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Alternative credit sources and green growth: The moderating role of internet usage popularity

Nguyen Bich Ngoc[1*], Nguyen Thi Thu[2]
[1,2]Banking Academy of Vietnam 12 Chua Boc, Dong Da, Hanoi, Vietnam; ngocnb@hvnh.edu.vn (N.B.N.) thunt@hvnh.edu.vn (N.T.T.).

Abstract: This paper investigates the impact of alternative credit sources on green growth in 74 countries from 2013 to 2019. The results of SGMM indicate that alternative credit sources (fintech and big tech) negatively impact green growth. However, the model results confirm the positive moderating significance of the proportion of customers using the internet on the relationship between alternative credit sources and green growth. For practical implications, countries should invest more in the development of technology infrastructure and the Internet's level of access and popularity among the population. Moreover, to ensure the effectiveness of alternative credit sources, it is crucial to develop and implement regulations on the appraisal and supervision of green projects.
Keywords: *Alternative credit sources, Bigtech, Fintech, Green growth.*

1. Introduction

Recently, in response to climate change, environmental degradation, and the rise of epidemics, green growth has gained significant attention from researchers and managers worldwide as a solution for balancing economic development with environmental protection. According to the United Nations Environment Programme (UNEP) [1] the green economy not only reduces environmental risks but also serves as a catalyst for emerging industries, creates jobs, and improves human well-being. Moreover, Taylor [2] argues that without intentional efforts to redirect the course of economic development, natural resource depletion and environmental degradation will inevitably threaten a nation's long-term prosperity.

As a result, many studies have explored the factors influencing green growth, particularly emphasizing technological, socioeconomic and environmental aspects. In terms of technology, Chen, et al. [3] demonstrated that the development and application of green technologies and innovations are powerful drivers of green growth. According to the authors, Technologies such as artificial intelligence (AI) and blockchain in management, production, and consumption have contributed to optimizing operational processes, minimizing waste, and improving productivity.

In addition, the emergence of financial technologies also helps increase transparency, reduce transaction costs, and expand access to finance for green businesses [4]. However, the authors warn that the high costs associated with investing in green technology and developing sustainable infrastructure can create significant barriers, especially for developing countries with limited financial resources. In addition, strict environmental regulations can temporarily erode business competitiveness by increasing production costs, slowing the transition to a green economy.

In line with Wang and Shao [4] and Sarkodie and Strezov [5] argue that disparities in access to technology in general and fintech/bigtech in particular in developing economies are significant obstacles limiting the ability to implement green growth initiatives, exacerbating global development disparities.

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* Correspondence: thunt@hvnh.edu.vn

Considering the impact of Socioeconomic factors on green growth, the OECD [6] emphasized that sustainable consumption forces businesses to adjust their production models and supply chains, thereby promoting green growth. Tesla, Unilever and Patagonia illustrate this trend by developing sustainable supply chains and environmentally responsible products. In addition, the OECD [7] recently asserted that instruments such as carbon taxes, renewable energy subsidies and emission regulations encourage behavioural changes among producers and consumers, promoting the transition to sustainable production and consumption patterns. Evidence is that countries such as Germany and Denmark have successfully implemented strict environmental policy regimes for green and sustainable development.

By contrast, Ng and Ong [8] show that while there are promoting factors, there are also significant barriers to green growth in society. The authors point to the entrenched resistance from traditional industries like oil, coal, and metallurgy, which has impeded the enforcement of stringent environmental policies. These industries often lobby to water down the legal framework, citing concerns about high compliance costs and profit margins. Consequently, the pace of green growth has been hampered.

Besides, Managi, et al. [9] also point out that the lack of international policy coherence poses significant challenges on the path to green growth. The authors highlight the phenomenon of "pollution havens", which refers to jurisdictions with lax environmental standards that attract companies to relocate their operations, thereby undermining global efforts to reduce emissions. Sarkodie and Strezov [5] further emphasize that uneven environmental standards will promote unfair competition, hindering sustainable green growth ecosystem development.

Thus, it can be seen that the factors affecting green growth have been analyzed from many different aspects; however, there is still a lack of in-depth empirical analysis on the relationship between technology, especially alternative sources of credit (such as fintech and big tech) and green growth, which is still quite limited [10]. More importantly, the extant literature only documents mixed empirical results on the nexus between alternative credit sources and green growth. Therefore, this study aims to fill that gap by using data on financial technology and green growth from 74 countries from 2013 – 2019 to shed light on the relationship between alternative credit sources (fintech/big tech) and green growth. The time limit to 2019 is because global green finance and financial technology data were only collected and standardized before the COVID-19 pandemic. In addition, data after 2019 may be distorted by short-term impacts from the global health shock, causing bias when analyzing the long-term relationship.

In particular, we also consider the moderating role of internet usage in each country regarding the above relationship. From there, we further clarify the mechanism of technology diffusion to green growth. The research results promise to provide valuable practical evidence for policymakers in designing legal frameworks and digital infrastructure investments to promote a more comprehensive and effective green growth.

In addition to the introduction, this paper includes the following contents: (2) Research overview; (3) Research methods and data; (4) Model results and discussion; and (5) Conclusions and limitations.

2. Research Overview

2.1. Green Growth

Green growth represents an economic development paradigm oriented toward long-term sustainability, where growth is pursued not merely for profit but also with an emphasis on environmental preservation and social equity. According to Sarkodie and Strezov [5] green growth seeks to reduce greenhouse gas emissions, improve resource efficiency, enhance environmental quality, and create sustainable economic opportunities. It embodies an integrated approach ensuring that a nation's development trajectory does not come at the expense of its natural ecosystems. This view is also endorsed by the OECD [7] which stresses that green growth integrates environmental considerations into economic policymaking, fostering technological innovation and structural transformation towards a low-carbon economy without compromising growth rates.

Thus, although different approaches to the definition of green growth exist, all affirm that green growth is economic growth that considers environmental and natural resource issues.

2.2. Alternative Credits

According to Frame and White [11] the development of technology has promoted strong innovations in the banking and finance sector, leading to changes from business models to products and services. In particular, two new types of credit intermediaries, Fintech and Biotech, have emerged and are growing strongly [12].

FinTech (financial technology) reflects the convergence of finance and technology to enhance efficiency, broaden accessibility, and foster innovation in financial services. According to Arner, et al. [13] FinTech combines technological innovation with the financial sector to generate advanced financial products and services, ranging from electronic payments and digital asset management to peer-to-peer (P2P) lending and blockchain-based solutions. A defining feature of FinTech lies in its flexibility, high accessibility, and capacity to leverage big data and artificial intelligence (AI) to optimize financial services. FinTech has profoundly reshaped the operations of traditional financial institutions, accelerating the digitization process and enhancing transparency within the global financial system.

Along with Fintech, BigTech is a term that refers to technology corporations on a global scale, possessing strong digital platforms and the ability to dominate many fields, including finance. According to Arner, et al. [14] corporations such as Google, Amazon, Facebook (now Meta), Apple, Alibaba, and Tencent have progressively expanded beyond core technological offerings into financial services encompassing electronic payments, consumer credit, digital insurance, and investment [15]. Unlike FinTech, BigTech's distinguishing feature is its deep integration into existing digital ecosystems, leveraging network effects and vast data repositories to deliver highly convenient and personalized financial services [16]. FinTech and BigTech are reshaping the global financial landscape, delivering unprecedented advances in financial accessibility, operational efficiency, and service personalization. However, they also introduce substantial data security, privacy, and market concentration challenges. To harness the full potential of FinTech and BigTech while mitigating emerging risks, regulatory bodies must establish appropriate legal frameworks that ensure transparency, fairness, and stability in the digital financial ecosystem.

2.3. The Relationship Between Alternative Credits (FinTech and BigTech) and Green Growth

Amid globalization and digital transformation, FinTech and BigTech are reshaping financial and economic ecosystems through digitalization, significantly impacting green growth. Nevertheless, their rapid development yields substantial benefits and critical challenges to the sustainability of green growth initiatives.

Enhancing Green Capital Mobilization and Sustainable Financing: One of FinTech's most critical contributions to green growth is its capacity to offer flexible financing channels for sustainable development projects, including green infrastructure, renewable energy, and eco-friendly business models. The proliferation of green bonds, sustainable investment funds, crowdfunding, and P2P lending has facilitated easier capital access for enterprises, reducing reliance on traditional banking systems [4]. Blockchain technology plays a vital role in enhancing the transparency of green financial transactions, ensuring that funds are used for their intended purposes and minimizing fraud risks [17].

The engagement of BigTech in green finance further expands access to sustainable finance. Major technology firms such as Google, Apple, Amazon, and Microsoft invest directly in renewable energy projects and provide digital payment platforms and comprehensive financial solutions that enable broader community participation in green investments [18]. Collaboration between BigTech and FinTech in building green financial ecosystems is fundamentally transforming capital mobilization models, fostering investments in emission-reduction projects, and driving sustainable development.

Improving Resource Efficiency and Environmental Governance: FinTech and BigTech are crucial in optimizing green supply chains, reducing resource waste, and enhancing energy efficiency.

Applications of AI, big data, and the Internet of Things (IoT) help businesses identify inefficiencies in production processes, thereby adjusting operations to minimize environmental impacts [19]. Advanced data analytics platforms also support governments and businesses in forecasting climate change impacts, assessing environmental risks, and developing adaptive strategies (UNEP, 2022).

Clearly, FinTech and BigTech are advancing circular economy models, promoting recycling, and optimizing material utilization. AI-based energy management systems are helping data centres, manufacturing plants, and transportation networks optimize electricity consumption, thus reducing carbon emissions across operations [16]. However, with its strengths, fintech and Bigtech also have drawbacks.

Increased Energy Consumption and Environmental Impact: While contributing to green growth, the rapid expansion of FinTech and BigTech also drives substantial increases in energy consumption and greenhouse gas emissions. Data centres, digital payment systems, and blockchain technologies demand vast electricity to operate Ng and Ong [8]. De Vries [20] found that the energy consumption of blockchain systems alone could rival that of small nations, undermining global carbon reduction efforts. Additionally, the surge in technology usage for FinTech and BigTech services generates significant volumes of electronic waste (e-waste), further straining waste management systems and exacerbating environmental degradation [21].

Financial Risks and Economic Instability: FinTech and BigTech are redefining financial markets through digital banking, cryptocurrencies, and P2P lending platforms. However, these technologies also introduce the risk of green asset bubbles. Investors drawn to sustainable finance without precise risk assessment mechanisms may misprice assets, leading to financial instability [14]. Furthermore, BigTech's control over data and capital flows can exacerbate power imbalances in the green finance ecosystem, creating barriers for smaller financial entities to participate effectively [7].

Regulatory Risks and Governance Gaps: Another critical challenge is the absence of comprehensive regulatory frameworks to oversee FinTech and BigTech activities in green finance. While traditional banks are subjected to rigorous supervision, technology firms often operate within regulatory grey zones, raising fraud risks, data misuse, and opacity in green financial practices [7].

3. Research Methodology and Data

3.1. Research Model

The model used in this study is based on Tawiah, et al. [22] and it also develops additional variables related to alternative credit sources and environmental variables. The general multiple regression model is as follows:

GG = B0 + B1*logACit + B2*CO2eit + B3*GDPGit + B4*EXPit + B5*FDIIit + B6*TNRit + B7*UPPit + B8*RDit + uit.

In there:

GG: Green growth in country i year t

logAC: Total alternative credit values provided by Fintech and Bigtech

CO2e : CO2 emissions (kg per PPP $ of GDP)

GDPG: Annual GDP growth rate (annual %)

EXP: Exports of goods and services (% of GDP)

FDII: Foreign direct investment, net inflows (% of GDP)

TNR: Total natural resources rents (% of GDP)

UPP: Urban population (% of total population)

RD: Research and development expenditure (% of GDP)

3.2. Data Source

The data in this study were collected from three primary sources. Data on green growth were collected from the dataset developed by Sarkodie and Strezov [5]. This dataset, based on data published in Scientific Data, is the result of a comprehensive assessment of green growth indices for countries worldwide. The assessment used five key pillars: natural resources, environmental policy responses, socio-economic outcomes, environmental productivity, and quality of life. Ten Green Growth (GG) indicator sets were developed from these five pillars, among which GG2 is considered the most optimal indicator set. Therefore, GG2 will be used as the primary variable to measure green growth in this study, while other green growth indices will be utilized for robustness checks of the model.

For alternative credit sources, data are extracted from the dataset published by Cornelli, et al. [12]. By synthesizing data from various sources, including the IMF World Economic Outlook, the World Bank, Brismo.com, the Cambridge Center for Alternative Finance and our esteemed research partners, WDZJ.com, companies' reports, and the authors' calculations, Cornelli, et al. [12] have synthesized data on Fintech and Bigtech in 79 countries worldwide during the period 2013 - 2019.

The World Bank, specifically the World Development Indicators, played a crucial role in providing other independent variables for the model. This study relied on the credibility and availability of data from the World Bank and other reputable sources. As a result, some countries with a history of less than 3 years were eliminated, leaving a dataset of 74 nations and constructing an unbalanced panel data with 402 observations.

Table 1.
Data explanation.

Variable	Explanation	Measurement	Data source
GG	Green growth	GG was constructed using all five dimensions (environmental productivity, environmental quality, natural asset base, policy response, and socioeconomics)	Sarkodie and Strezov [5]
logAC	The natural logarithm of total fintech and big tech credit volumes	The natural logarithm of total fintech and big tech credit volumes	Cornelli, et al. [12]
CO2e	CO2 emissions (kg per PPP $ of GDP)	Annual Weighted average	World Bank
GDPG	GDP growth	GDP annual growth rate	World Bank
EXP	Exports of goods and services (% of GDP)	Exports of goods and services are divided by GDP.	World Bank
FDII	Foreign direct investment, net inflows (% of GDP)	net inflows (new investment inflows less disinvestment) in the reporting economy from foreign investors and is divided by GDP.	World Bank
TNR	Total natural resources rents (% of GDP)	The estimates of natural resource rents are calculated as the difference between the price of a commodity and the average cost of producing it. These unit rents are then multiplied by the physical quantities countries extract or harvest to determine the rents for each commodity as a share of gross domestic product (GDP).	World Bank
UPP	Urban population (% of total population)	numbers of persons residing in an area defined as "urban" per 100 total population	World Bank
RD	Research and development expenditure (% of GDP)	The total expenditure on R&D covers basic research, applied research, and experimental development. Divided by GDP	World Bank

3.3. Regression Methodology

To thoroughly evaluate the impact of alternative credit sources from fintech and big tech on green growth, the authors conduct a comprehensive range of regression analyses using panel data, employing pooled OLS, REM, and FEM. The F-test and Hausman test are rigorously applied to determine the most appropriate model. The two-step system GMM is also utilized due to its three key advantages, ensuring a robust and reliable methodology.

First, the model exhibits heteroskedasticity, a common issue in regression analysis. To address this, the authors apply the GMM estimation method proposed by Arellano and Bover [23] and Blundell and Bond [24].

Second, the Durbin-Wu-Hausman test results play a pivotal role in the research, indicating the presence of an endogenous variable (RD). This finding leads the authors to mitigate endogeneity using the GMM estimation method, transforming the original model into a first-difference model and introducing the lagged dependent variable as an explanatory (independent) variable.

Third, the study period (2013-2019) is relatively short compared to the number of observations (74 countries). Therefore, the system GMM (SGMM) is chosen, as it typically provides more precise and efficient estimates than other GMM estimators [25, 26] ensuring the study's conclusions are based on the most effective method available.

For these reasons, SGMM, a reliable and widely accepted method, was employed in this study. The Arellano-Bond and Hansen tests were conducted to further verify the reliability of the results obtained through the SGMM method. Specifically, the AR(2) test examines autocorrelation with the null hypothesis (H_0), stating that no autocorrelation exists. In contrast, the Hansen test assesses the validity of instrumental variables under the null hypothesis (H_0) that the instruments are uncorrelated with the model's residuals. If both tests yield p-values greater than the 5% threshold, it indicates that the results derived from the SGMM method are reliable and can be used for further analysis.

Finally, the study conducts a robustness test, a crucial step to ensure the reliability of the findings. This test evaluates whether the results remain consistent when alternative indicators of green growth are applied, providing a comprehensive view of the study's outcomes.

Table 2.
Descriptive statistics.

Variable	Obs.	Mean	Std. Dev.	Min.	Max.	VIF	1/VIF
GG	402	.599	0.141	1.67e-09	1	1.74	0.575
AC	401	6661.962	52448.990	0	626713.6	1.34	0.743
CO2e	402	0.187	0.111	0.042	0.609	1.06	0.940
GDPG	402	0.032	0.029	-0.205	.244	1.74	0.575
EXP	395	0.392	0.302	0	1.951	1.61	0.621
FDII	402	0.041	0.081	0-.313	0.811	1.46	0.683
TNR	402	0.035	0.043	1.69e-06	0.274	1.37	0.730
UPP	402	0.646	0.230	.160	1	2.47	0.405
RD	347	0.014	0.012	0	0.052	1.91	0.522

4. Model Results and Discussion

4.1. Summary Statistics

Table 2 reports the descriptive statistics of green growth and independent variables used in our panel regression analysis. The results reveal that green growth scores of 74 selected countries in the period of 7 years (from 2013 - 2019) range from a low of 1.67e-09 to a high of 1 with an average score of 0.599, indicating that in general, countries are on the path of green growth. However, green growth is not uniform across countries, with Singapore having the highest green growth score at 1. In contrast, Sierra Leone is the country with the lowest GG score. More importantly, countries with high GG scores tend to be high- and middle-income countries, while those with lower GG scores tend to be low-income economies.

The primary explanatory variable in the paper is the total value of Fintech and Bigtech loans. The largest and smallest values of $626713.6mn and $53448.99mn, respectively, show a significant difference in the alternative credit market in countries. Fintech credit develops strongly in the US and UK, demonstrating stability and reliability in these markets. Meanwhile, Bigtech credit is rapidly expanding in China, Japan, Korea, Southeast Asia, and some countries in Africa and Latin America, driven by market openness, legal systems, and the strong development of the bond and stock markets, as noted by Cornelli, et al. [12].

The control variables, including CO2e, GDPG, EXP, FDII, TNR, UPP, and RD, also reveal clear differences between countries. For instance, CO2e ranges from a low of 0.0418 (in Malawi) to a high of 0.609 (in China). Moreover, statistics indicate that low-income countries witness lower carbon dioxide produced during consumption of solid, liquid, and gas fuels and gas flaring in comparison with middle and high-income countries. The same pattern can also be witnessed in UPP, ranging from a low of 0.16 (mainly in low-income countries) to a high of 1 (mainly in high-income countries). The average values of GDPG and FDII are 0.032 and 0.041, respectively, indicating a modest average growth rate of the countries. This modest growth rate underscores the need for further economic development. More importantly, there is a significant difference in GDPG between countries as some countries witnessed negative growth rates such as Argentina (2014,2016,2018,2019), Brazil (2015, 20160, Czech Republic (2013), Finland (2013, 2014), Italy (2013, 2014), Japan (2019), Lebanon (2019), Mexico (2019), Netherlands (2013), Nigeria (20160, Portugal (2013), Russian (2015), Sierra Leone (2015), Spain (2013); on the contrary, some countries recorded strong GDP growth rates above 0.2 such as Ireland - 0.244 (2015) and Sierra Leone - 0.211 (2013). It can be seen that most of the countries with negative growth rates are countries with incomes at the threshold high and above average. The same pattern can also be witnessed in FDII when negative FDII is only witnessed in high-income countries

Besides, RD has a mean of 0.014, indicating a less moderate rate within the dataset. Notably, EXP and TNR have an average value of 0.392 and 0.035, respectively, showcasing significant variability with a standard deviation of 0.302 and 0.0434, respectively.

Finally, the VIF indexes for the variables were all lower than 10.0, indicating no multicollinearity problem in any of the variables. The fact that the 1/VIF indexes were also above 0.10 [27] further reinforces that multicollinearity is not a concern when explaining the regression results.

4.2. Main Empirical Results

The results presented in Table 3 show the coefficient estimates and P-values for the variables from the SGMM regression. It is worth noting that both AR (2) and Hansen tests jointly confirmed that the model has not violated the econometrics diagnostics assumptions. Notably, the p-value for the AR(2) test was 0.896, indicating no second-order autocorrelation at the 5% significance level. Besides, the p-value for the Hansen test was 0.179, which is also higher than the 5% significance level at the Hansen test, revealing that the instruments used for this analysis were valid and not overidentified. As a result, the GMM regression results are reliable.

Table 3.
Regression results.

	OLS	REM	FEM	GMM
LogAC	-0.00725 (-1.09)	-0.0214** (-2.75)	-0.00593 (-0.47)	-0.0924*** (-4.25)
L.CO2e	0.0696 (0.97)	0.158 (1.56)	1.396*** (3.33)	0.124 (0.39)
GDPG	0.911* (2.23)	0.780 (1.81)	0.368 (0.78)	7.729*** (5.43)
EXP	-0.0329 (-1.02)	-0.0472 (-1.07)	-0.809** (-2.72)	-0.774*** (-4.35)
FDII	0.0415 (0.35)	-0.00683 (-0.06)	-0.130 (-1.08)	-0.687* (-2.24)
TNR	-0.114 (-0.47)	-0.111 (-0.34)	0.398 (0.53)	-3.234** (-3.03)
UPP	0.0571 (0.93)	0.0561 (0.70)	-2.586* (-1.98)	2.070*** (4.47)
RD	-0.251 (-0.28)	-0.0599 (-0.05)	-18.31** (-2.88)	-19.46*** (-3.85)
L.GG				-0.738*** (-9.47)
_cons	0.602*** (9.97)	0.704*** (9.60)	2.704** (3.00)	0.783* (2.13)
AR (2)				0.896
Hansen				0.179

The SGMM model shows that the coefficient of the alternative credits represented by the LogAC has a negative impact on green growth at a 5% level of significance. This outcome is similar to the conclusion reached by Arner, et al. [13]. Fintech and big tech are althought to be considered green products, but the real impact of alternative credit sources on green growth depends largely on the awareness and commitment of customers when using capital in the market. Therefore, while the processes and mechanisms for assessing the risks of green projects in Fintech and Bigtech are still unclear and specific, it is entirely possible that investments are misassessed or deviate from the target. The result is financial instability, which affects the green growth process.

However, the research results provide reassurance by confirming the positive moderating significance of the proportion of customers using the internet (PIU) on the relationship between alternative credit sources and green growth. This suggests that the internet, as a tool for increasing customer awareness, can significantly mitigate the negative impact of alternative credits on green growth.

Table 4.
GMM with moderating factor.

	GG
LogAC	-0.430*** (-4.44)
L.CO2e	0.647 (1.07)
GDPG	11.12*** (8.31)
EXP	-1.422*** (-4.60)
FDII	-1.038** (-3.09)
TNR	-4.015*** (-3.75)
UPP	4.815*** (3.42)
RD	-40.04*** (-4.03)
L.GG2	-0.844*** (-9.72)
logAC*PIU	0.334*** (3.92)
_cons	-0.548 (-0.62)
AR (2)	0.541
Hansen	0.339

The results presented in Table 4 revealed that the coefficient and the P-value for the interaction term (logAC*PIU) showed a positive and significant association with the green growth ($\beta = 0.334$; $p < 0.01$). Since the $P < 0.01$ or 1% significance, we conclude that the interaction between the proportion of individuals using the internet and the alternative credits is positively associated with green growth, implying that the moderator variable – the proportion of internet users weakens the negative relationship between alternative credit sources and green growth. This is entirely consistent with the observation of Teigland, et al. [28] when the author asserted that the internet is an important supporting tool for the development of financial technology.

From a user perspective, the internet plays a pivotal role in promoting financial inclusion. The increasing proportion of internet users makes it easier for individuals and SMEs to access capital sources, particularly green capital sources. Furthermore, the shift towards digital channels for product consumption, including financial products, is not only user-friendly but also environmentally friendly. Lastly, internet access fosters environmental awareness, promoting a green lifestyle and thereby contributing to green growth.

From the perspective of financial institutions, the increasing use of digital channels and the growing understanding of sustainable development among users present an opportunity for innovation. This trend can motivate financial institutions to digitize their processes and products in a sustainable and environmentally friendly direction, thereby contributing to green growth.

4.3. Robustness Test

This paper conducted robustness tests to analyze if the empirical findings hold as employing different proxies of green growth. Following Sarkodie et al. (2024), different proxies of green growth, specifically GG1, GG3, GG4, GG5, GG6, GG7, GG8, GG9, and GG10, were used. However, the only models with dependent variables are GG4,5,7 as a proxy for green growth that satisfies the conditions of AR(2) and Hansen test, respectively, and are therefore used to compare with the original model results. The empirical results based on alternative measures of green growth are reported in Table 5. In

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both models (except for model 4 – positive but not significant), the negative and significant relationship between LogAC and green growth remains a key finding of this study.

Table 5.
Models with different proxies of green growth.

	(1) **GG**	(2) **GG4**	(3) **GG5**	(4) **GG7**
LogAC	-0.0924*** (-4.25)	-0.110*** (-6.26)	-0.0405** (-3.20)	0.00324 (0.20)
L.CO2e	0.124 (0.39)	0.200 (0.58)	0.215 (0.81)	0.217 (0.76)
GDPG	7.729*** (5.43)	7.271*** (4.82)	-3.741*** (-4.83)	-6.455*** (-6.74)
EXP	-0.774*** (-4.35)	-0.120 (-0.91)	-0.438*** (-3.38)	-0.404** (-2.72)
FDII	-0.687* (-2.24)	-1.191** (-3.19)	1.100*** (3.73)	1.623*** (4.55)
TNR	-3.234** (-3.03)	-3.275** (-2.71)	-1.054** (-2.64)	0.909 (1.72)
UPP	2.070*** (4.47)	1.104* (2.45)	0.464 (0.90)	0.00888 (1.72)
RD	-19.46*** (-3.85)	-14.58*** (-3.29)	3.835 (1.06)	8.968* (2.20)
L.GG	-0.738*** (-9.47)			
L.GG4		-0.833*** (-5.73)		
L.GG5			-0.283*** (-6.37)	
L.GG7				-0.220*** (-4.18)
_cons	0.783* (2.13)	1.348*** (5.15)	0.783** (2.63)	0.608* (1.96)

Thus, even when using different proxy variables, alternative credit provision still has a negative impact on green growth.

5. Conclusion and Limitation

5.1. Conclusion

The study provided valuable insights into the impact of alternative credit sources, such as fintech and biotech, on the green growth of 74 countries from 2013 to 2019 using the GMM estimation method. The findings reveal a negative relationship between alternative credit sources and green growth despite the use of different proxies for green growth. Another significant finding of the study is the role of the proportion of internet users, as they act as moderators and significantly weaken the negative relationship between alternative credit sources and green growth. As a result, the clear policy implications of this study are:

- First, investing in the development of technology infrastructure as well as the Internet's level of access and popularity among the population.
- Second, developing specific regulations on appraisal and supervision of green projects

5.2. Limitations

This study is of particular importance, focusing on assessing the impact of alternative sources of credit on green growth. However, the dataset only covers 74 countries from 2013 to 2019, so increasing the number of countries and updating the data for the period 2020 - 2024 to compare the relationship between alternative sources of credit for green growth in the pre-and post-pandemic periods will help provide a more comprehensive perspective on this relationship.

In addition, the impact of fintech/big tech on green growth may not be uniform across countries/groups of countries. Therefore, examining the relationship between fintech/bigtech and green growth by a group of countries according to income capacity and geographical location will help provide better quantitative evidence to make appropriate policy recommendations for each group of countries.

Transparency:

The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

Copyright:

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References

[1] United Nations Environment Programme (UNEP), *Green economy: Supporting resource efficiency and sustainable development*. Nairobi, Kenya: UNEP, 2022.

[2] L. Taylor, "What is green growth?," *Ecological Economics*, vol. 162, pp. 166–171, 2020.

[3] Y. Chen, L. Huang, and X. Li, "BigTech and green growth: Opportunities and challenges," *Energy Economics*, vol. 91, 2020. https://doi.org/10.1016/j.eneco.2020.104879

[4] H. Wang and X. Shao, "Challenges in the integration of FinTech and BigTech for sustainable development," *Technological Forecasting and Social Change*, vol. 175, 2019.

[5] S. A. Sarkodie and V. Strezov, "Economic growth, energy consumption, and environmental degradation: Implications for sustainable development," *Green Growth Theory*, vol. 14, no. 3, pp. 1024–1043, 2023.

[6] OECD, *Green finance and investment: Mobilising bond markets for a low-carbon transition.* Paris, France: OECD Publishing, 2017.

[7] OECD, *Digital disruption in banking and its impact on competition*. Paris, France: OECD Publishing, 2020.

[8] T. Ng and W. Ong, "Regulating FinTech and BigTech: The challenges of ensuring sustainable digital finance," *Asian Journal of Financial Regulation*, vol. 7, no. 3, pp. 201–225, 2022.

[9] S. Managi, A. Hibiki, and T. Tsurumi, "Does trade openness improve environmental quality?," *Journal of Environmental Economics and Management*, vol. 58, no. 3, pp. 346-363, 2009. https://doi.org/10.1016/j.jeem.2007.09.006

[10] G. Zhou, J. Zhu, and S. Luo, "The impact of fintech innovation on green growth in China: Mediating effect of green finance," *Ecological Economics*, vol. 193, p. 107308, 2022. https://doi.org/10.1016/j.ecolecon.2021.107308

[11] W. S. Frame and L. J. White, "Technological change, financial innovation, and diffusion in banking," NYU Working Paper No. 2451/33549, 2014.

[12] G. Cornelli, J. Frost, L. Gambacorta, P. R. Rau, R. Wardrop, and T. Ziegler, "Fintech and big tech credit: Drivers of the growth of digital lending," *Journal of Banking & Finance*, vol. 148, p. 106742, 2023. https://doi.org/10.1016/j.jbankfin.2022.106742

[13] D. W. Arner, J. Barberis, and R. P. Buckley, "FinTech and financial stability: Managing risks in a changing landscape," *SSRN Electronic Journal*, 2022.

[14] D. W. Arner, J. Barberis, and R. P. Buckley, "FinTech, RegTech and the reconceptualization of financial regulation," *Northwestern Journal of International Law & Business*, vol. 42, no. 1, pp. 115–145, 2022.

[15] Financial Stability Board (FSB), "FinTech and financial stability: Managing risks in a changing landscape," Retrieved: https://www.fsb.org/2022/02/fintech-and-financial-stability-managing-risks-in-a-changing-landscape/, 2022.

[16] X. Li and Y. Wang, "FinTech and inclusive green growth: A causal inference based on double machine learning," *Sustainability*, vol. 15, no. 8, p. 4213, 2023. https://doi.org/10.3390/su15084213

[17] X. Wang, Y. Zhao, and J. Liu, "Blockchain and green finance: Enhancing transparency and efficiency in environmental investments," *International Journal of Finance & Economics*, vol. 29, no. 3, pp. 310–329, 2022.

[18] Z. Chen and T. Zhang, "Cloud computing and carbon footprint: The role of big data in sustainable development," *Journal of Cleaner Production*, vol. 312, p. 127858, 2021. https://doi.org/10.1016/j.jclepro.2021.127858

[19] Deloitte, *FinTech and environmental sustainability: How digital finance supports the green economy*. New York: Deloitte, 2023.

[20] A. De Vries, "Bitcoin's growing energy problem," *Joule*, vol. 2, no. 5, pp. 801-805, 2018. https://doi.org/10.1016/j.joule.2018.04.016

[21] R. Müller and K. Brown, "Green deal, green growth and green economy as a means of support for attaining the sustainable development goals," *Sustainability*, vol. 14, no. 3, p. 5901, 2022.

[22] V. Tawiah, A. Zakari, and F. F. Adedoyin, "Determinants of green growth in developed and developing countries," *Environmental Science and Pollution Research*, vol. 28, no. 29, pp. 39227-39242, 2021. https://doi.org/10.1007/s11356-021-13413-7

[23] M. Arellano and O. Bover, "Another look at the instrumental variable estimation of error-components models," *Journal of Econometrics*, vol. 68, no. 1, pp. 29-51, 1995. https://doi.org/10.1016/0304-4076(94)01642-D

[24] R. Blundell and S. Bond, "Initial conditions and moment restrictions in dynamic panel data models," *Journal of Econometrics*, vol. 87, no. 1, pp. 115-143, 1998. https://doi.org/10.1016/S0304-4076(98)00009-8

[25] B. H. Baltagi and B. H. Baltagi, *Econometric analysis of panel data*. Chichester: John Wiley & Sons Ltd, 2008.

[26] D. Roodman, "A note on the theme of too many instruments," *Oxford Bulletin of Economics and statistics*, vol. 71, no. 1, pp. 135-158, 2009. https://doi.org/10.1111/j.1468-0084.2008.00542.x

[27] J. F. Hair, W. C. Black, B. J. Babin, and R. E. Anderson, *Multivariate data analysis*, 7th ed. Harlow, England: Pearson Education Limited, 2014.

[28] R. Teigland, C. Ingram, N. Wesley-James, T. Bengtsson, and J. Lamberth, *Stockholm: Europe's No. 2 FinTech City: A dynamic hub for innovative payment, funding, banking, and transaction technologies*. Sweden: Invest Stockholm, 2015.