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Does Digital Finance Promote Green Economic Growth?

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Abstract: This paper constructs a balanced panel model of 285 cities in China to study the impact of digital finance on green economic growth. It is found that digital finance has a significant contribution to green economic growth. Green finance can increase green economic growth by promoting industrial structure upgrading. The contribution of green finance to green economic growth is higher in eastern cities and western cities than in the east. Digital finance has a significant threshold effect on green economic growth, and when the depth of digital finance exceeds the threshold value, the promotion effect of digital finance on green economic growth is greater.

Keywords: Digital finance, Green economic growth, Mediating effect, Mechanism of action, Threshold model.

1. Introduction

In 2021, China's GDP will grow by 8.1% over the previous year, and China's GDP will exceed 114 trillion yuan. However, along with the rapid economic growth, a large amount of ecological space has been squeezed and the ecological environment continues to deteriorate, especially the concentrated outbreak of environmental problems under the crude development mode, which has put the issue of sustainable economic development in front of the government and the public. According to the China Ecological Environment Status Bulletin, in 2019,180 cities exceeded ambient air quality standards, accounting for 53.4%. Therefore, how to achieve economic growth while taking into account environmental protection and resource conservation, and promote the green development of China's economy has become a difficult problem that the government must face. Existing research on green economic growth has suggested that scientific and technological innovation (Lorek and Spangenberg, 2014; Padilla-Pérez and Gaudin, 2014), industry structure (Boschma et al., 2017), and carbon emissions (Jianhua Yin, et al., 2015; Acemoglu et al. ,2016; Sohag,et al.,2019; Khan & Ulucak, 2020) are important enforcing factors for the development of green economic growth. Therefore, Financial development can promote green economic growth by reducing carbon emissions (Jalil & Feridun,2011; Mahmood et al., 2013) optimizing industrial structure (Wurgle,2000; Michalopoulos, 2015)and improving science and technology innovation(Thorsten, et al,2002).

The level of green development in China has been at a relatively low level. Several scholars at home and abroad have explored the reasons affecting green economic growth. The first explanation stems from the government's behavior under the Chinese fiscal decentralization system (Daming You, et al, 2019), where the government's competitive behavior leads to serious resource allocation distortions and environmental pollution problems, and more seriously, the emergence of rent-seeking behavior that further inhibits green economic growth. Although rapid economic growth is achieved, environmental problems are ignored; the second explanation is called "Dutch disease", in which natural resource-rich regions inhibit green economic growth (Nagasaka, 1977), and resource-rich regions rely excessively on resource extraction to achieve economic growth, which leads to resource depletion and the formation of a "green economy". This leads to resource depletion, forming a "resource curse" and inhibiting green economic growth (Zhonghua Cheng, et al.,2020); the third explanation is: market segmentation. Market segmentation has a significant worsening effect on environmental pollution (Yuanchao Bian, et al. ,2019). The fourth explanation is carbon emissions. (Bailey, et al.,2014). There are also domestic and international studies on the relationship between digital finance and the economy. Wang,wanxin (2019) confirms that the application of digitalization can create certain benefits for venture capital; the application of digital technologies in the healthcare industry helps to reduce infrastructure costs, making healthcare services cheaper and more accessible, bringing benefits to people (Roberto and Donato, 2020).

Through the above review, we found that digital finance has a big impact on the economy. Further, the contribution of digital finance to economic development is also significant. However, there are not many studies related to the impact of digital finance on the growth of green economy. Therefore, this paper establishes intermediary effect model and panel threshold model to analyze the influence of digital finance on China's green economic growth in detail.

The marginal contribution of this paper lies in: in the first place, this paper constructs the mediation effect model to study the influencing mechanism of digital finance on green economic growth in China based on the effective measurement of China's green economic growth. Second, this paper analyzes in detail the heterogeneity of digital finance on green economic growth in eastern, central and western China. Third, this paper further investigates the threshold effect of digital finance on green economic growth in China.

2. Data and Empirical Model

2.1. Data sources

The data in this paper come from two databases: digital finance from the "Digital Financial Inclusion Index of Peking University". The data of the explanatory variables, control variables and mediating variables are all from the China City Statistical Yearbook. Due to some missing data, the data in this paper include balanced panel data of 285 cities from 2011 to 2016..

2.2. Variables

2.2.1. Dependent variable: Green economic growth

This paper uses green total factor productivity as a proxy variable of green economic growth. The directional distance function (DDF) and Malmquist-Luenberger productivity index proposed by Chung et al. (1997) are used to measure total factor productivity under unintended output. The variables used to establish green economic growth in this paper are shown in Table 1. In this paper, the green economic growth variable is set as Green.

Table 1. Green Total Factor Productivity Evaluation Index System

category	variable	Data and Instructions	unit
Input	Labor	Number of people employed in each city that year	thousands
	capital stock	The capital stock is established by the perpetual inventory method, which is 100 million yuan. Kt=Kt-1*(1-δ)+It	billion
	energy	Energy input is measured by the annual standard coal consumption of each city	Tons
Output	GDP	With each city in those days actual gross national product will measure	billion
Undesirable output	solid waste	Output of industrial solid waste in each city that year	Tons
	SO2	The amount of sulfur dioxide produced in each city that year	Tons
	wastewater	The discharge of industrial waste water in each city that year	Tons

2.2.2. Explanatory variables: Digital finance

The explanatory variables in this paper include the digital finance index (digfin) and its two dimensional indices. The two dimensional indices are the depth of digital finance usage index (digfin2) and the breadth of digital finance coverage index (digfin3). Two of the dimensional indices are used as data for robustness testing. The data were obtained from the Digital Financial Inclusion Index of Peking University (Guo Feng et al., 2020).

2.2.3. Mediating variable

The mediating variable in this paper is industrial structural upgrading (isu). The formula for industrial structure upgrading is as follows:

$$isu = S_3 / S_2 \quad (1)$$

S_i denotes the ratio of the output value of industry i to the total output value. This indicator mainly reflects the upgrading relationship among the three industries. a larger value of isu indicates a higher level of industrial structure development in the region, which also means a more advanced industrial structure in the region.

2.2.4. Control variable

In this paper, the following control variables are used: post revenue (the ratio of local post revenue level to GDP), foreign investment level (the ratio of foreign investment amount to local GDP), financial development level (the ratio of financial loan balance to GDP), and human capital (the ratio of students receiving higher education to local population). The above four control variables indicators are set as: post, fdi, loan, and humcap.

2.3. Model

First, we set up the panel regression model. The panel model is shown below.

$$Green_{it} = a_0 + a_1 digfin_{it} + a_2 \times control_{it} + \varepsilon_{it} \quad (2)$$

$Green_{it}$ stands for green economic growth; $digfin_{it}$ stands for digital finance; i denotes city and t denotes year. $control_{it}$ is the control variable, ε it is the error disturbance term .

Equation (2) reflects the direct impact mechanism of digital finance on the growth of the green economy. This paper introduces the mediating variable Industrial Structural Upgrading (isu) to further examine the potential indirect impact mechanism of digital finance on green economic growth. The mediating effect model constructed in this paper can be expressed as:

$$Green_{it} = a_0 + a_1 digfin_{it} + a_2 \times control_{it} + \varepsilon_{it} \quad (3)$$

$$isu_{it} = b_0 + b_1 \times digital_{it} + b_2 \times control_{it} + \varepsilon_{it} \quad (4)$$

$$Green_{it} = \lambda_0 + \lambda_1 \times digital_{it} + \lambda_2 \times isu_{it} + \lambda_3 control_{it} + \varepsilon_{it} \quad (5)$$

To test whether digital finance has a non-linear effect on green economic growth, this paper uses the panel threshold model established by Hansen (2000) to do a non-linear mechanism examination. In this paper, we use the depth of digital finance (digfin2) as the threshold variable to examine the non-linear impact of data finance on green economic growth. This paper further constructs the threshold model based on equation (2) as shown below.

$$Green_{it} = c_0 + c_1 digfin_{it} \cdot I\left(q_{it} \leq \gamma\right) + c_2 digfin_{it} \cdot I\left(q_{it} > \gamma\right) + c_3 control_{it} + \varepsilon_{it} \quad (6)$$

I(·) is an indicative function, the value of which depends on the relationship between the threshold variable and the threshold value γ. When ≤γ holds, the function value is 1, otherwise it is 0.

3. Empircal Results

3.1. Baseline results

Table 2 displays the regression results for the panel fixed effects and random effects of the model. Meanwhile, the Hausman test was conducted in this paper, and the p-value of the results of the Hausman test was 0.0006, indicating that the fixed-effects model is more appropriate. From Table 2, it can be seen that digital finance has a facilitating effect on green economic growth at the 99% significance level.

Table 2. Baseline results

Variables	fe	re
digfin	0.0430***	0.0492***
	(0.0073)	(0.0065)
post	0.0154*	0.0263***
	(0.0089)	(0.0072)
loans	-0.0252	-0.0668***
	(0.0171)	(0.0121)
humcap	0.000406	0.000909
	(0.0031)	(0.0029)
fdi	-0.142	-0.564**
	(0.3168)	(0.2591)
Constant term	0.231***	0.129**
	(0.067)	(0.0602)
N	1710	1710

Standarderrors in parentheses;* p<0.1, ** p<0.05, *** p<0.01

3.2. Heterogeneity analysis

In this paper, cities are divided into eastern, central and western cities for heterogeneity analysis of digital finance for green economy growth. Table 3 shows the results of the heterogeneity analysis. The contribution of digital finance to green economic growth in central cities is relatively small. Digital finance contributes relatively more to green economic growth in eastern and western cities.

Table 3. Heterogeneous influence of digital finance on green economic growth

digfin	0.0582**	0.0233**	0.0584***
	(0.0115)	(0.0102)	(0.0191)
post	0.00976	0.0237*	0.0215
	(0.0156)	(0.0131)	(0.0191)
loans	0.0121	0.0369*	-0.146***
	(0.0354)	(0.0209)	(0.0439)
humcap	0.00139	-0.00558	0.00593
	(0.0047)	(0.0046)	(0.0074)
fdi	0.693**	-1.016	-1.649
	(0.3511)	(0.7055)	(1.7963)
Constant term	0.199*	0.282***	0.128
	(0.1148)	(.0999)	(0.1485)
Fixed Effect	YES	YES	YES
N	690	648	372
R-sq	0.0843	0.1501	0.1363

Standarderrors in parentheses;* p<0.1, ** p<0.05, *** p<0.01

Table 4. Mediating effect test

Variables	(1)	(2)	(3)
	Step1	Step2	Step3
digfin	0.0430***	0.0662***	0.0383***
	(0.0073)	(0.0055)	(0.0077)
isu			0.0697**
			(0.0349)
post	0.0154*	-0.00133	0.0155*
	(0.0089)	(0.0067)	(0.0088)
loans	-0.0252	0.230***	-0.0413**
	(0.0171)	(0.013)	(0.0188)
humcap	0.000406	0.0260***	-0.00141
	(0.0031)	(0.0023)	(0.0032)
fdi	-0.142	-0.329	-0.119
	(0.3168)	(0.2407)	(0.3166)
Constant term	0.231***	3.510***	-0.0142
	(0.067)	(0.0509)	(0.1396)
Fixed Effect	Yes	Yes	Yes
N	1710	1710	1710
R-sq	0.1447	0.5098	0.1422

Standarderrors in parentheses; * p<0.1, ** p<0.05, *** p<0.01

3.3. Mechanism of inspection

This paper constructs a mediating effect model to analyze whether digital finance can promote green economic growth by influencing industrial structure upgrading. Table 4 displays the regression results of the mediating effect model. Column (2) of Table 4 displays that digital finance has a positive influence on industrial structure upgrading at the 99% significance level. Column (3) of Table 4 displays that digital finance and industrial structure upgrading have a significant positive influence on green economic growth. This indicates that digital finance can promote green economic growth by influencing industrial structure upgrading.

3.4. Threshold effect analysis

Referring to Hansen (2000), this paper uses the depth of digital finance use as a threshold variable to construct a threshold model to test whether digital finance has a nonlinear effect on green economic growth. Table 5 demonstrates the results of the double threshold effect test. Table 5 demonstrates that there is a single threshold effect at the 90% significance level. The threshold value is 5.1390.

To better understand the estimation of the threshold value and the process of constructing confidence intervals, this can be done with the help of the likelihood ratio function plot, where the likelihood ratio function sequence LR(γ) is used as a trend plot for the threshold parameter, and when the likelihood ratio LR(γ) is 0, the threshold value is calculated as γ = 5.1390, as demonstrated in Figure 1, and the 95% confidence interval for γ is indicated below the dashed line.

Table 5. Threshold effect test results

Number of thresholds	F-statistic	P-value	Threshold value
Single Threshold	27.87	0.0867	5.1390
Double Threshold	8.65	0.8433	4.2726

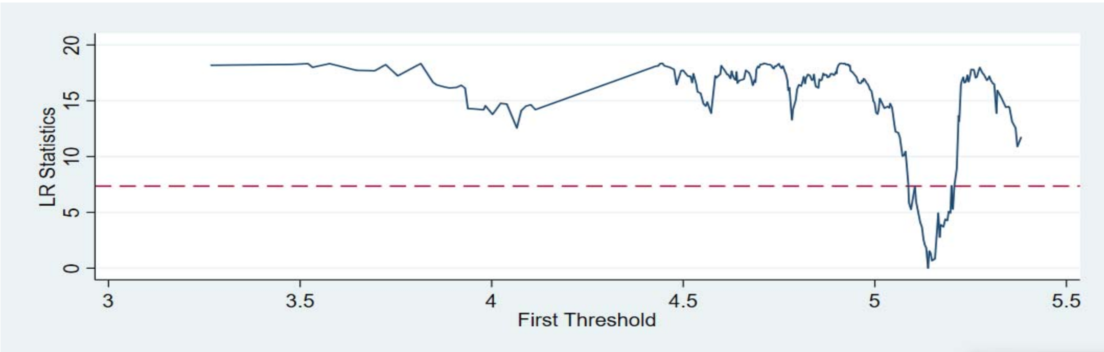

Figure 1. Confidence interval of the single threshold model

Table 6 shows the results of the panel threshold model regression. As can be seen from Table 6:Digital finance has a significant threshold effect on green economic growth when the depth of digital finance use (digifin2) is the threshold variable. Specifically, at the 99% significance level, the effect of digital finance on green economic growth is 0.0362 when the depth of digital finance use (digifin2) is less than 5.1390 and 0.0431 when the depth of digital finance use (digifin 2) is greater than 5.1390.This indicates that when the depth of digital finance use (digifin2) is depth (digifin 2) is higher, the greater the contribution of digital finance to green economic growth. The threshold effect of digital finance on green economic growth arises because when the depth of digital finance use exceeds a certain threshold, digital finance has a better contribution to the upgrading of industrial structure and thus better promotes green economic growth.

Table 6. Regression results of threshold model

Variables	Digfin2<5.1390	Digfin2>51390
digfin	0.0362***	
	(0.0074)	
digfin		0.0431***
		(0.0072)
post	0.0147*	0.0147*
	(0.0088)	(0.0088)
loans	0.0346**	0.0346**
	(0.017)	(0.017)
humcap	0.00445	0.00445
	(0.0032)	(0.0032)
fdi	0.0341	0.0341
	(0.3151)	(0.3151)
Fixed Effect	YES	YES
N	1710	1710
Constant term	0.229***	0.229***
	-0.0665	-0.0665

3.5. Robustness checks

In this paper, we use depth of digital financial usage (digfin2) and breadth of digital financial coverage (digfin3) to replace the core parsing variables for robustness testing. Table 7 demonstrates the results of the robustness tests. Both depth of financial usage (digfin2) and breadth of digital financial coverage (digfin3) have a significant contribution to green economic growth. This indicates that the results of this paper are robust.

Table 7. Robustness test results

Variables	(1)	(2)
digfin2	0.0375***	
	(0.0075)	
digfin3		0.0299***
		(0.0064)
Controls	YES	YES
Fixed Effect	YES	YES
Constant term	0.244***	0.290***
	(0.0681)	(0.0653)
N	1710	1710
R-sq	0.1524	0.155

Standarderrors in parentheses; * p<0.1, ** p<0.05, *** p<0.01

4. Conclusion

This paper constructs a balanced panel model of 285 cities in China to study the impact of digital finance on green economic growth. It is found that: first, digital finance has a significant contribution to green economic growth. Second, green finance can enhance green economic growth by promoting industrial structure upgrading. Third, green finance has a higher contribution to green economic growth in eastern cities and western cities than in the east. Finally, digital finance has a significant threshold effect on green economic growth, and when the depth of digital finance exceeds the threshold, the promotion effect of digital finance on green economic growth is greater.

The results of the study have the following policy implications: first, accelerate the development of digital finance, enhance the coverage of digital financial services, and promote a balanced distribution of financial resources. Second, the government should formulate policies to further improve the development of digital finance in central and western China. By formulating effective digital finance policies, it will in turn improve the level of green economic growth and high-quality economic development.

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