurship is found to foster both environmental and economic sustainability but does not appear to support social sustainability. These findings provide a strategic framework for developed nations to harness fintech and green entrepreneurship, underscoring the need for integrated policy measures across social, environmental, and economic domains to facilitate the attainment of sustainable development goals.

**Keywords:** Fintech; Green Entrepreneurship, Economic, Environmental and Social Sustainability, Developed Countries.

## INTRODUCTION

Fundamental societal challenges, including population expansion, climate change, and environmental degradation, continue to intensify despite the substantial economic progress and advancements in human development over the past century (Zheng et al., 2024; Neumann, 2022). SD is a comprehensive concept encompassing environmental sustainability (ENVS), economic sustainability (ECONS), and social sustainability (SS). ECONS pertains to an economy's capacity to sustain a specific level of gross domestic product (GDP). SS, defined in terms of capabilities, ensures the enhancement of well-being for both current and future generations by promoting equity (intra-generational distribution) and transmitting capabilities across generations (Younis & Chaudhary, 2017). Sen (2000) characterises SS as encompassing diversity, social cohesion, equity, quality of life, democracy, maturity, and human well-being. The social dimension of SD includes aspects such as health, social welfare, and safety (Alwakid et al., 2021). It ensures atmospheric stability, biodiversity conservation, and other environmental functions, mitigates pollution, manages hazardous and solid waste, and minimises the adverse effects of natural disasters and climate change (Dat & Hung, 2023).

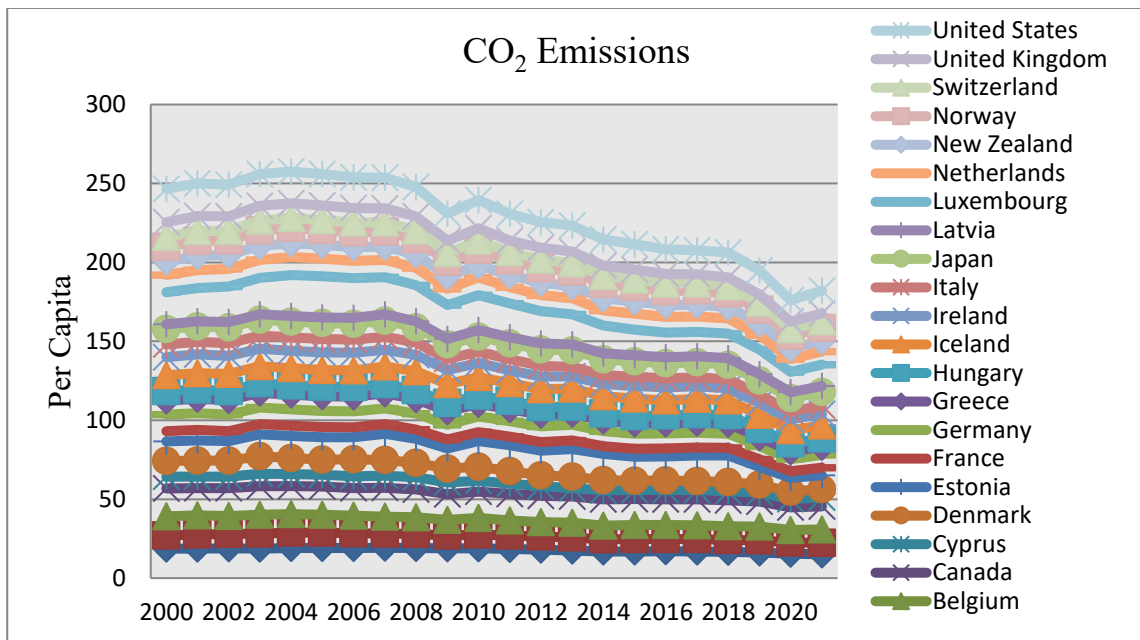
Among the various factors contributing to the attainment of environmental (ENVS), social (SS), and ECONS, financial technology (FT) plays a pivotal role due to its capacity to enhance the efficiency and effectiveness of sustainable practices across these dimensions (Berawi, 2019). The financial sector has undergone a transformation with the rise of FT, as companies and products integrate innovative technologies to automate and improve financial services. Investment in FT start-ups has surged from \$1 billion in 2008 to \$247 billion in 2022, highlighting its growing influence. By driving financial and technological innovations, FT fosters economic growth through the reduction of financial service costs, mitigation of transactional risks, and reinforcement of financial intermediation (Cevik, 2024).

Additionally, FT has been recognised for its capacity to address critical environmental and climate-related challenges. It facilitates the development of green finance, which

supports climate action and environmental protection, offering developed nations a strategic opportunity to achieve sustainable development. This is largely attributed to FT's ability to reduce information asymmetry for investors seeking to engage in green financial services. Consequently, FT firms are increasingly investing in such initiatives, as their involvement positively influences both their book and market values (Pawłowska et al., 2022). Similarly, FT holds substantial potential in combating extreme poverty and inequality by fostering financial inclusion in both developing and developed economies. The adoption of mobile technology enables broader financial access in remote and rural regions, integrating a larger population into the banking system through simplified financial services (Emara, 2023; Li et al., 2023). By ensuring equitable access to financial services across diverse economic groups, FT-driven initiatives can contribute to reducing income disparities and stimulating economic growth (Pawłowska et al., 2022).

Similarly, green entrepreneurship (GE) & SD are closely interconnected. GE is a structured process that enables entrepreneurs to gain support from stakeholders, allowing them to efficiently pursue both entrepreneurial and environmental initiatives (Audu, 2022). It is posited that green entrepreneurs who address market inefficiencies and exhibit a strong environmental orientation contribute to both environmental and economic development (Neumann, 2022). This is attributed to the high level of innovation, strong social orientation, and turnover performance of new green ventures, all of which influence the three dimensions of sustainability (Méndez-Picazo et al., 2021). In essence, GE involves proactive measures to tackle environmental and social challenges by developing innovative, cost-effective technological solutions that maintain a balance between economic and social sustainability while addressing environmental concerns (Chandel, 2022). However, macro-level analyses on the role of GE in ECONS, SS, and ENVs remain limited. Therefore, the primary objective of this study is to examine the influence of FT and GE on ECONS, ENVs, and SS across 23 developed countries over the period 2000–2021.

The impetus for this research stems from the necessity for strategic initiatives and policy interventions that foster sustainable economic development while aligning with environmental sustainability imperatives. Developed nations play a pivotal role in advancing global SD objectives. While many developed economies have successfully transitioned towards SD by relocating environmentally harmful industries, this shift has allowed them to meet economic demands while mitigating environmental burdens (Adebayo et al., 2024). However, the rapid economic expansion in these countries has led to escalating energy consumption, exacerbating environmental degradation, as illustrated in Figure 1 (Adebayo et al., 2024). Consequently, it is essential to examine the key determinants influencing ENVs, SS, and ECONS to facilitate the achievement of SD in developed nations (Duran et al., 2024).



**Figure 1:** Trend in Carbon Emissions in Selected Developed Countries (2000-2021)  
**Source:** WDI (2022)

This study makes several contributions by addressing key research gaps. Firstly, it examines developed economies, where no prior research has explored the long-term relationship between GE, FT, and SD. Secondly, unlike previous studies that rely on single indicators for SS, ENVs, and ECONS, this research integrates multiple indicators into comprehensive indices. Thirdly, while earlier studies focus on individual countries or varied country groups, this study analyses a panel of 23 developed nations using robust econometric methods. The findings offer valuable insights for governments, policymakers, and scholars on the role of GE and FT in achieving SD.

This research is structured as follows: Section 2 presents the literature review, while Section 3 outlines the data and empirical methodology. Section 4 discusses the empirical findings, and Section 5 concludes with policy recommendations.

## LITERATURE REVIEW

This section is divided into two subsections: (i) FT and economic, social, and environmental sustainability, and (ii) GE and economic, social, and environmental sustainability.

### Fintech and Social, Economic and Environmental Sustainability

Few studies have examined the relationship between FT and SD. [Udeagha and Ngepah \(2023\)](#) analysed FT's impact on CO<sub>2</sub> emissions in BRICS countries (2000–2018) and

found, using CS-ARDL, AMG, and CCEMG estimates, that FT improved ENVs by reducing emissions. Similarly, (Udeagha & Muchapondwa, 2023) studied BRICS nations (1990–2020) and reached the same conclusion using CS-ARDL estimation. For the top six manufacturing countries, (Udeagha & Muchapondwa, 2023) applied the GMM-PVAR approach, confirming FT's role in lowering CO<sub>2</sub> emissions. In ASEAN countries (1990–2021), (Cevik, 2024) found, via CS-ARDL analysis, that FT reduced emissions. In developing nations, (Azmeah & Al-Raei, 2024) explored FT's role in EG, with PCSE and FGLS regressions showing FT's positive impact. Narayan (2019) reached similar findings in Indonesia (1998–2018). Cevik (2024), analysing 198 countries (2012–2020) using GMM estimation, confirmed FT's positive effect on EG. In China, Bu et al. (2023) employed threshold regression analysis, revealing a U-shaped relationship where FT initially reduced but later boosted EG.

Bu et al. (2023) examined FT's impact on poverty alleviation across Chinese provinces (2011–2017) and found a significant positive effect. In Sub-Saharan Africa, (Emara, 2023) analysed FT's role in poverty reduction (2004–2020) using GMM estimation, concluding that FT reduced poverty but at a diminishing rate. Demir et al. (2022) studied FT and income inequality in 140 countries, with panel quantile regression showing FT's role in reducing inequality through financial inclusion. Deng et al. (2019) investigated FT's influence on SD in 31 Chinese provinces, revealing a U-shaped relationship. Elias et al. (2024) explored FT and AI in achieving SD goals, highlighting FT's significant impact on financial inclusion, poverty reduction, and economic growth.

### **Green Entrepreneurship and Economic, Social and Environmental Sustainability**

GE is a key driver of SD, contributing through green services, production technologies, demand for green finance, and job creation (Vasilescu et al., 2023). However, its role across all SD dimensions remains underexplored. Sharma and Singh (2025) found, via Panel Quantile regression, that GE reduced CO<sub>2</sub> emissions and ecological footprints in 11 Asian countries (2000–2019). Wei et al. (2023) used PMG-ARDL regression to show GE's positive impact on green economic development in Asia (1990–2019). Sun et al. (2020) examined environmental entrepreneurship in Sub-Saharan Africa (2000–2014) and found it reduced CO<sub>2</sub> emissions. Singh et al. (2023) analysed GE's effect on economic development in 34 countries (2000–2019), confirming its positive impact. Mondal (2023) studied 114 countries and found GE reduced environmental pollution while enhancing financial development and credit policy. Neumann (2022) investigated GE's role in SD (measured by CO<sub>2</sub> emissions, HDI, and GDP) across 53 countries, concluding that GE significantly influenced social and economic sustainability but not environmental sustainability. In 13 Saudi cities (2012–2017), (Alwakid et al., 2021) found GE positively linked to all SD dimensions. Audu (2022), using a descriptive approach in Nigeria's Kogi State, found GE contributed to poverty reduction.

## Research Gap

The review of existing literature highlights several gaps. Firstly, prior studies have primarily examined the impact of FT and GE on CO2 emissions, economic growth, and social development, with limited focus on their role in SD. Secondly, there is a lack of evidence on how FT and GE influence SD specifically in developed countries. Thirdly, while some studies have assessed the effects of FT and GE on social, economic, and environmental sustainability using single indicators, few have constructed comprehensive indices encompassing all relevant factors. These gaps underscore the need for further research in developed countries to evaluate whether FT and GE can contribute to achieving SD.

## ECONOMETRIC MODELLING AND ESTIMATION STRATEGIES

### Model Specification

#### Model 1: ENVIS

The work investigated the impact of GE and FT on ENVIS, ECONS, and SS in developed countries, drawing on the Stochastic Impact by Regression on Population, Affluence, and Technology (STIRPAT) framework (Dietz & Rosa, 1997), the Triple Bottom Line (TBL) theory (Elkington, 1994), and the Cobb-Douglas production function. TBL theory posits that sustainability is shaped by environmental quality, social equity, and economic prosperity, with entrepreneurship playing a key role in all three dimensions (Gu et al., 2022). The STIRPAT framework models environmental impact as a function of affluence (A), technology (T), and population (P), expressed as:

$$I_i = \alpha P_i^\beta A_i^\gamma T_i^\delta \varepsilon_i \quad (1)$$

And the logarithmic form of this model is given as:

$$\log I_i = \alpha + \beta \log P_i + \gamma \log A_i + \delta \log T_i + \varepsilon_i \quad (2)$$

Where  $\beta$ ,  $\gamma$ , and  $\delta$  represent the parameters defining the relationship between dependent and independent variables (Yasmeen et al., 2023). In essence, the STIRPAT model suggests that environmental quality is primarily influenced by human demand (population), technological advancements (technology), and economic growth (affluence). Within the context of TBL and STIRPAT frameworks, the model for ENVIS is formulated as follows:

$$ENVIS_{it} = \beta_0 + \beta_1 FT_{it} + \beta_2 GE_{it} + \beta_3 EG_{it} + \beta_4 URB_{it} + \beta_5 NR_{it} + \varepsilon_{it} \quad (3)$$

In the STIRPAT model, the technology (T) component is represented by FT, population (P) by urbanisation, and affluence (A) by economic growth. Following Neumann (2022) and Alwakid et al. (2021), GE is incorporated as it addresses various environmental

challenges. Additionally, based on (Zheng, et al., 2024), natural resources are included as a control variable to enhance the model's robustness.

### Model 2: SS

The TBL model highlights the necessity of balancing social well-being with organisational profitability. Within this framework, FT contributes to SS by facilitating access to financial services, promoting financial inclusion, and enhancing social equity (Geylan, 2021). Therefore, GE and FT are considered key determinants of SS, and the baseline model for SS is specified as follows:

$$SS_{it} = \beta_0 + \beta_1 GE_{it} + \beta_2 FT_{it} + \varepsilon_{it} \quad (4)$$

Additionally, following Wu et al. (2022), population and economic growth are incorporated as control variables. The final model is thus specified as follows:

$$SS_{it} = \beta_0 + \beta_1 GE_{it} + \beta_2 FT_{it} + \beta_3 EG_{it} + \beta_4 POP_{it} + \varepsilon_{it} \quad (5)$$

### Model 3: ECONS

The third model for ECONS is formulated based on the TBL theory and (Solow, 1956) growth model, which posits that economic productivity is determined by labour, capital, and technological progress. The fundamental equation of Solow's growth model is given as follows:

$$Y_{(t)} = f(L_{(t)}, K_{(t)}, A_{(t)},) \quad (6)$$

Where Y, K, L, and t denote productivity, capital, labour, and time period, respectively.

Subsequent economic models extended this production function by incorporating entrepreneurship as a key determinant of production, often substituting capital due to its economic significance. In line with TBL theory, FT enhances productivity and profitability. Thus, FT and GE are included as determinants of ECONS in the specified model. Additionally, following Zheng et al. (2024) and Sun et al. (2020), natural resources are incorporated as control variables, yielding the final model formulation.

$$ECONS_{it} = \beta_0 + \beta_1 FT_{it} + \beta_2 GE_{it} + \beta_3 LAB_{it} + \beta_4 CAP_{it} + \beta_5 NR_{it} + \varepsilon_{it} \quad (7)$$

Where FT, GE, LAB, CAP, and NR represent fintech, green entrepreneurship, labour, capital, and natural resources, respectively.

### Data and Variables

Due to data limitations, this study utilises a balanced panel of 23 developed countries from 2000 to 2021. ENVs, SS, and ECONS are measured through separate indices

constructed via Principal Component Analysis (PCA), following (Nguyen & Su, 2021) and (Singh et al., 2021). Tables 1–3 outline the indicators for each index.

**Table 1: Indicators to Measure ENVS**

Variable	Indicators	Unit	Data Source
	CO <sub>2</sub> Emissions	(Metric Ton Per Capita),	
	Energy Intensity Primary Energy Level	MJ/2011 PPP US\$ GDP	
	Renewable Energy Consumption	% of Total Energy Consumption	
	Forest Area	% of Land Area	
	Agriculture Land Area	% of Land Area	
	Arable Land	% of Land Area	
	Infant Mortality Rate	Per 1000 Live Births	World Development Indicators
Environmental Sustainability Index	Incidence of Tuberculosis	Per 100,000 People	
	Total Fertility Rate	Births Per Woman	
	People having Access to (at least) Basic Sanitation Services	% of Population	
	People having Access to (at least) Basic Drinking Water Services	% of Population	
	Population Growth	Annual %	

**Table 2: Indicators to Measure SS**

Variable	Indicators	Unit	Data Source
	Female to Male Labour Force Participation Rate Ratio	Percent	
	Sex Ratio at Birth (Male to Female Births)	Number	
Social Sustainability Index	Female Unemployment	% of Female Labour Force	
	Female Labour Force	% of Total Labour Force	World Development Indicators
	Life Expectancy at Birth, Total	Years	
	Infant Mortality Rate, Female	Per 1000 Lives Birth, Number	
	Fixed Telephone Subscriptions	Per 100 People	
	Age Dependency Ratio	% of Working Age Population	

**Table 3: Indicators to Measure ECONS**

Variable	Indicators	Unit	Data Source
	GDP Per Person Employed	2011 PP \$ Constant	
	GDP Per Capita (Constant 2010 US\$)	MJ/2011 PPP US\$ GDP	
	Wage and Salaried Workers, Total	% of Total Employment	
	Total Self Employed	% of Total Employment	
	Vulnerable Employment, Total	% of Total Employment	
	Inflation GDP Deflator	Annual %	
	Net Inflows of Foreign Direct Investment	% of GDP	World Development Indicators
Economic Sustainability Index	Gross Capital Formation	% of GDP	
	Exports of Goods and Services	% of GDP	
	Gross Fixed Capital Formation	% of GDP	
	Total Labour Force Participation Rate	% of Total Population Ages 15+	
	Final Consumption Expenditures	% of GDP	
	Total Employers,	% of Total Employment	
	Total Unemployment	% of Labour Force	

The primary explanatory variable, FT, is derived from three indicators using PCA, while GE is measured as environment-related technological innovations (percentage of total technologies). Control variables include economic growth, population, urbanisation, and natural resources, detailed in [Table 4](#).

**Table 4: Explanatory and Control Variables of the Study**

Variables	Measurement	Data Source
FinTech	The index consists of mobile cellular subscriptions and fixed broadband subscriptions (both per 100 people), along with the percentage of individuals using the internet.	WDI
Green Entrepreneurship	Environment-related technological innovations are measured as the percentage of total technologies.	OECD
Economic Growth	GDP per capita (constant US\$)	WDI
Population	Population growth (annual %)	WDI
Urbanization	Urban population (% of total population)	WDI
Natural Resources	Total natural resource rents (% of GDP)	WDI

## Techniques of Empirical Estimation

### Cross-sectional dependence (CSD) Test

The empirical analysis follows four steps. First, the presence of cross-sectional dependence (CSD) is assessed using the (Pesaran, 2021) test. The null hypothesis assumes no CSD, while the alternative indicates its presence (Chien et al., 2021). The test equation is as follows:

$$CD = \sqrt{\frac{2T}{N(N-1)}} \left( \sum_{i=1}^{N-1} \sum_{j=i+1}^N \hat{\rho}_{ij} \right) \sim N(0,1)_{i,j} \quad (8)$$

Where,  $\hat{\rho}_{ij}$  shows the coefficients of pairwise correlation.

### Slope Heterogeneity Test

The second step applies the slope homogeneity test by (Pesaran & Yamagata, 2008) to determine whether slope parameters are homogeneous or heterogeneous. This test is more efficient than traditional heterogeneity tests as it accounts for CSD (Zheng, et al., 2024). The test equations are as follows:

$$\tilde{\Delta} = \sqrt{N} \left( \frac{N^{-1}\tilde{S}-k}{\sqrt{2k}} \right) \quad (9)$$

$$\tilde{\Delta}_{adj} = \frac{\sqrt{N}[N^{-1}\tilde{S}-E(\tilde{Z}_{it})]}{\sqrt{Var(\tilde{Z}_{it})}} \quad (10)$$

Where,  $\tilde{\Delta}$  and  $\tilde{\Delta}_{adj}$  represent delta tilde and adjusted delta tilde, respectively.

### Unit Root Analysis

The third step applies CIPS and CADF unit root tests (Pesaran, 2007) to determine the order of integration, as they outperform conventional tests under CSD. The CADF test statistic is given as:

$$\Delta y_{it} = \alpha_i + \rho_i^* y_{it-1} + d_0 \bar{y}_{t-1} + \sum_{j=0}^p d_{j+1} \bar{\Delta y}_{t-j} + \sum_{k=1}^p c_k \Delta y_{it-k} + \varepsilon_{it} \quad (11)$$

And we can get the CIPS test statistics from CADF as follows:

$$CIPS = \frac{1}{N} \sum_{i=1}^N CADF_i \quad (12)$$

## Regression Analysis Using Driscoll-Kraay Standard Error (DK-SE) Approach

The final step employs the DK-SE method to estimate long-run relationships, effectively addressing CSD, autocorrelation, and heteroskedasticity. This approach supports fixed effects and accommodates both balanced and unbalanced panel data by handling missing values efficiently (Liu et al., 2024). Figure 2 outlines the empirical estimation steps.



Figure 2: Graphical Illustration of Methods of Analysis

## RESULTS AND DISCUSSION

This section presents descriptive statistics for all variables in Table 5, including mean, standard deviation, and data range. ENVS and ECONS exhibit negative mean values, while EG has the highest mean and standard deviation, and ENVS the lowest. Minimum and maximum values indicating data range are also provided.

Table 5: Summary Statistics

Variables	Mean	Standard Deviation	Minimum Value	Maximum Value
ENVS	-1.2009	1.000	-1.872	2.454
ECONS	-1.5509	1.712	-2.254	7.447
SS	4.67001	1.000	-1.1801	6.056
GE	10.814	4.207	0.8426	26.615
FT	5.2500	1.000	-3.010	1.299
EG	43608.6	21807.8	6336.38	112417.9
POP	0.601	0.766	-2.081	2.890
URB	78.351	10.135	57.115	98.11
NR	1.134	2.142	0.000	13.357
CAP	23.025	4.603	11.888	53.713
LAB	61.262	6.207	48.13	78.54

Table 6 presents the CSD test results, indicating that all data series exhibit cross-sectional dependence, as evidenced by highly significant test statistics.

Table 6: CSD Test Outcomes

Variables	Test Statistics	P-Value
ENVS	52.265***	0.000
ECONS	9.16***	0.000
SS	14.215***	0.000

GE	36.455***	0.000
FT	70.279***	0.000
POP	4.797***	0.000
URB	42.567***	0.000
NR	20.233***	0.000
CAP	19.05***	0.000
LAB	5.422***	0.000
EG	51.016***	0.000

Where, \*\*\* shows significance at 1%.

Table 7 findings indicate that the null hypothesis of slope homogeneity is rejected, as the highly significant delta and adjusted delta tilde statistics confirm the heterogeneity of slope coefficients.

**Table 7: Outcomes of Slope Heterogeneity Analysis for all Models**

DV=ENVS		Model 1	
Delta Tilde	16.142***		0.000
Adjusted Delta Tilde	19.595***		0.000
DV=SS		Model 2	
Delta Tilde	16.182***		0.000
Adjusted Delta Tilde	19.011***		0.000
DV=ECONS		Model 3	
Delta Tilde	13.763***		0.000
Adjusted Delta Tilde	16.707***		0.000

Where, \*\*\* shows significance at 1%

Moreover, Table 8 confirms a mixed order of integration among variables, with some stationary at level and others at first difference.

**Table 8: Outcomes of Unit Root Tests**

Variables	CIPS		CADF	
	Level	First Difference	Level	First Difference
ENVS	-0.655	-4.176***	-1.011	-3.097***
ECONS	-1.694	-4.155***	-1.629	-3.258***
SS	-1.897	-3.636***	-1.895	-2.300**
GE	-3.072***	-----	-2.229**	-----
FT	-2.294**	-----	-2.691***	-----
POP	-1.315	-3.224***	-1.633	-3.053***
URB	-1.123	-2.542***	-1.443	-2.986***
NR	-2.031	-3.833***	-1.427	-2.700***
CAP	-2.036	-4.042***	-1.969	-3.226***
LAB	-1.558	-3.704***	-1.534	-2.788***
EG	-0.802	-2.889***	-0.939	-2.016*

Where, \*\*\*, \*\* & \* show significance at 10, 5 and 1%, respectively.

After completing the necessary prerequisites, the DK-SE estimation results are analysed. In Model 1, FT exhibits a positive association with ENV5 in the selected countries, as indicated in [Table 9](#). The corresponding coefficient suggests that a one-unit increase in FT leads to a 0.029-unit rise in ENV5. This finding aligns with [Wagner \(2015\)](#), who reported that FT enhances ENV5 by reducing carbon emissions through carbon trading funds, energy transition, and green finance. Similarly, [Liao et al. \(2024\)](#) provided evidence supporting the positive role of FT in ENV5 by mitigating environmental degradation. Likewise, GE also demonstrates a positive relationship with ENV5. The regression coefficient indicates that a one-unit increase in GE results in a 0.0013-unit rise in ENV5. This suggests that GE fosters environmentally sustainable practices by facilitating the establishment of businesses that prioritise waste reduction and resource efficiency. Consistent with these findings, ([Alwakid et al., 2021](#)) and ([Wagner, 2015](#)) also identified a positive association between GE and the environmental dimension of sustainability. Regarding the control variables in Model 2, the results do not indicate a significant impact of EG, NR, or URB on ENV5, as their respective coefficients are statistically insignificant. These findings are in line with ([Ali et al., 2019](#)) and ([Liao et al., 2024](#)), who also reported an insignificant effect of URB on environmental quality. Likewise, [Liao et al. \(2024\)](#) corroborated the present study's findings by confirming the negligible impact of EG on environmental quality. Additionally, [Wagner \(2015\)](#) provided evidence supporting the insignificant influence of NR on ENV5.

**Table 9: DK-SE Estimation for Model 1 (ENV5)**

Variables	Coefficient	P-Value
FT	0.029***	0.000
GE	0.0013**	0.006
URB	-0.0013	0.176
EG	-0.00002	0.962
NR	-0.0011	0.300

Where, \*\*\*,\*\*&\* show significance at 1 and 5%, respectively.

The regression results for Model 2 in [Table 10](#) indicate that FT enhances SS in developed countries, with a one-unit increase in FT leading to a 0.188-unit rise in SS. This aligns with ([Demir et al., 2022](#)), who found that FT reduces income inequality, and ([Pawłowska et al., 2022](#)), who argue that FT fosters social equality in G-10 countries. Conversely, Model 1 suggests that GE is irrelevant to SS, as its coefficient is positive but statistically insignificant. This may stem from a misalignment between entrepreneurial rewards and sustainable development goals ([Pacheco et al., 2010](#)) or barriers such as weak support mechanisms, environmental regulations, and inclusive policies ([Salaheldeen et al., 2024](#)). However, [Neumann \(2022\)](#) and [Alwakid et al. \(2021\)](#) contradict these findings, highlighting GE's significant role in promoting SS.

**Table 10: DK-SE Estimation for Model 2 (SS)**

Variables	Coefficient	P-Value
FT	0.1882*	0.088
GE	0.0027	0.771
POP	-0.410***	0.000
EG	-0.00004**	0.030

Where, \*\*\*, \*\*&\* show significance at 1, 5 and 10%, respectively.

The findings of Model 2 indicate that POP does not contribute to SS in developed countries, contradicting (Demir et al., 2022). The estimated coefficient suggests that a one-unit increase in POP results in a 0.410-unit decline in SS. Similarly, the parameter for EG shows a 0.00004-unit reduction in SS for each unit increase in EG. These results align with (Wahiba & El Weriemmi, 2014) and (Sarker, 2009), who found that EG hampers social development by exacerbating inequality. The regression results for Model 3, presented in Table 11, indicate that FT negatively impacts ECONS, with a coefficient suggesting a 0.252-unit decline in ECONS for each unit increase in FT. This finding implies that financial sector technological innovations have not effectively supported ECONS in developed countries. Similarly, Bu et al. (2023) reported a decline in ECONS due to FT at later stages in China. Conversely, GE has a positive and significant effect on ECONS, as evidenced by (Alwakid et al., 2021) and (Neumann, 2022), with the coefficient indicating a 0.023-unit increase in ECONS per unit rise in GE. Among the control variables, only LAB exhibits a positive and significant impact on ECONS, aligning with theoretical expectations and partially supporting (Sun et al., 2020). In contrast, CAP is found to have a negative yet insignificant effect, while NR does not support ECONS, consistent with (Arslan et al., 2022).

**Table 11: DK-SE Estimation for Model 3 (ECONS)**

Variables	Coefficient	P-Value
FT	-0.252***	0.000
GE	0.0233**	0.007
CAP	-0.0019	0.745
LAB	0.0419**	0.001
NR	-0.0452***	0.000

Where, \*\*\* and \*\* show significance at 1 and 5%, respectively.

## CONCLUSION AND POLICY RECOMMENDATIONS

The escalating concerns regarding climate change and global warming have positioned SD as a critical global challenge. While existing literature acknowledges the role of FT and GE in achieving SD, limited attention has been given to their impact on the environmental, social, and economic dimensions, particularly in developed countries. To address this gap, the present study examines the influence of FT and GE on ENVs, SS, and ECONS across 23 developed nations from 2000 to 2021, employing the DK-

SE regression approach. The findings reveal that FT fosters SS and ENVs but does not support ECONS. Conversely, GE enhances ENVs and ECONS but has an insignificant effect on SS.

Governments should actively promote the adoption and diffusion of FT by providing subsidies to FT firms, ensuring greater financial inclusion, particularly in rural areas. Additionally, funding for R&D and investments in FT initiatives supporting green finance and energy should be prioritised. To mitigate FT's negative impact on ECONS, authorities should implement interest rate caps and regulate transaction fees to protect consumers. Furthermore, fostering collaborations between communities and green enterprises can help align business strategies with social needs. Supporting new startups that integrate social, environmental, and economic objectives will further strengthen sustainability efforts. Future research could expand the sample size and incorporate additional indicators related to environmental policies and regulations to assess their influence on sustainability. Moreover, examining causal relationships among these variables would provide further insights for policy development.

## REFERENCES

- Adebayo, T. S., Özkan, O., & Eweade, B. S. (2024). Do energy efficiency R&D investments and information and communication technologies promote environmental sustainability in Sweden? A quantile-on-quantile KRLS investigation. *Journal of Cleaner Production*, 440, 140832. <https://doi.org/10.1016/j.jclepro.2024.140832>
- Ali, R., Bakhsh, K., & Yasin, M. A. (2019). Impact of urbanization on CO2 emissions in emerging economy: evidence from Pakistan. *Sustainable Cities and Society*, 48, 101553. <https://doi.org/10.1016/j.scs.2019.101553>
- Alwakid, W., Aparicio, S., & Urbano, D. (2021). The influence of green entrepreneurship on sustainable development in Saudi Arabia: The role of formal institutions. *International journal of environmental research and public health*, 18(10), 5433. <https://doi.org/10.3390/ijerph18105433>
- Arslan, H. M., Khan, I., Latif, M. I., Komal, B., & Chen, S. (2022). Understanding the dynamics of natural resources rents, environmental sustainability, and sustainable economic growth: new insights from China. *Environmental Science and Pollution Research*, 29(39), 58746-58761. <https://doi.org/10.1007/s11356-022-19952-y>
- Audu, S. J. (2022). Green Entrepreneurship and Sustainable Development in Kogi State, Nigeria. *International Journal of Public Administration and Management Research*, 8(2), 82-96. <https://journals.rcmss.com/index.php/ijpamr/article/view/687>
- Azmeh, C., & Al-Raei, M. (2024). Exploring the dual relationship between fintech and financial inclusion in developing countries and their impact on economic

- growth: Supplement or substitute? *PloS one*, 19(12), e0315174. <https://doi.org/10.1371/journal.pone.0315174>
- Berawi, M. A. (2019). The role of industry 4.0 in achieving Sustainable Development Goals. *International Journal of Technology*, 10(4), 644-647. <https://doi.org/10.14716/ijtech.v10i4.3341>
- Bu, Y., Yu, X., & Li, H. (2023). The nonlinear impact of FinTech on the real economic growth: evidence from China. *Economics of Innovation and New Technology*, 32(8), 1138-1155. <https://doi.org/10.1080/10438599.2022.2095512>
- Cevik, S. (2024). Is Schumpeter right? Fintech and economic growth. *Economics of Innovation and New Technology*, 1-12. <https://doi.org/10.1080/10438599.2024.2413478>
- Chandel, T. A. (2022). Green entrepreneurship and sustainable development. In *International perspectives on value creation and sustainability through social entrepreneurship* (pp. 173-208). IGI Global. <https://doi.org/10.4018/978-1-6684-4666-9.ch009>
- Chien, F., Sadiq, M., Nawaz, M. A., Hussain, M. S., Tran, T. D., & Le Thanh, T. (2021). A step toward reducing air pollution in top Asian economies: The role of green energy, eco-innovation, and environmental taxes. *Journal of environmental management*, 297, 113420. <https://doi.org/10.1016/j.jenvman.2021.113420>
- Dat, P. T., & Hung, H. T. (2023). Determinants of sustainable development: a case study in Vietnam. *Montenegrin Journal of Economics*, 19(2), 97-107. <https://doi.org/10.14254/1800-5845/2023.19-2.8>
- Demir, A., Pesqué-Cela, V., Altunbas, Y., & Murinde, V. (2022). Fintech, financial inclusion and income inequality: a quantile regression approach. *The European Journal of Finance*, 28(1), 86-107. <https://doi.org/10.1080/1351847X.2020.1772335>
- Deng, X., Huang, Z., & Cheng, X. (2019). FinTech and sustainable development: Evidence from China based on P2P data. *Sustainability*, 11(22), 6434. <https://doi.org/10.3390/su11226434>
- Duran, M. S., Bozkaya, Ş., Rehman, M. Z., & Hossain, M. E. (2024). Are green innovation, green energy and green manufacturing successful in promoting ecological development? Evidence from G-20 countries. *Environment, Development and Sustainability*, 1-25. <https://doi.org/10.1007/s10668-024-05367-x>
- Elias, O., Esebre, S. D., Abijo, I., Timothy, A. M., Babayemi, T. D., Makinde, E. O., Oladepo, O. I., & Fatoki, I. E. (2024). Harnessing artificial intelligence to optimize financial technologies for achieving sustainable development goals. *World J. Adv. Res. Rev.*, 23, 616-625. <https://doi.org/10.30574/wjarr.2024.23.2.2385>
- Elkington, J. (1994). Towards the sustainable corporation: Win-win-win business strategies for sustainable development. *California management review*, 36(2), 90-100. <https://doi.org/10.2307/41165746>

- Emara, N. (2023). Asymmetric and threshold effects of FinTech on poverty in SSA countries. *Journal of Economic Studies*, 50(5), 921-946. <https://doi.org/10.1108/JES-03-2022-0158>
- Geylan, Z. (2021). Sustainability in Fintechs: Evaluation of TBL Approach. *Anadolu Akademi Sosyal Bilimler Dergisi*, 3(3), 477-485. <https://dergipark.org.tr/en/pub/anadoluakademi/issue/65160/998172>
- Gu, W., Pan, H., Hu, Z., & Liu, Z. (2022). The triple bottom line of sustainable entrepreneurship and economic policy uncertainty: An empirical evidence from 22 countries. *International journal of environmental research and public health*, 19(13), 7758. <https://doi.org/10.3390/ijerph19137758>
- Li, C., Razzaq, A., Ozturk, I., & Sharif, A. (2023). Natural resources, financial technologies, and digitalization: the role of institutional quality and human capital in selected OECD economies. *Resources Policy*, 81, 103362. <https://doi.org/10.1016/j.resourpol.2023.103362>
- Liao, X., Nawi, H. M., An, P. H., Mabrouk, F., Kholikova, R., Arnone, G., & Sahawneh, N. M. (2024). Influence of fintech, natural resources, and energy transition on environmental degradation of BRICS countries: Moderating role of human capital. *Resources Policy*, 92, 105022. <https://doi.org/10.1016/j.resourpol.2024.105022>
- Liu, P., Ur Rahman, Z., Józwick, B., & Doğan, M. (2024). Determining the environmental effect of Chinese FDI on the Belt and Road countries CO2 emissions: an EKC-based assessment in the context of pollution haven and halo hypotheses. *Environmental Sciences Europe*, 36(1), 48. <https://doi.org/10.1186/s12302-024-00866-0>
- Méndez-Picazo, M.-T., Galindo-Martín, M.-A., & Castaño-Martínez, M.-S. (2021). Effects of sociocultural and economic factors on social entrepreneurship and sustainable development. *Journal of Innovation & Knowledge*, 6(2), 69-77. <https://doi.org/10.1016/j.jik.2020.06.001>
- Mondal, S. (2023). The nexus between green entrepreneurship and sustainable development: An econometric study. *Global Business Review*, 09721509231157009. <https://doi.org/10.1177/09721509231157009>
- Narayan, S. W. (2019). Does fintech matter for Indonesia's economic growth? *Bulletin of Monetary Economics and Banking*, 22(4), 437-456. <https://doi.org/10.21098/bemp.v22i4.1237>
- Neumann, T. (2022). Impact of green entrepreneurship on sustainable development: An ex-post empirical analysis. *Journal of Cleaner Production*, 377, 134317. <https://doi.org/10.1016/j.jclepro.2022.134317>
- Nguyen, C. P., & Su, T. D. (2021). Tourism, institutional quality, and environmental sustainability. *Sustainable Production and Consumption*, 28, 786-801. <https://doi.org/10.1016/j.spc.2021.07.005>
- Pacheco, D. F., Dean, T. J., & Payne, D. S. (2010). Escaping the green prison: Entrepreneurship and the creation of opportunities for sustainable development.

- Journal of business venturing*, 25(5), 464-480.  
<https://doi.org/10.1016/j.jbusvent.2009.07.006>
- Pawłowska, M., Staniszewska, A., & Grzelak, M. (2022). Impact of FinTech on sustainable development. *Financial Sciences. Nauki o Finansach*, 27(2), 49-66.  
<https://www.ceeol.com/search/article-detail?id=1112780>
- Pesaran, M. H. (2007). A simple panel unit root test in the presence of cross-section dependence. *Journal of applied econometrics*, 22(2), 265-312.  
<https://doi.org/10.1002/jae.951>
- Pesaran, M. H. (2021). General diagnostic tests for cross-sectional dependence in panels. *Empirical economics*, 60(1), 13-50. <https://doi.org/10.1007/s00181-020-01875-7>
- Pesaran, M. H., & Yamagata, T. (2008). Testing slope homogeneity in large panels. *Journal of econometrics*, 142(1), 50-93.  
<https://doi.org/10.1016/j.jeconom.2007.05.010>
- Salaheldeen, M., Ateeq, A., Al Ani, Z., Alzoraiki, M., Ali, S. A., & Milhem, M. (2024). Green entrepreneurship and sustainability in developing countries: Opportunities, challenges, and future research directions. *The AI Revolution: Driving Business Innovation and Research: Volume 1*, 525-534.  
[https://doi.org/10.1007/978-3-031-54379-1\\_45](https://doi.org/10.1007/978-3-031-54379-1_45)
- Sarker, K. (2009). Economic growth and social inequality: does the trickle down effect really take place? *New Proposals: Journal of Marxism and Interdisciplinary Inquiry*, 3(1), 42-60.  
<https://ojs.library.ubc.ca/index.php/newproposals/article/view/241>
- Sen, A. (2016). The ends and means of sustainability. In *The capability approach and sustainability* (pp. 5-19). Routledge.  
<http://dx.doi.org/10.1080/19452829.2012.747492>
- Sharma, S., & Singh, S. (2025). Exploring the nexus of green entrepreneurship and environment quality in selected Asian economies. *Management of Environmental Quality: An International Journal*, 36(2), 380-405.  
<https://doi.org/10.1108/MEQ-12-2023-0418>
- Singh, A. K., Jyoti, B., Kumar, S., & Lenka, S. K. (2021). Assessment of global sustainable development, environmental sustainability, economic development and social development index in selected economies. *International Journal of Sustainable Development and Planning*, 16(1), 123-138.  
<https://doi.org/10.18280/ijstdp.160113>
- Singh, A. K., Kumar, S., & Sharma, A. K. (2023). Does green entrepreneurship ecosystem have causal association with economic development? Evidence from country-wise panel data investigation. *Journal of International Business Research*, 22(2), 1-18. <https://doi.org/10.4018/978-1-6684-4666-9.ch008>
- Solow, R. M. (1956). A contribution to the theory of economic growth. *The quarterly journal of economics*, 70(1), 65-94. <https://doi.org/10.2307/1884513>

- Sun, H., Pofoura, A. K., Mensah, I. A., Li, L., & Mohsin, M. (2020). The role of environmental entrepreneurship for sustainable development: evidence from 35 countries in Sub-Saharan Africa. *Science of the Total Environment*, 741, 140132. <https://doi.org/10.1016/j.scitotenv.2020.140132>
- Udeagha, M. C., & Muchapondwa, E. (2023). Green finance, fintech, and environmental sustainability: fresh policy insights from the BRICS nations. *International Journal of Sustainable Development & World Ecology*, 30(6), 633-649. <https://doi.org/10.1080/13504509.2023.2183526>
- Udeagha, M. C., & Ngepah, N. (2023). The drivers of environmental sustainability in BRICS economies: do green finance and fintech matter? *World Development Sustainability*, 3, 100096. <https://doi.org/10.1016/j.wds.2023.100096>
- Vasilescu, M. D., Dimian, G. C., & Gradinaru, G. I. (2023). Green entrepreneurship in challenging times: a quantitative approach for European countries. *Economic research-Ekonomska istraživanja*, 36(1), 1828-1847. <https://doi.org/10.1080/1331677X.2022.2093767>
- Wagner, B. (2015). Implementing and managing economic, social and environmental efforts of business sustainability. *Management of Environmental Quality: An International Journal*, 26(2), 195-213. <https://doi.org/10.1108/MEQ-09-2013-0099>
- Wahiba, N. F., & El Weriemmi, M. (2014). The relationship between economic growth and income inequality. *International Journal of Economics and Financial Issues*, 4(1), 135-143. <https://dergipark.org.tr/en/pub/ijefi/issue/31961/351987>
- Wei, X., Ren, H., Ullah, S., & Bozkurt, C. (2023). Does environmental entrepreneurship play a role in sustainable green development? Evidence from emerging Asian economies. *Economic research-Ekonomska istraživanja*, 36(1), 73-85. <https://doi.org/10.1080/1331677X.2022.2067887>
- Wu, H., Zhang, N., & Phommilath, P. (2022). Has E-government Facilitated the Social-economic Sustainable Development? Empirical Evidence from Global Panel Data. *Proceedings of the 15th International Conference on Theory and Practice of Electronic Governance*(pp. 456-466). <https://doi.org/10.1145/3560107.3560176>
- Yasmeen, R., Zhang, X., Sharif, A., Shah, W. U. H., & Dincă, M. S. (2023). The role of wind energy towards sustainable development in top-16 wind energy consumer countries: Evidence from STIRPAT model. *Gondwana Research*, 121, 56-71. <https://doi.org/10.1016/j.gr.2023.02.024>
- Younis, F., & Chaudhary, M. A. (2017). Sustainable development: Economic, social, and environmental sustainability in Asian economies. <https://mpr.ub.uni-muenchen.de/100551/>
- Zheng, X., Mousa, S., Mat Nawi, H., Nawaz, M. A., & Hanif, S. (2024). Does resource richness help in uplifting the economic status of resource-abundant developing countries? Evidence from Organization of Petroleum Exporting Countries using

method of moments quantile regression. In *Natural Resources Forum*.  
<https://doi.org/10.1111/1477-8947.12429>