



Study on the Development Path of Green Finance to Support Low-carbon Economy Based on Neural Network Model

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Abstract. Promoting high-quality economic development and improving the ecological environment is China's development goal. Continuously promoting green financial practices, guiding and leveraging financial resources to lean towards low-carbon industries, and promoting energy conservation and emission reduction are important guarantees for achieving the "dual carbon" goal. At present, the research on finance, economy and environment focuses more on the specific impact of finance on the ecological environment and the relationship between green finance and economic growth. The scope of research is basically limited to the real economy and the research topic is generally a one-way impact of a variable. There is a lack of research on green finance to support the dynamic development of low-carbon economy from an economic perspective. To this end, this paper adopts the method of literature and data analysis, calls the corresponding data from the database, preprocesses and cleans the data, and calculates the relevant index, including Growth Rate of Credit Balance, Green Financial Credit Balance Month on Month Growth based on SPSS, quantifies the content of the analysis in the form of data, and finally analyzes the green finance to support the status quo and solve existing problems of low-carbon economic development using Neural Network Model. Through analysis, this paper finds that there are such problems as incomplete green financial policies and regulations, perfect green financial products, perfect environmental information disclosure system, and unclear role of government and market. Finally, this paper proposes strategies such as improving green finance laws and regulations, innovating products and services, correctly handling the relationship between the government and the market, and clarifying the division of labor among various entities, which is conducive to better realizing the contribution of green finance.

Keywords: Green Finance; Low Carbon Economy; Double Carbon; SPSS; Database; Growth Rate of Credit Balance; Green Financial Credit Balance Month on Month Growth; Neural Network Model.

1 Introduction

Green finance refers to a financial business that combines direct and indirect financing to make reasonable use of ecological resources and achieve economic development and environmental protection. One of the effective policy tools is green finance. On the one hand, green finance is to allocate limited financial resources to industries with lower energy consumption and emission levels. On the other hand, it is to promote the development of environmental protection and energy-saving technologies[1]. Low-carbon economy is a new development model that reduces energy consumption, emissions and pollution and achieves sustainable development through technological progress, industrial transformation and the development of clean energy. The development speed and scale of low-carbon economy will affect the overall quality of economic development. Green finance can play a positive transmission role, guide and leverage financial resources, support carbon capture, utilization and storage technology projects, and promote the sustainable development of low-carbon economy.

2 Analysis of the Current Situation of Green Finance

2.1 Continuously Increasing Green Finance Investment in Low-carbon Economy

Table 1. Green credit balance and growth rate of 21 listed banks in China from 2013 to 2020

Year	Green Credit Balance (RMB 100 million)	Growth Rate of Credit Balance (%)
2013	5.41	---
2014	6.01	11.11
2015	7.01	16.64
2016	7.79	11.13
2017	8.66	11.19
2018	9.68	11.78
2019	10.22	9.86
2020	11.95	16.93

Data source: China Banking and Insurance Regulatory Commission¹

Growth Rate of Credit Balance can be calculated by the formula:

$$\text{Growth Rate of Credit Balance} = \frac{\text{Increment}}{\text{Green Credit Balance}} \times 100\%$$

As we can see from the above table 1, Green Finance in the low-carbon economy continues to increase. By the end of 2020, China's outstanding green loans reached 12 trillion yuan, ranking first in the world, and its stock of green bonds reached 813.2

¹<http://www.cbirc.gov.cn/cn/view/pages/Item-List.html?itemId=926&itemName=%E6%94%BF%E7%AD%96%E6%B3%95%E8%A7%84&itemPid=923&itemUrl=ItemListRightMore.html>

billion yuan, ranking second in the world. Outstanding green credit at China’s 21 major listed banks has been increasing, from 5.41 trillion yuan in 2013 to 11.95 trillion yuan in 2020 (see chart 1). The annual growth rate of green credit has remained at around double digits, most notably in 2015 and 2020, when the growth rate exceeded 15%. Since 2018, the People’s Bank of China has strengthened its assessment of the performance of green finance. In 2019, China’s outstanding green credit exceeded 10 trillion yuan for the first time. Although China’s green bond started late, it developed rapidly. From 2015 to 2019, the scale of green bond issuance increased year by year, with the issuance exceeding 200 billion yuan in all years except 2015. China’s new outstanding green bonds hit a record high of \$34.989 billion in 2017, accounting for about half of the total outstanding green bonds[2]. Meanwhile, the volume of labeled green bonds reached \$38.246 billion in 2017, up 23 percent from 2016. In 2018, China issued a total of 282.6 billion yuan of green bonds in domestic and overseas markets, an increase of 12 percent compared with 2017, accounting for 18 percent of global green bonds and ranking second among green bond sources. By the beginning of 2021, China had issued more than 1.2 trillion yuan of green bonds, one of the largest in the world. As shows in the Figure 1:

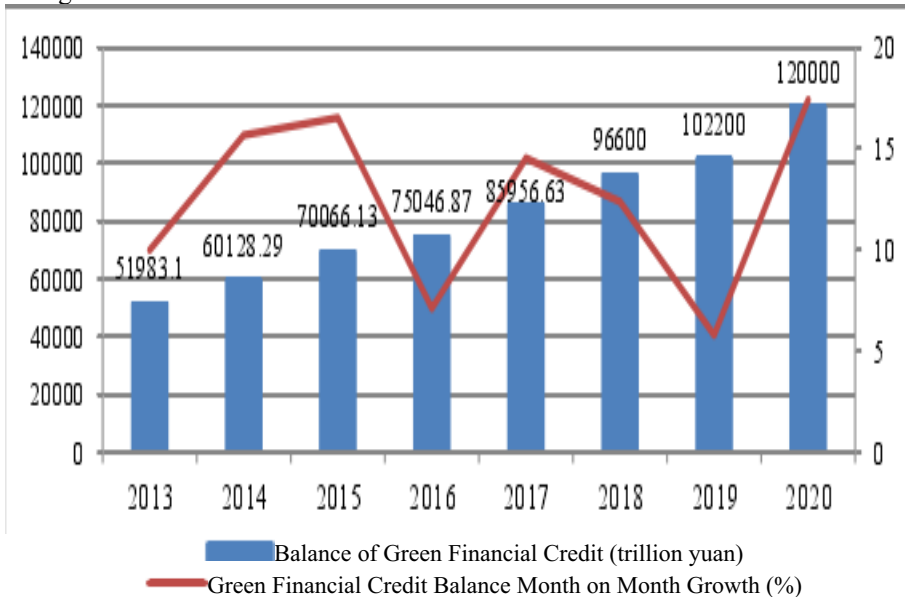


Fig. 1. Green finance in the low-carbon economy continues

Green Financial Credit Balance Month on Month Growth can be calculated by the formula:

$$\frac{\text{Green Financial Credit Balance Month on Month Growth Increment}}{\text{Balance of Green Financial Credit}} \times 100\%$$

After calculation based on SPSS, the following table can be obtained:

Table 2. Balance of Green Financial Credit and Green Financial Credit Balance Month on Month Growth

Year	Balance of Green Financial Credit (trillion yuan)	Green Financial Credit Balance Month on Month Growth (%)
2013	51983.1	---
2014	60128.29	15.67
2015	70066.13	16.53
2016	75046.87	7.11
2017	85956.63	14.54
2018	96600	12.38
2019	102200	5.80
2020	120000	17.42

As we can see from the table 2, green credit is the earliest green financial product. It now the ratio of more than 90% of the existing green financial instruments in our country has relatively mature operation mode[3]. By the end of 2020, China's outstanding green credit was about 12 trillion yuan, ranking first in the world. It is not difficult to see from the above chart that the balance of green credit in our country has shown a steady rising trend in recent years, with the growth rate basically maintaining at 5%-18%.

2.2 Gradually Clear Green Finance Positioning under the Low-carbon Economy

Green finance is mainly invested in seven aspects of low-carbon economy, including energy conservation, ecological protection and climate change adaptation, resource conservation and recycling, pollution prevention and control, clean energy, clean transportation and working capital supplement, and it is developing in a diversified, multi-level and multi-field direction. As it shows in the figure 2:

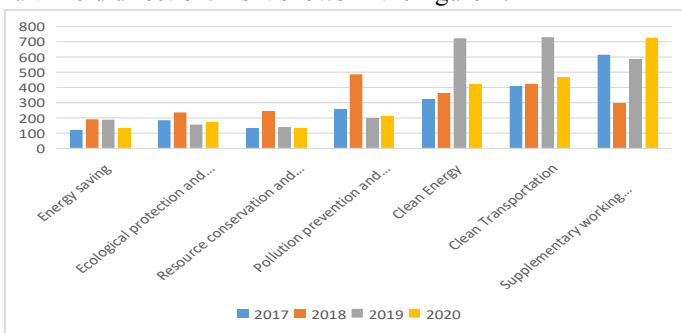


Fig. 2. 2017-2020 China Green Bond sub-low-carbon economy investment (Data source: Wind Database²)

²<https://www.wind.com.cn/portal/en/EDB/index.html>

By the end of 2020, green transportation, renewable resources, energy conservation and environmental protection projects are the largest in terms of loan balance and growth scale. Green bonds provide a new way of financing for enterprises[4]. As can be seen from the capital investment of China’s green bonds in low-carbon economy from 2017 to 2020, clean energy, clean transportation and pollution prevention and control accounted for the largest proportion of capital investment, especially in 2019, accounting for 26.04%, 26.01% and 12.73% respectively. Investment in supplementary working capital or other aspects also accounts for a large proportion, mainly because other aspects include many small areas. In 2017 and 2018, the combined share of clean energy, clean transportation and pollution prevention and control also exceeded 50 percent, and in 2019, clean transportation accounted for the largest share. Because with the continuous improvement of the green finance market, the issued green ABS include green income rights, green leases, green accounts receivable, green enterprise loans and affordable housing and other asset classes[5]. These products are directly or indirectly invested in green and low-carbon projects. For example, the largest green revenue bonds include electricity charges from renewable energy sources such as wind power and photovoltaic, sewage treatment charges, and the right to benefit from green travel. The first national Green Investment Fund will play the leading role of government funds and guide private capital to support low-carbon sectors such as environmental protection, pollution prevention, clean transportation and natural energy. See the figure 3 :

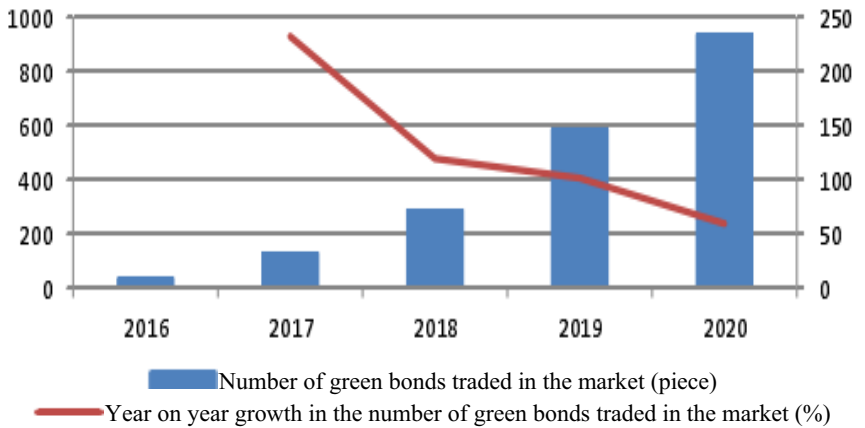


Fig. 3. 2017-2020 China Green Bond sub-low-carbon economy investment (Data source: Wind Database³)

Although practice of green bond is late than that of many developed countries, its embryonic form is growing quickly in our country. But growth has slowed in recent years. At present, the development level of green bond market in our country has been advanced in the world. At present, the number of transactions in the market is nearly 1,000, and the stock exceeds 800 billion yuan, ranking second in the world.

³<https://www.wind.com.cn/portal/en/EDB/index.html>

2.3 Enriching the Categories of Green Finance under the Low-carbon Economy

In recent years, China's green finance market has been expanding with increasingly diverse products. Among them, green credit and green bond are located at the base of the pyramid of green finance, with the largest amount of investment in the market, the most significant effect and the most stable. They are the main products of green finance. China's green bonds are mainly financial bonds, corporate bonds and corporate bonds, with an investment term of 1-5 years. In addition to green credit and green bonds, green insurance and green leasing are also making continuous efforts. In 2019, China launched nearly 60 green finance products, expanding the service areas of green finance and improving the service quality of green finance[6]. Green insurance is an insurance plan related to environmental insurance, mainly used to deal with environmental pollution, energy replacement, ecological damage and other problems. The biggest feature of green leasing is that it can make reasonable and efficient use of assets and make full use of existing assets while developing economy, which is conducive to mutual promotion and common development of economy and environment. Green finance is a product that converts part of green credit into securitized assets. Its appearance provides an important way for green infrastructure financing and has become one of the key contents of green finance cooperation between China and Western countries.

2.4 Nascent Green Finance Market under the Low-carbon Economy

At present, China's green finance market has basically formed the situation of "five pillars". In terms of the standard system of green finance, China has accelerated the construction of a market system. In 2020, China's first national standard system of green finance was formally approved and applied to the market. In terms of information disclosure and financial regulation, various work has been strengthened, with clearer information points that must be disclosed, more standardized information disclosure, and greater transparency in the green financial market. In the aspect of green finance performance evaluation, the government has supplemented and improved the original green credit evaluation. In terms of green financial products and services, China has initially formed a green financial market system with a reasonable structure and various levels, and all kinds of green financial products and services are developing together to enhance their market competitiveness. In terms of the international market of green finance, China's international cooperation in green finance is becoming increasingly mature, and it actively uses various multilateral and bilateral platforms to strengthen exchanges and cooperation with other countries. Integrating green finance into the development strategy of low-carbon economy can reduce the conflict between economic development and environmental protection to a large extent. Especially in the context of urgent market demand, high pollution, high energy consumption, high emission industries such as ceramics, cement technology innovation, reduce excess resource consumption and unnecessary pollution emissions, product quality has been improved accordingly[7]. And the original low-carbon environmental protection industry will also

get more rapid development, whether in the market development, or in the efficiency improvement, will get a qualitative improvement.

2.5 The Construction of Genetic Algorithm Optimizing Neural Network Model⁴

BP (Back Propagation) neural network is a multi-layer feed-forward network model based on the error-reverse propagation algorithm, which consists of three layers: input layer, hidden layer and output layer. The model continuously adjusts the weights and thresholds of the network by transmitting signals between the topological nodes of the neural network forward and the error between the topological structures backward, so that the error of a single sample decreases accordingly, and finally the total error E tends to be the smallest, and its formula is as follows:

$$E_k = 1/2 \sum_{j=1}^M (d_j - Y_j)^2$$

$$E = \sum_{k=1}^K E_k = 1/2 \sum_{k=1}^K \sum_{j=1}^M (T_j^k - Y_j^k)^2$$

Among them, E_k is the training sample error, M is the number of units in the set output layer, d_j is the target value of the training sample for unit j , Y_j is the output value of the training sample, and E is the total error calculated by the neural network.

The prediction of urban green finance by BP neural network includes two parts: training and testing. The steps are as follows: first learn through training samples, store network weights and threshold information, then input testing samples, and compare its predicted output with The actual output is compared and tested.

3 Problems

The framework system of green finance is constantly improved, the policy system is increasingly optimized, the market scale is constantly expanded, the total number of products continues to increase, the services are gradually enriched, and the environmental benefits are increasingly significant. However, there are still some problems in terms of policies and regulations, product scale, information disclosure, government and market responsibilities.

⁴Zhang Yifan, Dong Xiaohong, Wu Jingquan. Measurement of Green Finance Development Level in Guangdong Province ——Research of Neural Network Model Based on Genetic Algorithm Optimization [J]. Journal of Foreign Trade and Economic Cooperation,2018(10): 95-101.

3.1 Imperfect Environmental Information Disclosure System

At present, there are many problems and deficiencies in the application of computer big data, which need to be perfected and improved by relevant technicians. Among them, one of the most prominent problems is that the efficiency of data collection cannot meet the needs of practical applications. Therefore, technical personnel must find feasible schemes and technologies to further improve the current data collection technology, so as to effectively improve the efficiency of data collection. However, due to the great differences in the types and formats of information in the process of collection, information collection becomes quite complicated. Therefore, technical personnel must take the information format as the starting point, constantly optimize and improve the information collection technology, and ensure that all types of information data can achieve the collection function through similar collection technology, which can greatly reduce the information collection engineering Difficulty, so as to improve the efficiency of information collection[8].

In this era of high velocity and high development, the storage needs of computers increase. But when the corresponding hardware and software are upgraded. Therefore, computer designers combine computer hardware technology and software equipment application into a new science. People from all walks of life in the world, professionals are studying this subject. The demand for talents is extremely urgent, and a large number of engineers and experts are needed to jointly solve the research and development of computer software design. Because the data is too big, the development of computer hardware also has a certain limit, when this limit reaches a critical point, then a new computer technology is born, which is the inevitable result of the development of computer, people painstakingly study and then there is a new technology -- "cloud technology", this technology can store and calculate massive data. At the same time, he also has a huge arithmetic mechanism to deal with the cumbersome data.

3.2 Unclear Role of Government and Market

The main responsibility of the government is the regulation of green finance and the construction of green finance infrastructure. The establishment of sound green finance infrastructure by the government is conducive to the market playing its own role. The green finance standard of the nature of public infrastructure is the basis of green certification or green rating, the former belongs to the government responsibility, the latter belongs to the market behavior. The establishment of professional green investment institutions is mainly an act of market entities, and the establishment of relevant professional institutions cannot be separated from the supporting support of financial policies. The risk management system is the responsibility of both the government and financial institutions and enterprises. It is the responsibility of the government to prevent regional and systemic green finance risks, while it is the responsibility of financial institutions and enterprises to disperse and control green risks of projects. The responsibilities of the government and the market intersect and the boundary is unclear, resulting in inefficient and ineffective.

4 Development Path for Green Finance to Support the Development of Low-carbon Economy

4.1 Innovating Green Financial Services

At the present stage, green bonds and green credit can provide financial support for green and low-carbon industries by guiding the capital flow, so as to achieve the concentration of funds in the green and low-carbon industries in a short period of time. With a strong economic base, the green and low-carbon industry is developing rapidly. Carbon finance has just started, and its role is relatively weak. It mainly uses the funds raised for green transportation and clean energy, but it will gradually grow and mature as time goes by. The green insurance rate is directly affected by the enterprise's environmental risk probability. If the enterprise's environmental risk rate is high, its green insurance rate will be correspondingly higher. In order to pursue high profit targets and reduce production costs, enterprises will reduce environmental risks as much as possible[9]. Therefore, the path of green insurance improves enterprises' awareness of environmental risks, enhances their awareness of prevention, and enterprises intensify low-carbon efforts, actively carry out projects with low consumption, low pollution and low emission, thus promoting the development of China's low-carbon economy. Production equipment is the foundation. If traditional industries with high consumption, high pollution and high emission want to complete the transformation of low carbon and environmental protection, they should first start from upgrading production equipment, eliminate aging and backward machinery and equipment, and purchase energy-saving and environmental protection equipment.

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This process will cost enterprises a lot of capital, resulting in some enterprises unable to transform due to the cost of transformation, and fall into financial difficulties[11]. Green leasing provides a solution for these enterprises. Enterprises can use energy saving and environmental protection equipment by means of financial leasing. They will not fall into financial difficulties while completing the transformation of enterprises, which is conducive to the development of low-carbon industry and thus promote the energy saving and emission reduction of the whole society.

5 Conclusion⁵

To sum up, low-carbon economy is the only way for the sustainable development of society. Promoting the development of low-carbon economy through the development of green finance is a trend in the future. However, the development of green finance under the current low-carbon economic development is facing a series of problems, such as green finance has not yet formed a system, and has not yet established corresponding laws and regulations on the development of green finance, etc., which have largely hindered the development of green finance development. Therefore, in the future, we should focus on solving the problems in the process of green finance development. To solve the problems we are facing, it is high time that we build a complete system and continuously innovate related technologies, establish laws and regulations related to the development of green finance, to provide support for low-carbon economy and green finance and create the right conditions for mutual development.

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