



Empirical Analysis of Green Finance Development on Regional Economic Growth

-- A Case Study of Three Provinces and One City in the Yangtze River Delta Region

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ABSTRACT

This paper takes the three provinces, and one city in the Yangtze River Delta region as the study target, the inter-provincial panel data of the three provinces and one city in the Yangtze River Delta region from 2011 to 2020 are selected, and actualizes a positive study on how green finance (G-Finance) influences regional economic growth. This study reached the following conclusions: According to the data from 2011 to 2020, the level of G-Finance in this region increases year by year. It has a remarkable positive consequence on the development of the regional economic level. Besides, from the regional grouping regression results, green finance positively promotes the economic development of the three provinces and one city. The effect is the largest in Shanghai and the smallest in Zhejiang Province. Therefore, vigorously developing G-Finance and promoting economic structural transformation can shelter the ecological environment and inject power into the sustainable bloom of the economy.

Key words: *Green finance, Economics development, Regional economic growth, Robustness test*

1. INTRODUCTION

The economy of China has gathered momentum since the reform and opening to the outside world, but the problems of extravagant resource consumption and uncleanness have become increasingly prominent (Chen et al., 2017; Xiong and Xu, 2021)^{[1][2]}. In 2010, 91.9% of China's domestic consumption of coal and oil, resulting in the election of a great abundance of dirtiness such as solid waste, carbon dioxide, and sulphur dioxide (Liu and Lee, 2020; Lv et al., 2021)^{[3][4]}, which is not only harmful to human health but also leads to the volatile natural condition and profitable development. Hence, to achieve sustainable growth of the economy and environment in a low-carbon and green environment system, there is an urgent need to strike a balance between energy costs, economic improvement, and geographical area. For the sustainable development of the economy and the environment in the Yangtze River Delta, it is essential to seek cooperation and compensation and reduce environmental risks. The economic development aim of rapid economic growth into high-quality growth has been transformed by China's government (Ma and Zhu,

2022)^[5]. Green finance (G-Finance) is vital in evaluating economic growth and the ecological condition and has been adopted far and wide in China and the world (Akomea-Frimpong et al., 2021)^[6]. G-Finance refers to the financing of sustainable development, ecological defence, as well as pollution-dropping programs to promote the growth of a circular economy, including promoting clean energy and reducing greenhouse gas emissions, among other environmental goals (Wang et al., 2022)^[7]. Different from traditional finance, G-Finance lays emphasis on environmental profits. It regards environmental defence and significant use of resources as essential standards to measure the validity of its significance (Zhou et al., 2020)^[8].

At present, the global G-Finance development trend is good, among which we focus on green stocks, green bonds, green credit, and so on. Green credit has always been the absolute financing subject of China's green industry, and its scale keeps rising (Chen et al., 2021)^[9]. The remaining sum of green credit in China was 11.95 trillion yuan, an increase of 3.46% over the previous quarter by the final phase of the fourth quarter of 2020.

China started the pilot work of compulsory environmental liability insurance in 2013. In recent years, relevant systems have been constantly improved. In 2017, it was proposed to accelerate the development of green insurance by innovating ecological and environmental liability insurance products.

Chinese issuers, consisting of banks, real estate developers, railway operators, etc., issued \$15.7 billion in bonds in 2021 to provide funds for green projects such as clean energy and renewable energy, catapulting China to the second place in the world (Reuters, 2021)^[10]. However, there are many deficiencies in China's financial market. For example, the definition of green credit standards differs from international standards, and the relevant restraint supervision mechanism and incentive mechanism are still lacking. The construction capacity of green credit in the banking industry needs to be improved (Zhou et al., 2021)^[11]. People from all walks of life have an insufficient understanding of green insurance. Its liability compensation mechanism is imperfect, enterprises are not strong in environmental awareness, and green insurance products are single (Peng et al., 2018)^[12]. Despite a more significant green financial role in an emerging economy, green finance is conducive to the burgeon of a high-quality economy, it is still unclear (Yang et al., 2021)^[13].

Despite the notion of G-Finance having been defined and distinguished in the academic circles far and wide, policymakers have also recognized the effect of G-Finance in achieving high-quality economic bloom, as well as how to optimize green monetary policies to facilitate economic advance further. Nevertheless, at present, the research direction of the literature on G-Finance mainly shows solicitude for the G-Financial product system and the impact of G-Financial development on the environment, the research on the interaction between G-Finance and regional growth is still in its infancy, it is significant to clarify the effect of G-Finance on regional economic growth consequently.

The main research results and possible contributions of this paper are as follows : (1) It makes a thorough inquiry on the influence of G-Finance on regional economic growth in an empirical way, and the previous research projects focus mainly on China. The research results are of great importance for the three provinces and one city in the Yangtze River Delta. (2) This paper breaks through the limitations of traditional research indicators, which are single or unreasonable. The index system consists of green credit, green insurance, green securities, and green investment. For the calculation of the comprehensive indicators of G-Finance development in different regions, this paper uses the entropy method, which accurately reflects the development level of regional G-Finance, and has certain practical significance for future research.

The structure of this paper is organized as follows:

Section 1 is the heading introduction of this paper. Section 2 covers the relevant literature, when it comes to Section 3, presents the relevant empirical methods and data. The empirical results are expressed in section 4, and the method and technique are presented in section 5. Section 6 shows the main conclusions and policy recommendations of this study.

2. LITERATURE REVIEW

With the improvement and promotion of green financial policy, green financial products have been paid more and more attention and have developed rapidly in various fields in China. The research on G-Finance of China's market growth is increasingly hot. Zhang Hongying and Geng Chengxuan and Wei Jiahui^[14] use the coupling degree model and spatial panel model etc. and analyse the space-time characteristics and prime mover factors of the coordinated expansion of G-Finance and environmental merits based on the panel data of 30 provinces in China from 2008 to 2019. The results show that the degree of economic growth and environmental regulation have a vigorous effect on the coordinated development of G-Finance and environmental performance, and the degree of impact varies from region to region. From the perspective of the effect of green credit on the credit risk of commercial banks, Luo Sumei and Yu Shenghui and Zhou Guangyou^[15] use DID to analyze and conclude that green credit has an important influence on the comprehensive competitiveness of banks. The increase in green credit level can heighten the core competitiveness of banks with low credit and fame. Zhang et al.^[16] analyze the effect of green credit on energy intensity and environmental pollution and its mechanism by using the dynamic spatial Dubin model with the data of 30 provincial administrative regions and six polluting industries in China from 2007 to 2018 and concluded that the energy-saving and emission reduction effect of green credit has significant regional heterogeneity. Chai et al.^[17] find that for those enterprises that cause serious environmental problems, the green credit policy has played a certain role in restraining their non-current liability financing. However, due to some special measures taken by enterprises to respond to the policy, China's green credit has not played a perfect role in the resource allocation of capital flow.

Since the first issuance of green bonds by the European Investment Bank (EIB) in 2007, the global green bond market has developed double (Chen & Zhao, 2021)^[18]. Green bonds can play a certain role in raising funds for environmental protection projects so that they can promote sustainable development (Naeem et al., 2021)^[19]. Ren et al.^[20] empirically analyze the influence of green investment and institutions on environmental pollution in terms of green investment. They found that China's environmental pollution has evident spatial dependence. Green investment negatively

affects local environmental pollution, but not a green investment in surrounding areas. In terms of evaluation and monitoring of green economy effects, Wu et al.^[21] note that the efficiency of China's regional green economy is slowly growing. Raising the productiveness of the area's green economy helps narrow regional differences and furnishes a theoretical rationale for developing the G-Economy. Xiong and Sun^[22] conclude that if endogenous demand factors such as green investment and green innovation are the necessary prerequisites between green finance and environmental damage, exogenous demand factors such as green insurance and industrial structure will play a supporting role. We suggest that the government and insurance companies jointly carry out new ecological insurance. Chen et al.^[23] propose integrating green insurance into the overall layout of local carbon neutrality and carbon peak.

At present, scholars at home and abroad have made outstanding accomplishments in the fields of green finance and economic growth. In the traditional theoretical analysis, scientists pointed out that G-Finance can accelerate green investments and thus promote economic growth. Overall flexible investment in waste treatment and the construction of urban environmental infrastructure may exceed 0.9 (Zhang and Gui., 2020)^[24]. Economic improvement, as well as clean energy consumption, are encouraged effectively by green investment (Wan and Sheng, 2021)^[25]. Luo et al.^[26] and Zhang et al.^[27] find that G-Finance can enlarge the scope of green investment and accelerate economic growth. Wang et al.^[28] show that green investment can advance the rise of green properties, boost economic growth, create new growth points and accumulate necessary economic development potential.

Based on the current research results, the available literature has made considerable progress in the state of growth and interfering factors of G-Finance. However, further improvements and extensions are needed. In the few published confirmative studies, a significant part of the articles focuses on green credit. However, the results of research and analysis are still inconsistent, which hampers the progress of research. On this basis, the present paper discusses the influence of G-Financial development on regional economic bloom on the basis of existing research results in order to enrich the literature, supply a foundation for the formulation of regional green financial policies and create a new empirical basis for the expansion of the G-Economy. Make proposals for the internal mechanism and the sustainable development of the green financial system.

3. DATA

3.1. Data sources and variable selection

This article chooses panel data of three provinces and one city in The Yangtze River Delta from 2011 to 2020

as research samples. The data used are from the National Bureau of Statistics, China Statistical Yearbook, China Provincial Statistical Yearbook, China Insurance Yearbook, etc.

In this paper, the per capita GDP of three provinces and one city in the Yangtze River Delta (ten thousand yuan) is chosen to represent the level of economic development and is represented by GDP PC. Most researchers use GDP or PER capita GDP to measure economic development in the existing literature. For the sake of judging the overall economy and people's living standards thoroughly, this paper uses GDP per capita (TEN thousand yuan) (GDP PC) to calculate according to the following formula, in which the unit is ten thousand yuan.

$$GDP = \frac{GDP}{total\ population} \quad (1)$$

In this paper, the green finance index of each province is selected to represent the development level of green finance and is expressed by GFI. The index is generally regarded as an essential statistical method to analyze the quantity change of social and economic phenomena. This indicator is often objective and easy to compare. In this essay, the entropy method is used to construct comprehensive indicators of green finance. The entropy method is an objective weighting method for comprehensive evaluation based on the dispersion degree of an index to reflect the relevant statistical data of the development level and change trend of G-Finance in a specific region or field over a while. The specific process is as follows:

First of all, each indicator is standardized:

Make positive indicators:

$$Y_{ij} = \frac{\max(X_{ij}) - X_{ij}}{\max(X_{ij}) - \min(X_{ij})} \quad (2)$$

Make negative index:

$$Y_{ij} = \frac{X_{ij} - \min(X_{ij})}{\max(X_{ij}) - \min(X_{ij})} \quad (3)$$

Among them, X_{ij} said the first j area of the i th indicators observed value; Y_{ij} stands for standardized value; $\max(X_{ij})$ indicates the maximum value of item I . $\min(X_{ij})$ indicates the minimum value of item I . Secondly, the information entropy of each index E_i is calculated:

$$E_i = -\ln(n)^{-1} \sum_{j=1}^n p_{ij} \ln p_{ij}, p_{ij} = \frac{Y_{ij}}{\sum_{j=1}^n Y_{ij}} \quad (4)$$

Finally, determine the weight of each index.

$$W_i = \frac{1-E_i}{n-\sum_{i=1}^n E_i} \tag{5}$$

W_i is the i th indicator weight.

The comprehensive index of green finance development can be obtained by multiplying each weight by the standardized value of each index. Where G represents the comprehensive index of green finance development; a_n represents the standardized value of each index; W_i indicates the weight of each indicator.

$$G = a_n W_i \tag{6}$$

In this paper, the control variable is the general financial expenditure of three provinces and one city (100 million yuan) represented by FE . Since fiscal expenditure acts on boosting economic development, most researchers in the existing literature adopt the size of local government, namely local fiscal expenditure, as a control variable (Helder and Adriana, 2022)^[29]. Therefore, this paper selects the local financial general expenditure as the control variable.

3.2. Model building

This paper uses G-Finance for testing the effect of G-Finance on economic growth.

Index (GFI) and fiscal expenditure (FE) are explanatory variables, and GDP per capita (GDP PC) are explained variables. The following Model I is constructed, as shown in formula (7).

$$GDP\ PC_{it} = \alpha_1 GFI_{it} + \alpha_2 FE_{it} + \mu \tag{7}$$

GDP PC represents per capita GDP; GFI stands for Green Finance Index; FE stands for general financial expenditure; α are coefficients; μ is the error term.

The Hausman test shows the result that the random effect model is evidently better than the fixed effect model. Therefore, this paper adopts a random-effect model to analyze panel data. Based on the above analysis and selected panel data, Model II is constructed, as shown in Formula (8).

$$GDP\ PC_{it} = \alpha_1 GFI_{it} + \alpha_2 FE_{it} + \mu_i + \varepsilon \tag{8}$$

Where i represent three provinces and one city, t stands for time. GDP PC refers to the per capita GDP of province i in the year t , GFI_{it} refers to the G-Finance index of the province i in the year t , and general fiscal expenditure of province i in the year t is FE_{it} . Both α_1 and α_2 are coefficients. μ_i represents the individual difference term, and ε represents the random disturbance term.

4. ANALYSIS OF EMPIRICAL RESULTS

4.1. Descriptive statistics

Descriptive statistics were analyzed for each variable to obtain their sample size, minimum, maximum, mean, and standard deviation, as shown in Table 1.

Table 1. Descriptive statistical results of major variables

Variable Name	Sample size	minimum	maximum	mean	standard deviation
GDP PC (GDP per capita)	40	27314.000	157279.000	83396.550	32740.958
GFI(Green Finance Index)	40	0.106	0.403	0.257	0.079
FE (Financial Expenditure)	40	3150.800	13682.500	6721.448	2610.901

The data show that among the three provinces and one city in the Yangtze River Delta region, the average value of GDP per capita is RMB 83,396.55, the average value of the Green Finance Index is 0.257, and the average value of the Green Finance Index value of local general fiscal expenditure is RMB 672.1448 billion. From the standard deviation of the three, the GDP per capita, green financial index, and local general fiscal expenditure differ significantly, indicating that the four regions in the

Yangtze River Delta region have different economic development and green financial development levels and government support.

4.2. Regression analysis of panel data

In this paper, the regression results of the RE model (Model II) using panel data are shown in the following table.

Table 2. The regression results of the RE model

	Model II
Variable	GDP PC
GFI	220463.191***
	(5.000)

FE	4.818**
	(4.511)
Intercept distance	-5719.810
	(-0.464)
Adjusted coefficient of determination	0.890

Note: *,**,*** indicates significant at the 10%, 5%, 1% level. And standard deviation is in parentheses.

From the data in the table, we know that the coefficient of GFI is significantly positive at the 1% level ($=220463.191$), which states that the level of G-Finance development has a positive and significant influence on the level of regional economic development. Through the effective and reasonable allocation of resources, the level of green technology and the development of green finance have improved the efficiency and structure of economic operation and have contributed to the regional economic development. This shows no difference from the conclusions of Wang et al.'s (2020)^[28] study.

In terms of local general fiscal expenditure, from the

data, its coefficient is significantly positive ($\alpha_2=4.818$) at the 5% level, expressing that fiscal expenditure has a certain positive driving influence on economic growth, but in this paper, this item is not elaborated too much as a control variable.

4.3. Grouping regression of different regions

In order to verify the effect of G-Finance on local economic development in Shanghai, Jiangsu, Zhejiang, and Anhui provinces, grouping regression was used to analyze the four groups of panel data, and the results are revealed in the table below.

Table 3. The regression results of Grouping regression

	Shanghai	Jiangsu	Zhejiang	Anhui
Variable	GDP PC	GDP PC	GDP PC	GDP PC
GFI	506260.557**	135267.201*	75489.033*	295532.090*
	(4.763)	(4.241)	(4.125)	(4.083)
FE	1.412**	9.743**	5.904*	3.596*
	(4.320)	(4.244)	(2.782)	(3.018)
Intercept distance	-17863.595	15422.345	28617.121	-19443.227
	(-1.596)	(0.931)	(1.453)	(-1.790)
Adjusted coefficient of determination	0.962	0.986	0.937	0.932

Note: *,**,*** indicates significant at the 10%, 5%, 1% level. And standard deviation is in parentheses.

According to the data in the table, at the 5% level, the COEFFICIENT of GFI in Shanghai is significantly positive ($\alpha_1=506260.557$); at the 10% level, the coefficient of GFI in Jiangsu, Zhejiang, and Anhui is also significantly positive, indicating that green finance has a significant positive effect in accelerating the economic rise of the four regions. Nevertheless, due to the different geographical environment, economic base, industrial structure, and consumption levels are different, the coefficient of GFI, Shanghai GFI coefficient value maximum, minimum, Zhejiang province, shows that Shanghai green finance in Shanghai some more significant influence on the development of the economic

level, it also has a relationship with Shanghai itself developed financial sector. However, the GFI coefficient of Zhejiang province is lower, which may be because Zhejiang has other industries to promote economic growth, and the proportion of G-Finance is not so high.

4.4. Robustness test

The robustness of the model was tested using the method of replacing the explanatory variables with disposable income per capita and expressed by DI PC to construct Model III and perform panel data regression, which yielded the results shown in the table below.

Table 4. Robustness test results

	Model III
Variable	DI PC
GFI	96752.693**

	(5.139)
FE	2.799**
	(6.087)
Intercept distance	-1723.599
	(-0.417)
Adjusted coefficient of determination	0.927

Note: *,**,*** indicates significant at the 10%, 5%, 1% level. And standard deviation is in parentheses.

As can be shown from the data in the table, the descriptive variables of the model still show a significant positive relationship after the explanatory variables are replaced, which proves that the conclusions of this paper have high robustness.

5. CONCLUSIONS

As an exemplary region in China's economic construction, the Yangtze River Delta region is one of the first regions to implement green finance. This paper aims to study the influence of the level of G-Finance development in this region on the regional economic level. Using panel data, a regression model is established to conclude that the level of G-Finance in the Yangtze River Delta region increased year by year from 2011 to 2020 and had a significantly positive influence on the rise of the regional economic level.

In addition, from the regional grouping regression results, green finance positively promotes the economic development of the three provinces and one city. The effect is the largest in Shanghai and the smallest in Zhejiang Province. Therefore, vigorously developing green finance and promoting the transformation of economic structure is not only a kind of protection for the ecological environment but also can inject momentum into the sustainable development of the economy.

6. POLICY COMMENTS

China has initially built a relatively complete G-Financial system structure. Various green financial products have formed a specific scale to advance the construction of G-Finance in China. At the same time, China also encourages enterprises to animatedly participate in implementing G-Finance. With the help of policies, continuously increase the innovation of green financial instruments and expand pilot projects' scope. The government will pay more attention to the construction of G-Finance with the growth of the economy, and G-Finance will also get more space for development in China. Based on this, and combined with the above study findings, the following policy recommendations are raised in this paper:

On one side, efforts should be made to publicize green ideas and boost the rapid development of G-Finance. From the government's perspective, it is significant to

carry out the top-level design of the green finance system in an overall way and effectively guide and advance the development of G-Finance from the aspects of the standard system, institutional system, and legal system, and market system. For example, we should bring into great play the leading role of fiscal policies and lead more social funds to flow into green industries by utilizing financial subsidies and credit guarantees to accelerate the circulation of G-Finance. We will build a G-Finance information sharing platform, speed up the construction of relevant laws and regulations, standardize green finance business, and further reduce green enterprises' financing and information costs. From the perspective of financial inter-mediation, first, actively implement policies related to green finance and shoulder corporate social responsibility bravely. We will follow the policy direction and strictly control the flow of funds. Second, we will continue to promote innovation in green financial products. With the rapid economic development, existing green financial products cannot meet social needs. Therefore, diversified green financial products should be created, and the entry threshold of traditional green financial products should be appropriately lowered. Third, establish a green fund tracking system to track the flow and use of each green fund, improve the efficiency of the use of green funds, and achieve a rational allocation of green resources. From the perspective of micro-enterprises, it is necessary to strengthen green consciousness, shoulder social responsibility, carry out self-restraint, make reasonable use of green funds and raise the use efficiency of funds.

On the other side of the shield, different green financial policies are implemented according to regional characteristics. For economically developed areas, we should ensure the implementation of green finance policies. Simultaneously, we should emphasize the development of G-Finance and adhere to the road of green development. For economically developing areas, we should reduce dependence on infrastructure construction and real estate, enhance green awareness, increase G-Finance, expand the scope of G-Finance services, and achieve green development.

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