IMPACT OF THE DIGITAL ECONOMY ON GREEN ECONOMY DEVELOPMENT IN VIETNAM

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Abstract: ***This study investigates the impact of digital economic development on green economic development in Vietnam. Time series data compiled in Vietnam from 2016 to 2022, used to assess the level of digital economy development and investigate the impact of the digital economy on green economy development. In addition, the article examines the impact of factors that are control variables including total national income, number of workers, science and technology investment expenditure, foreign direct investment and production index industry to green economic development. The findings show that the digital economy significantly stimulates sustainable economic development, factors such as foreign direct investment, science and technology spending and total national income have an impact in facilitating this relationship. The contribution of this study provides management insights into how regions can promote green economy development in the digital age.***

• Keywords: *digital economy, green economy, scientific research and innovation development, foreign investment, economic growth.*

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1. Introduction

The United Nations Environment Program (UNEP, October 2008) launched the "Green Economy Initiative", after which the term green economy was widely used with many different definitions. A green economy can be considered an economy with low carbon emissions, efficient use of resources and social inclusion" (UNEP, 2011). The core meaning of green economy is economic growth that simultaneously ensures two goals: protecting a clean and sustainable living environment. In Vietnam, the issue of green growth and sustainable development has received special attention from the Party and State in recent times.

Vietnam is promoting the development of the digital economy, considering this a "breakthrough" in the context of the Fourth Industrial Revolution with increasingly rapid technological innovation, mobile communications technology with 4G network currently covering more than 95% of households. With the emergence of many new industries and the blurring of geographical borders between countries, the digital economy plays a role and has an impact not only in forming a new growth method - digital growth, but also, as a new source of growth, the environmental impact of the digital economy is receiving special attention. Considering the possibility of using the creativity and dynamism of the digital economy for the benefit of not only the economy, but also environmental and social values, has led to the concept of "sustainable digital economy" as a solution to environmental problems.

This study examines how the digital economy impacts green economic development in Vietnam using a quantitative regression model.

2. Research overview

The first type focuses on the synchronous development of the digital economy and the green economy, which benefits the recovering economy. Accordingly, the path to realizing the coordinated development of the digital economy and the green economy needs to go hand in hand. Regional governments should choose the right path to promote the coordinated development of the digital economy and the green economy according to their existing resources and local conditions according to Zhang M, Yin S. (2023). According to Lahouel BB, Taleb L, Zaied YB, Managi S. (2021), with the guidance of appropriate green policies, the synergistic effect between these two areas stimulates the development of related industries integration, enhancing labor market flexibility and facilitating transformation and upgrading of industrial structure. Castro GDR, Fernandez MCG, Colsa AU (2021) present a comprehensive systematic review and in-depth qualitative analysis of the research field and rationale behind the Development Goals Sustainability in the United Nations 2030 Agenda, sheds light on whether digital paradigms and ICT technologies, especially Big Data Analytics and Artificial Intelligence, can be exploited effectively responsibility or not.

The second type of research explores the impact of the digital economy on the development of the green

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economy. It posits a positive relationship between the two, as the digital economy provides high-quality technological resources that support various aspects of life, according to Ghobakhloo M. (2020). The development of the digital economy promotes the green transformation of the Chinese economy (Lingzhang Kong, Jinye Li, 2023). Specifically, using China's provincial panel data from 2011–2019, this study builds a comprehensive digital economy index system and green economic performance to explore the impact of digital economy to green economic performance. This view is also shared by Shi, H., & Chen, L. (2023) when considering the role of the digital economy in green consumption, the digital economy can promote promote the development of green consumption. Li, Q., Cheng, H., & Liu, F. (2023) also examined the impact of digital financial inclusion on green consumption spending of Chinese rural households, and said that building green concepts and promoting green consumption are inherent requirements for promoting high-quality economic development in China. Seo et al. (2009) found that countries with relatively low productivity levels can take advantage of information technology knowledge spillovers to narrow gap with developed countries. Other view that the digital economy has improved economic efficiency compared to the traditional economy, improved economic structure and deeply integrated with the real economy (Gao et al., 2022; Niu et al., 2022; Niu et al. al., 2024). At the macro level, the digital economy can move the production point closer to the production possibilities frontier and push the frontier limit, thereby optimizing the ratio of production factors and increasing allocative efficiency (Nambisan et al., 2019; Sanders et al., 2019; Mishra et al. al., 2022). With an empirical research method using the entropy weighting method, An Q, Wang R, Wang Y and Pavel K (2024) investigated the impact of the digital economy on sustainable development outcomes concluded that the digital economy can promote sustainable development after conducting a baseline regression and several robustness checks. The above-mentioned findings are consistent with the results of Zhang (2022) and Xu et al. (2023). Zhang used a set of 12 indicators to measure the development of the digital economy at the provincial level in China. The study also uses a single metric method, total factor productivity, to evaluate the high quality of economic development. Xu confirms the development synergies between the digital economy and the green economy using an LSTM-GM Model. Savchenko and Borodina (2020) provided a Taxonomy of Sustainable Development Goals that advocates the integration of digital solutions to promote urban sustainability. In addition to the conclusions about the impact of the digital economy on the green economy, research by Li and colleagues (2022) suggests that the development of the digital economy is a new form of promoted economic growth by technological innovation. As a result, green innovation can help the digital economy grow.

In general, the above studies have focused on an overall assessment of the development of the digital economy and the impact of the digital economy on the green economy. However, there has been no official research analyzing and measuring the impact of the digital economy on the green economy in Vietnam with secondary data in the period 2016-2022. Therefore, the authors chose to analyze in this study.

3. Research model and research hypothesis

3.1. Research model

Diagram 1: Research model

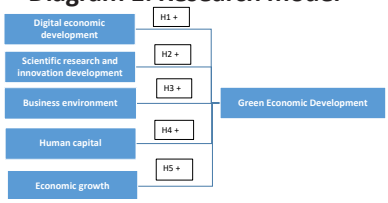


Table 1: Definition of variables

Encryption	Content of measurement variable	Data source	Reference
Dependent variable			
GE (measured by PCA)	**GE: Green economic development**		
	Electricity consumption ratio/Total energy consumption (%)	General Statistics Office (GSO) data	Suggested by the author
	Total emissions due to fuel combustion	GSO data	An Q, Wang R, Wang Y và Pavel K (2024)
	Emissions per capita	GSO data	Suggested by the author
	Emissions per GDP	GSO data	Chen, H.; Ma, Z.; Xiao, H.; Li, J.; Chen, W. (2023);
	Water supply; waste and wastewater management and treatment activities	GSO data	Suggested by the author
	Forest ratio	GSO data	Chen, H.; Ma, Z.; Xiao, H.; Li, J.; Chen, W. (2023)
	Solid waste is processed on average per day	GSO data	Suggested by the author
	Electricity consumption ratio/Total energy consumption (%)	Vietnam Energy Yearbook	An Q, Wang R, Wang Y và Pavel K (2024)
Independent variable			
DE: (measured by PCA)	**DE: Digital economic development**		
	Telephone subscriber number	GSO data	Zhao, T., Zhang, Z., and Liang, S. (2020), An Q, Wang R, Wang Y và Pavel K (2024); Zhang J, Zhao W, Cheng B, Li A, Wang Y, Yang N and Tian Y (2022)
	Number of mobile subscribers in the number of telephone subscribers	GSO data	
	Number of fixed broadband internet subscribers (ADSL)	GSO data	
	Telecommunications revenue	GSO data	
Control variable			
	Scientific research and innovation development		
CKH	Expenditure on science and technology	GSO data	Zhang J, Zhao W, Cheng B, Li A, Wang Y, Yang N and Tian Y (2022)
BPM	Number of patents granted protection	GSO data	Jiangquan Wang et al (2023)
	Business environment		
CCN	Industrial production index	GSO data	Suggested by the author
FDI	Realized foreign direct investment capital	GSO data	Zhang Yunfei (2022)
SDN	Number of operating enterprises with production and business results	GSO data	Suggested by the author
	Human capital		
LD1	Total number of employees	GSO data	Bustonov M. Mardonakulovich (2020)
LD2	Percentage of workers with informal jobs	GSO data	Suggested by the author
	Economic growth		
TT1	Gross domestic product GDP	GSO data	Zhang Yunfei (2022)
TT2	Gross national income GNI	GSO data	

Based on the research overview, the authors compiled a group of indicators including: Telephone subscriber number, Number of mobile subscribers among

telephone subscribers, Number of fixed broadband internet subscribers (ADSL), Telecommunication revenue information to measure the development of the digital economy. Indices reflecting the development of the green economy include: Ratio of electricity consumption/Total energy consumption (%); Total emissions due to fuel combustion; Emissions per capita; Water supply; waste and wastewater management and treatment activities; Forest ratio; Solid waste is processed on average per day; Ratio of electricity consumption/ Total energy consumption (%). In addition to research on the impact of digital economic development on green economic development, the authors propose a number of control variables including: research on science and innovation development; business environment; human capital; economic growth.

3.2. Research hypothesis

(i) With the prevailing economic uncertainties, the advancement of both the digital economy and the green economy has become indispensable to achieve a harmonious combination of economic growth and progress environment (WenqiLiao, 2023).

=> H1: Digital economic development has a positive impact on green economic development.

(ii) Scientific research and innovation development are the keys to the development of a green economy, especially for countries in the developing stage. This factor is quantified through two indicators: spending on science and technology and number of patents .

=> H2: Scientific research and innovation development have a positive impact on green economic development

(iii) According to Rosatom State Corporation (2018): Factors of the business environment related to access to financial resources, human resources and infrastructure as well as availability of conditions for establishment and development business development.

=> H3: The business environment has a positive impact on green economic development.

(iv) Human capital is a key factor ensuring economic growth efficiency (Voronin & al., 2020). The factor that plays a decisive role in the sustainable development of countries is high-quality human resources, not just material wealth.

=> H4: Human capital has a positive impact on green economic development.

(v) Economic growth based on GDP indicators helps businesses, investors and market analysts make decisions appropriate to the current state of the economy. An increase in GDP is a sign that the economy is performing well, businesses are confident to invest more, thereby promoting investment in innovating infrastructure, facilities and conditions for economic development. green. However, a study by author Pham Thi Bich Thao (2020) found that the higher Vietnam's economic growth, the more environmental hazards and resource scarcity risks there are because the research criteria tend to be inseparable.

=> H5: Economic growth has a positive/negative impact on green economic development.

3.3. Research methods

In this study, the author uses quantitative methods, using regression econometric tools to estimate and test the model and thereby determine the impact of the digital economy on the green economy in Vietnam. The author uses Stata 20 software to analyze secondary data. Secondary data on the development of the digital economy, green economy, business environment, scientific research and innovation development, human capital and economic growth were collected during the period 2016-2022 (7* 21 = 147 observations).

* Descriptive statistical analysis: The statistical indicators described include: Obs (Observation) - number of observations; Mean Std. - Average number; Dev. (Standard Deviation) - Standard deviation; Min - Minimum value; Max - The largest value is shown in the following results table:

Variable	Obs	Mean	Std. Dev.	Min	Max
GE	7	-2.86E-08	1.224095	-2.64399	0.971235
DE	7	1.59E-17	1.000002	-1.49112	1.41145
CKH	7	39273.29	6822.983	29694	45787
BPM	7	2713	1196	1505	4597
CCN	7	107.9571	2.974255	103.3	111.3
FDI	7	18142.86	2273.747	14500	20380
SDN	7	598579.1	101137.1	442485	718697
LD1	7	53112.56	1859.371	49072	54659.2
LD2	7	72.36286	2.644905	68.54	75.99
TT1	7	6910390	1249563	5191324	8487476
TT2	7	6556564	1205051	4927884	8053249

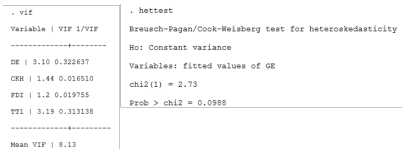
* Correlation analysis: The model's correlation analysis results show that the GE variable is correlated with indicators reflecting Scientific Research and Innovation Development, Business Environment, Human Capital and Growth economy.

	GE	DE	CKH	BPM	CCN	FDI	SDN	LD1	LD2	TT1	TT2
GE	1										
DE	0.6747	1									
CKH	0.7521	0.6267	1								
BPM	0.5891	0.267	0.8924	1							
CCN	0.8246	0.5688	0.9817	0.899	1						
FDI	0.825	0.7565	0.9779	0.8203	0.9591	1					
SDN	0.8225	0.577	0.984	0.895	0.9984	0.9636	1				
LD1	-0.1603	0.4144	-0.2073	-0.3463	-0.3272	-0.0742	-0.3232	1			
LD2	-0.7615	-0.4711	-0.9612	-0.9058	-0.9872	-0.914	-0.9852	0.4549	1		
TT1	0.7647	0.5173	0.9828	0.9227	0.9928	0.9454	0.9947	-0.3673	-0.9923	1	
TT2	0.7527	0.5094	0.9837	0.9308	0.9914	0.9436	0.9926	-0.361	-0.9912	0.9996	1

* Time series data regression model gives the following results:

```
reg GE DE CKH FDI TT1
------------------------------------------------------------------------------
          GE |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          DE |   1.095347    .375109     2.92   0.043     .0538773    2.136817
         CKH |   .0001349   .0000529     2.55   0.021    -1.01e-06    .0002709
         FDI |   .0004441   .0001361     3.26   0.022     .0000943    .0007939
         TT1 |   7.49e-07   2.82e-07     2.65   0.045     2.35e-08    1.47e-06
       _cons |   18.56977   10.71959     1.73   0.158    -11.19259    48.33213
```

* Checking the model's defects: multicollinearity, heteroskedasticity and autocorrelation obtained the following results:



```
. vif
Variable | VIF 1/VIF
-------------+--------
DK | 3.10 0.322637
CKH | 1.44 0.016510
FDI | 1.2 0.019755
TTI | 3.19 0.313138
-------------+---------
Mean VIF | 8.13
```

```
. hettest
Breusch-Pagan/Cook-Welsberg test for heteroskedasticity
Ho: Constant variance
Variables: fitted values of GE
chi2(1) = 2.73
Prob > chi2 = 0.0988
```

- Multicollinearity test: with VIF value = 8.13 < 10, the model used does not have multicollinearity phenomenon.

- Testing heteroskedasticity: found that the value Prob>chi2 = 0.0988 > 0.05, so the model does not have heteroskedasticity.

The results show that the above model has 4 factors affecting green economic development: Digital economic development; Industrial development index; Spending on science and technology; Foreign direct investment. From the results of the study when estimating parameters on Stata20 software, the following conclusions can be drawn:

- Digital economic development: Strengthening information technology reduces carbon emissions and is a positive driving factor for economic growth. The results show that digital technology transformation and digital innovation capability transformation have a significant impact on green manufacturing performance and green service performance. Experimental results in Vietnam have also explored the impact of digital transformation on environmental pollution, arguing that the internet of things allows for more resource-efficient production and improved recycling processes.

- Spending on science and technology has a positive impact on the development of the green economy. In Vietnam when science and technology facilitate the transformation of the growth model from breadth to depth. Science and technology develop with the introduction of a series of new and modern technologies that contribute to changing and improving old and outdated growth models with economic development models consistent with trends globally towards a green growth economy.

- Foreign direct investment index has positive impact on green economic development. FDI activities contribute to the transfer of advanced and high technology into Vietnam. In fact, in Vietnam, FDI enterprises have contributed to changing thinking and behavior, creating new and groundbreaking changes in green consumption and green production. Typically: Coca Cola and Unilever built the "Zero to Waste"; Nestlé carries out many sustainable initiatives on combating climate change and managing water resources, waste recycling; Heineken Vietnam announced that it recycles nearly 99% of waste and by-products, with 4/6 breweries using renewable energy and biomass fuel, with no carbon emissions (Ly Hoang Phu, 2020).

- Economic growth index has a positive impact on green economic development. In fact, in the coming time, Vietnam will need about 368 - 380 billion USD for the whole period or 6.8% of GDP each year until 2040 to transition to a green economy and cope with the impacts of change. climate. Investment demand will focus largely on energy, agricultural transport and industry. Therefore, it requires close coordination of ministries and branches as well as the companionship of all people and businesses.

4. Conclusion and recommendations

From the results of empirical research, it shows that the development of the digital economy in Vietnam is influenced by the following factors: digital economic development; scientific research and innovation development; foreign direct investment and economic growth. In the current context of the country's economy, with the goal of sustainable and long-term economic growth, digital economy and green economy are the most appropriate and mainstream development methods in the current period, ensuring the goal of rapid and sustainable development. Thus, the core digital economic sector itself is information technology, which has a huge impact on economic development. Promote scientific research and innovation development, especially low-carbon emission technologies, encourage businesses to invest in innovation, absorption and mastery of technology, especially core technology, source technology, stabilizing the macroeconomy, especially controlling inflation, stabilizing the value of new currency create favorable conditions to maintain order and promote investment, production, business, consumption, through promotes overall economic growth. To enhance the impact of FDI and international trade on Vietnam's economic growth, there needs to be a policy of prioritizing projects with advanced, clean technology, modern management, high added value, spillover effects, and global connectivity. However, to achieve this goal, synchronous coordination of agencies and businesses is needed, people in promoting digital transformation and applying information technology in all areas of socio-economic life.

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