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The Coupling and Driving Effect of Financial Technology and Green Venture Capital

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Abstract: The "supply side" of financial technology is coupled with the "demand side" of green venture capital development, which has played a guiding role in technological change and industrial upgrading and will promote great changes in the financial industry. As an important part of the financial industry, green investment has high-risk characteristics, and financial technology plays a key role in reducing the risk of green investment. In this paper, firstly, by extracting the data of 31 provinces, municipalities, and autonomous regions from 2013 to 2020, the measurement system of financial technology and green venture capital is constructed, and then the regression model is constructed to empirically analyze the relationship between financial technology and green venture capital, and the robustness test and the calculation of coupling degree are carried out. Finally, based on the analysis results, some feasible suggestions are put forward in order to improve the coupling degree between financial technology and green venture capital.

Keywords: Financial technology; Green venture capital; System coupling; Fixed effect; Panel Data.

1. Introduction

The report of the 19th National Congress pointed out that we must unswervingly implement the development concept of innovation, coordination, green and sharing. The "Thirteenth Five-Year National Science and Technology Innovation Plan" proposes to promote the innovation of products and services in technology and finance, and the combination of science and technology and finance is closer. Therefore, it is particularly important to study the coupling between financial technology and green venture capital, mainly in the following aspects:

First, by selecting different indicators and making an empirical analysis by constructing a model, we can compare the differentiated influence of financial technology level in different regions on green venture capital.

Second, the advantages of financial technology are in line with the bottleneck of green financial investment. Financial technology improves the ability of enterprise risk identification, reduces the excessive cost caused by information asymmetry between the two parties, and finally improves the operating efficiency of the whole system.

Third, financial technology has increased the proportion of government and enterprises' investment in green enterprises. Because of the original scale of foreign investment, financial technology has reduced the cost of enterprise investment. Compared with the original enterprises' real investment in green enterprises, the proportion of funds has increased, bringing greater economic and environmental benefits, and forming a virtuous circle.

2. Literature Review

The research on financial technology and green venture capital at home and abroad mainly focuses on the development of green finance driven by financial technology and direct research on "green financial technology". With the increasing attention paid by scholars to both, their research mainly focuses on the following aspects:

First, research on the coupling between financial technology and green finance. For example, Hu Ying (2020) selects the data of 31 provinces, cities and autonomous regions in the country from 2014 to 2019 to analyze, and uses fixed effect model to empirically study the driving effect of block chain on green finance[1]; Xue Chang (2023) found through theoretical analysis that financial science and technology can break through the structural barriers of the transition from traditional economy to green economy and play a catalytic role in the development of green finance[2]; Zhu Jiaming et al (2020) calculated the coupling degree between financial agglomeration and ecological efficiency and the coupling coordination degree after optimization based on the coefficient of variation method, and found that the coupling coordination degree of the two systems is continuously increasing [3]; Zhang Wei et al (2022) found that financial science and technology, with big data, block chain and artificial intelligence as the underlying technologies, has great advantages in reducing the cost of identifying green projects and effectively managing the use of funds for green projects[4], and has become an effective means to prevent the risk of "greenwashing". Cristina Chueca Vergara et al. (2021) analyzed the relationship between financial technology and sustainability through literature review and case study, and concluded that financial technology can make financial business more sustainable by promoting green finance[5]; Liu Zhiyang et al (2022) found that financial science and technology serves green finance through data information recording and disclosure, financial capital formation for green investment, risk management and financial governance [6].

Second, the research on the driving factors of green venture capital. For example, Tao Cen et al (2018) took Ant Financial Services as an example to explain the promotion role of financial technology in inclusive green investment[7]; Qiao Qin et al (2021) based on the analysis of the spatial and temporal distribution characteristics and influencing factors of venture capital in 139 cities along the "the belt and road

initiative" in China from 2003 to 2018[8], using the spatial analysis method and spatial measurement model, found that the number of venture capital institutions, the number of national high-tech zones, the withdrawal of venture capital, the government-led fund development and the financial and technological expenditures have significant promotion effects on regional venture capital; Robyn Owen et al. (2018) et al. found that government policies play a key role in solving the financing gap of long-term low-carbon investment demand and encouraging green investment [9]; Li Lingyu (2020) points out the significance of policy orientation and cultural atmosphere to green investment by constructing the theoretical framework of corporate green investment driving mechanism and realization path [10].

3. Research Design and Results

3.1. Model setting

3.1.1. Financial Technology Development Score Calculation

According to the research thinking, the purpose of this part is to obtain quantitative criteria for evaluating the development degree of financial science and technology. As the measurement index is a system, the selection of the weighting method is particularly important. Information entropy refers to the concept of entropy in thermodynamics and is used to describe the average amount of event information, i.e. the expectation of the amount of information contained in an event. The entropy method is characterized in that the information given by the decision matrix is directly used to calculate the weight without introducing the subjective judgment of the decision maker, and has theoretical basis. Compared with the subjective weighting, the entropy method has higher reliability and accuracy. In addition, the entropy method is relatively simple to calculate, and can reflect the difference of indicators, and then determine the weight. It is also more reasonable to choose the entropy method from the perspective of the data characteristics in this paper. The specific process is as follows: firstly, the original data matrix is established according to the selected indicators; Secondly, the extreme value method is used to standardize the original matrix, so as to eliminate the possible deviation caused by the attributes such as the order of magnitude of the index and the dimension, thus obtaining a standardized matrix; Then, a "0" value will appear after the data is normalized, and the normalized data is further translated and normalized; Finally, the information entropy and difference coefficient are calculated based on the matrix, and then the weights of each index are determined. The calculation formula is:

$$p_{ij} = x_{ij} / \sum_{i=1}^{n} x_{ij}, e_j = -k \sum_{i=1}^{n} p_{ij} Inp_{ij}, k = 1/Inn$$

Where x_{ij} is the normalized value of each index; e_j is the entropy value. The weight $s_i = (1 - e_j) / \sum_{j=1}^{p} (1 - e_j)$, the score is $\sum x_{ij} s_j$, the value range is (0,1), the closer to 1, the better the degree of development.

3.1.2. Coupling coordination model

This paper uses the panel data of each province from 2014 to 2019 to introduce the time series three-dimensional data factor analysis, constructs the financial technology-green venture capital coupling model, obtains the coupling value of the two systems from 2014 to 2019, and uses the statistical analysis method to analyze the obtained results, and obtains the conclusion. At the same time, for different regions, the relevant financial science and technology-green venture capital coupling value is calculated, and the causes of regional differences are obtained through statistical analysis. The basic model is as follows:

$$\begin{cases} D = (C \cdot T)^{1/2} \\ T = \alpha U_1 + \beta U_2 + \cdots + \omega U_t \end{cases}$$

Where D is the degree of coupling coordination between each subsystem, the value range is (0,1), $\alpha, \beta \ldots \omega$ is the undetermined coefficient, and $\alpha + \beta + \cdots + \omega = 1$; U_i represents the contribution of the i-th subsystem to the overall order degree; C is the coupling degree, and the specific calculation formula is:

$$C = \sqrt{a_{1i}(x) \cdot a_{2i}(x)} / a_{1i} + a_{2i}$$

a_{1i} and a_{2i} respectively represent the comprehensive development level of financial science and technology and green venture capital. The value range of coupling coefficient C is [0,1]. The greater the coupling coefficient, the higher the coupling degree of financial science and technology and green venture capital, the stronger the interaction relationship, and the coordination and order among the systems.

3.2. Variable Selection and Data Description

We have established a financial science and technology index system as shown in Table 1.

Table 1. Financial science and technology index system table.

Variable name	Subindex	Indicator representation mode
Fintech	Government financial expenditure	Financial expenditure on science and technology/finance
	Science and technology loans from financial institutions	Loans from financial institutions /GDP
	Technology and finance environment	Full-time equivalent of R&D personnel/total population

The weight of development index calculated by entropy method is 0.067, 0.068 and 0.065 respectively. In order to study the general situation of the coupling and coordinated development of financial science and technology and green venture capital systems, firstly, we divide the coupling types and coordination levels in Table 2.

Table 2. Coupling level range.

Coupling factor	Range	Rank
Low coupling	0.00~0.09	Extreme disorder
	0.10~0.19	Severe disorder
	0.20~0.29	Moderate disorder
Antagonistic stage	0.30~0.39	Mild disorder
	0.40~0.49	On the verge of disorder
Running-in stage	0.50~0.59	Basic coordination
	0.60~0.69	Primary coordination
	0.70~0.79	Intermediate coordination
High coupling	0.80~0.89	Good coordination
	0.90~1.00	Quality coordination

In addition, for green venture capital, this paper defines green venture capital as venture capital invested in new energy, new materials, and environmental protection industry with reference to Jiang Hong-li et al. [11] (2020), referred to as green venture capital. The data is from the private equity database in Zero2IPO Group. The venture capital of the above three industries will be matched to each province based on the registered places of the invested enterprises by year, and the

green venture capital data for 2014-2019 will be obtained. For the data of missing years, multiple interpolation method is used for interpolation.

Based on the above model, the coupling degree and coordination level of financial science and technology and green venture capital systems of major provinces and cities in China from 2014 to 2019 are calculated by collecting relevant data. The calculation results are as Table 3.

Table 3. Coordination Degree and Coupling Degree Results of China's Financial Technology-Green Venture Capital System from 2014 to 2019.

Age	Coupling factor	Coupling state	Coordination degree	Coordination status	Fintech level	Green venture capital level
2014	0.49	Antagonistic	0.36	Medium	0.47	0.5
2015	0.49	Antagonistic	0.41	Medium	0.49	0.58
2016	0.49	Antagonistic	0.42	Medium	0.51	0.62
2017	0.49	Antagonistic	0.47	Medium	0.51	0.66
2018	0.50	Antagonistic	0.51	Higher	0.54	0.68
2019	0.51	Running-in	0.58	Higher	0.56	0.69

By calculating the coupling degree, coordination degree and the development level of financial science and technology and green venture capital, it can be found that the coupling degree of financial science and technology and green venture capital in China is on the rise, and reached a higher level in 2018, which reflects the gradual realization of coordinated development after a period of grinding [11].

From 2014 to 2019, the development level of green venture capital has been higher than that of financial science and technology. It is influenced by environmental factors and policies. The concept of green development is deeply rooted in the hearts of the people. At the same time, China's economic development has entered a new normal, and the economic growth rate is gradually slowing down, which to a certain extent limits the development of financial science and technology. With the release of the "General Plan for the Reform of Ecological Civilization System" by the State Council in September 2015, the top-level design of the reform in the field of ecological civilization in our country has been carried out and the green financial system strategy has been put forward for the first time. In August 2016, the Central Bank, the Ministry of Finance and other seven ministries jointly issued the "Guidance on the Construction of a Green Financial System", which clarified the definition, incentive mechanism, development direction and risk monitoring measures of China's green finance and established the top-level framework system of China's green finance. Thanks to these policies, the coupling degree and coordination level of China's financial science and technology and green venture capital increased from the antagonistic coupling and moderate coordination level in 2014 to the running-in coupling and higher coordination level in 2019 respectively. With the continuous improvement of relevant policies, the development of financial science and technology will strongly promote the development of green venture capital and form a high level of coordination.

By calculating the Person correlation coefficient between the development level of green financial technology and green venture capital is 0.936, which is a highly positive correlation. It shows that the continuous development of financial technology can effectively promote the development level of green venture capital. At the same time, combining the coupling degree and coordination of the two systems, it can be found that the correlation level between the two systems is high, and the two systems show obvious synchronization, indicating that financial technology is the key to affect green venture capital.

In order to further clarify the evolution trend and system development of the coupling degree between the two systems, we further calculate the coupling degree between financial technology and green venture capital in 2014-2019 by distinguishing the eastern, central and western regions, as shown in Table 4.

Table 4. Coordination Degree and Coupling Degree Results of Financial Technology-Green Venture Capital System in Three Major Regions of China from 2014 to 2019.

Age	2014	2015	2016	2017	2018	2019
Eastern coupling	0.30	0.50	0.60	0.70	0.77	0.81
Central coupling	0.17	0.20	0.28	0.32	0.40	0.50
Western coupling	0.14	0.18	0.20	0.25	0.31	0.40

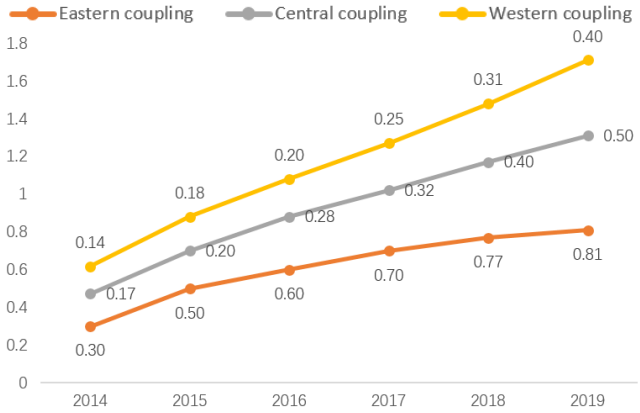


Figure 1. Evolution of Coupling Degree between Financial Technology and Green Venture Capital in Three Major Regions of China from 2014 to 2019.

Figure 1 shows the coupling of the two systems in three major regions of China from 2014 to 2019. From the time perspective, the coupling degree of the three regions and two systems in China showed obvious synchronization from 2014 to 2019, and increased year by year, indicating that financial technology is the key to the development of green venture capital. From a spatial point of view, regions with higher levels of financial science and technology development have higher degree of coupling and coordination among systems, and vice versa, indicating that the imbalance in financial science and technology development among regions in China is the key factor that causes the difference in coupling and coordination between the two systems in each region. In recent years, the development level of green finance in various regions has been improved. The development of financial technology enables green finance and promotes the development of green venture capital. However, it can be seen from the figure that with the enhancement of coupling degree,

the greater the difference in coupling degree between regions, indicating that the problem of unbalanced regional development is increasingly prominent and the regional difference in financial science and technology level has increased.

4. Conclusions and Recommendations

This paper investigates the development trend of green venture capital and financial science and technology in China from the macro perspective of system coupling. Based on the panel data of 31 provinces (cities) in China from 2014 to 2019, the fixed effect panel data model is constructed, the index system of green venture capital and financial science and technology is established, the relationship between the two is empirically analyzed, and the coupling development trend of financial science and technology-green venture capital is analyzed from a macro perspective. Based on this, the problems existing in the development of the two systems in China are found, the conclusions are drawn and the corresponding countermeasures are put forward.

First, from 2014 to 2019, the development of China's financial science and technology and green venture capital systems was in an antagonistic coupling state, but the coordination degree between the two systems showed a gradual upward trend during the same period, gradually developing from near-maladjustment to moderate coordination, and the gap between the two systems began to narrow around 2016.

Second, in the two systems, the obvious lag of financial technology is the key to the long-term antagonistic coupling between the two systems. At this stage, funds should be directed to the financial science and technology field represented by the block chain, to increase the enterprise risk identification ability, reduce the risk of venture capital, and increase the investment confidence of investors, in order to promote the further development of green venture capital, and promote the high-quality coordinated development of financial science and technology and green venture capital.

Thirdly, from a time perspective, the coupling degree of the two systems in the three regions in China increased year by year from 2014 to 2019; From a spatial perspective, the difference in green coupling between regions has been increasing with the passage of time. The difference in financial science and technology-green financial coupling between regions is large, and the imbalance in regional development has become increasingly prominent.

Therefore, the government should attach importance to and promote the development of financial science and technology, improve the quality of financial science and technology supply, create a good innovation environment through guiding policies, and encourage financial markets and financial institutions to allocate more funds to the field of financial science and technology. Financial science and technology can make use of its advantages in information and coordination brought by its technological advantages such as decentralization to bring more sufficient funds and innovative financial products and services for green risk investment.

Conflict of interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

Data availability

The data used to support the findings of this study are included within the article.

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