

The Relations Study on Green Finance and Upgrading of Industrial Structure in China - Based on Grey Correlation Analysis Model

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Abstract: In economic development, green finance and industrial structure are interrelated closely. Based on up-to-the-date China's supply-side industrial structure reform and upgrading, it is of pragmatic significance to put green finance study into economic development mechanism and optimize the industrial structure to accelerate better eco-environment. By establishing a grey correlation analysis model, this paper provides an empirical research on the relationship between them on the ground of data from 2008 to 2017. In order to further boost green finance to promote the optimization and upgrading of industrial structure, through discussion, some policy suggestions are put forward. Technology innovation is also presented as a key factor which connects the twos.

1. Introduction

Economic development is accompanied by eco-environmental issues, such as air pollution, soil pollution, and water pollution. Green finance advances technology innovation, and then makes industrial structure optimization, so as to improve environment, like clean energy, low carbon emission. Although economic sustainable development has featured more and more prominently on the international agenda for governments and businesses over the last few decades, the awareness of its dependence on the environment dates back to the very beginning of mankind history. From time to time, the form, dimension, scale, degree, and location of environmental problems have changed respectively. Environmental problems are well described by the metaphor of the 'tragedy of the commons'[1], in which an insufficient appreciation of the scarcity of resources leads to soil exhaustion, erosion and an interference with nature's ability to regenerate itself.

According to S. Labatt et al.[2], environmental finance is a recently coined term, one that probably could not have appeared until the closing moments of the twentieth century. It encompasses all market-based instruments designed to deliver environmental quality and to transfer environmental risk. M. Jeucken emphasized in financial institutes sustainable research[3], for GF implementation, on intersection of green economy and finance.

As far as green finance measurement, there are lots of researchers' contributions. P. Street et al. pointed, as in many business sectors, the more forward-thinking banks and financial service providers are currently looking at the need for, and possible ways of addressing, sustainable development. A bank on an innovative project assesses the environmental impacts of the way in which the Bank delivers its services, and develops indicators to monitor those impacts. The Bank is recognized as a trailblazer in corporate reporting of ecological and social responsibility. It plays a pivotal role in moving towards sustainability. P. Street Assessing the sustainability of bank service channels by choosing relevant GF product and service indicators to analyze[4]. In the book *Sustainable Banking: The Greening of Finance*, J.J. Bouma, M. Jeucken, and L. Klinkers showed[5] that the comprehensive debate on sustainable development has been produced in order to take a global pulse on how the financial services sector is responding to the growing challenge of shareholders and their expectations on environmental performance. Given the intermediary role banks play within economies, their potential contribution toward sustainable development is enormous.

In China, the term GREEN in its national 13th Five-Year Plan appears firstly out of its strategic development five ideologies –Innovation, Coordination, Greenness, Openness and Sharing- and green financial system construction is one of the national state strategies. People's Bank of China, Ministry of Finance, National Development and Reform Commission, Ministry of Environmental Protection, China Banking Regulatory Commission, China Securities Regulatory Commission, and China Insurance Regulatory Commission in Aug. 2016 issued *Guidelines for Establishing the Green Financial System*. In 2017, China's State Council announced its decision to set up pilot zones for green finance to support its industrial upgrading. [6] This year, China primarily introduced GF initiative into G20 and set up GF research group. In context, with the construction of GF system as a national strategy, more remarkable breakthroughs have achieved for China's GF development. China's economic development promotes the supply side industrial structure adjustment, GF innovation and R&D to make industrial upgrading. It has pragmatic significance to tackle eco-environmental issues. J. Ma, in his *On the Construction of China's Green Financial System*, realized green finance sustainable, and put forward framework and policy discussion from theoretic perspective systematically[7]. This paper will make efforts to set financial system and method for reducing eco-environmental risk into consideration and integrate economic sustainable development with industrial structure upgrading. Meanwhile, it is necessary for financial institutes to analyze the mechanism of GF and industrial structure upgrading and empirically analyzes the correlation between GF and industrial structure by forming GRA Model through data of 2008-2017. Combined with the status-quo of GF development in correspondent areas, the relevant counter measures are applied. Also some suggestions are put forward to promote industrial structure upgrading. 1). GF mitigate obstacles of low carbon, energy-saving firms' financing; 2). GF curb high carbon emissive, high energy consumptive firms; 3). GF reduce risk management costs; 4). GF system service more financing instrument diversity.

2. Materials and Methods

2.1 Grey Correlation Analysis

To better investigate correlations between green finance and upgrading of industrial structure in China, we used grey correlation analysis. Grey Correlation Analysis, proposed by the renowned cyberneticist Ju-long Deng in 1982, is used to discover the system behavior and evolution by means of modeling based on the partially known information[8]. Typically, a grey correlation degree between two or more time series reveals the entire relationship of the system[9][10]. As a tool of grey system for analyzing the relationship between a reference series and other series, GCA aims to measure the similarity between the compared series and is widely used in Economics, Finance, Environmental science and so on. The GCA methodology is as follows:

- 1) Determine the analysis series: determine reference series $\{X_{0k}\}$ and alternative series $\{X_k\}$.

Reference series is a combination of dependent variables. Alternative series consists of independent variables.

- 2) Normalization: in order to make the values free of unit the normalization process is done. This process is called grey relational generating. There are two general processing methods:

- a. Mean value processing: obtain the average value of the raw data of each indicator, use the mean value to remove each data of the corresponding indicators, and then obtain the new data.

$$C_k^i \in (0,1), C_k^i = \frac{j_k^i}{\sum_{j=1}^m j_k^i}, i = 1,2, \dots, m, k = 1,2, \dots, n \quad (1)$$

- b. Initial value processing: let the change interval of the Kth indicator be $[j_{k1}, j_{k2}]$. j_{k1} is the minimum value of the Kth indicator among all the evaluated objects, and j_{k2} is the large value of the Kth indicator among all the evaluated objects, and the original value in the above formula can be changed to the dimensionless value by the following formula.

$$C_k^i \in (0,1), C_k^i = \frac{j_k^i - j_{k1}}{j_{k2} - j_{k1}}, i = 1,2, \dots, m, k = 1,2, \dots, n \quad (2)$$

Compared with the mean value processing, the initial value processing method is more sensitive to the dynamic change, and the mean value processing method is only a simple arithmetic average calculation of the logarithmic value, which cannot reflect the dynamic change process.

- 3) Calculate series difference $\Delta i(k)$, minimum difference a, maximum difference b.

$$\Delta i(k) = |X_0(k) - X_i(k)| \quad (3)$$

$$a = \min_i \min_k \Delta i(k) = \min_i \min_k |X_0(k) - X_i(k)| \quad (4)$$

$$b = \max_i \max_k \Delta i(k) = \max_i \max_k |X_0(k) - X_i(k)| \quad (5)$$

- 4) Calculate the grey correlation coefficient: grey correlation coefficient is an indicator of the similarity between the reference series and alternative series.

$$\epsilon_i(k) = \frac{\min_k |X_0(k) - X_i(k)| + \theta \max_k |X_0(k) - X_i(k)|}{|X_0(k) - X_i(k)| + \theta \max_k |X_0(k) - X_i(k)|} \quad (6)$$

$\theta \in (0,1)$ is the resolution coefficient, which is generally taken as 0.5.

5) Calculate the grey correlation grade : grey correlation grade(GCG) is used for overall evaluation of alternatives depending on all criteria.

$$r_i = \frac{1}{n} \sum_{k=1}^n \epsilon_i(k), i = 1, 2, \dots, m \quad (7)$$

The GCG values are used to rank the alternatives according to the similarity to reference series. The higher GCG value indicates the higher similarity.

2.2 Indicators and data description

As of October 2018, China Green Finance Committee has 221 member institutions. The financial asset under management of member institutions amounts to RMB 178 trillion, accounting for roughly 73% of the total asset of China’s financial industry[11].Some of the major green finance businesses of China’s commercial banks are shown as Figure 1.

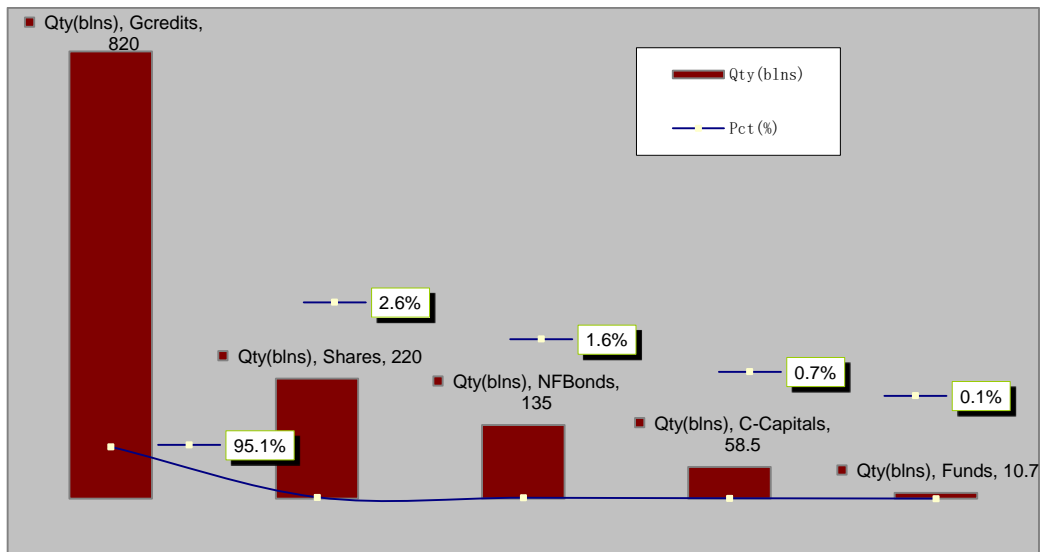


Figure 1 China’s 21 major commercial banks’ green finance structure of 2017

(data source: Wind Finance Database, CBRC, CIB Research)

Currently, indirect financing plays a dominant role in China’s financial market. As aforementioned in Figure 1, it shows that China’s green finance mainly concentrate upon credit business. Therefore, this paper uses green credit size to express the development of green finance in China between the years of 2008-2017. The data used for green credit size were extracted from CBA (China Banking Association), China Statistical Yearbook, Almanac of China's Finance and Banking. Meanwhile, this paper uses the annual added value of primary industry, secondary industry and tertiary industry between the years of 2008-2017 as the indicator of the upgrade of China's industrial structural. The data was taken directly from China Statistical Yearbook.

2.2 Result

According to the calculation steps of the grey correlation analysis, the reference series is determined to be green credit size, and the alternative series is the added value of primary industry, secondary industry and tertiary industries respectively. The grey correlation coefficient between green credit and the three industries is shown on Table 1.

Table1: Grey Correlation Coefficient between Green Credit and the Three Industries

| Grey Correlation Coefficient | Year | | | | | | | | | | |
|------------------------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--|
| | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | |
| Primary Industry(ϵ_1) | 1.0000 | 0.7620 | 0.7267 | 0.6690 | 0.3333 | 0.6057 | 0.5569 | 0.5048 | 0.4849 | 0.4422 | |
| Secondary Industry(ϵ_2) | 1.0000 | 0.7656 | 0.7367 | 0.6808 | 0.3355 | 0.6109 | 0.5623 | 0.5062 | 0.4868 | 0.4537 | |
| Tertiary Industry(ϵ_3) | 1.0000 | 0.7748 | 0.7439 | 0.6884 | 0.3399 | 0.6384 | 0.5954 | 0.5510 | 0.5409 | 0.5040 | |

Based on the results on Table 1, the grey correlation grades are $R_1=0.6085$, $R_2=0.6138$, $R_3=0.6377$ respectively.

Empirical results show that $R_3 > R_2 > R_1$, which means the relationship between green finance and the three industries from high to low is tertiary industry, secondary industry and primary industry.

3. Discussion

China's green finance has a significant effect on the upgrading of industrial structure. Based on the grey correlation analysis of the data from 2008 to 2017, there is a relationship between the development of green finance and the upgrading of industrial structure. The grey correlation degree between China's green finance and the proportion of the three industries in GDP increases successively, and the correlation between green credit and the proportion of the secondary and tertiary industries is higher than that of the primary industry. The increase in green credit supply will increase the proportion of the secondary and tertiary industries, which is higher than that of the primary industry. The proportion of industrial structure to the tertiary industry is higher than that of the secondary industry, and the proportion of the secondary industry is higher than that of the second industry. The development of an industry in the proportion of the industry, the industrial structure is naturally optimized.

As far as green credit is concerned, P.Thompson& C.J.Cowton argued that[12], in recent years, it has come to be recognized that banks' credit business affect, and are affected by, the state of the natural environment, UK. In particular, rising public concern about the state of the natural environment, as reflected in legislation and consumer attitudes, poses risks for the state of a bank's credit portfolio. Even if they are not directly concerned about the environment, banks therefore have an incentive to understand the environmental

implications of credit business decisions. This generates a potential demand for environmental information on firms. Their empirical research conducted to explore the interface between bank credit business and the demand for environmental information.

The development of green finance has positive impacts on the upgrading of industrial structure. It aims at reducing environmental risks and ecological scarcities, and also targets for sustainable development without degrading the environment. It is closely related with ecological economics. Green financing projects usually have a good forward-looking and return; hence, green finance attracts capital moving from high pollution and low return industries to green industries. At the same time, during the adjustment of the internal structure of enterprises, the green credit policies have effects on the cost of capital. Because of the signaling mechanism, enterprises benefiting or punished from green policies provide a strong demonstration effect to the market. With the innovation of green finance, the diversification of green finance plays an increasing vital role in the development of green finance. Not only green credit, but also green securities, green insurance and green funds gradually meet the needs of the upgrading of industrial structure.

Green finance helps enterprise to produce value in the same manner which an ecosystem does, neither producing waste nor consuming unsustainable resources. The flow process shows the loop between enterprise and natural capital. In another word, strengthening the utilization ratio of raw materials to increase output, meanwhile, enhancing the technology to reduce input of sources and waste products. To accomplish sustainability is, in this case, to make the economy functioning better.

Green finance cuts external cost and social cost. In economics, an externality is the cost or benefit that affects a party who did not choose to incur that cost or benefit. The cost of the environment is usually termed as the external cost of an enterprise. Social cost in economics may be distinguished from "private cost". For example, Air pollution from burning fossil fuels causes damages to buildings and public health. Taking green finance into consideration in the process of operation and management of an enterprise and establishing a green finance system and regulations do advantage to improve CSR and lower image and financial risk. The ideal situation of enterprise is to cut parts of the negative external cost and social cost by green finance.

B.Scholtens et al. in 2006 and 2007 suggested green finance could be used as a driver of corporate social responsibility and analyzed the performance of banks that adopted the Equator Principles. The Equator Principles are designed to assure sustainable development in project finance. The social, ethical, and environmental policies of the adopters differ significantly from those of banks that did not adopt the Equator Principles. They are also significantly larger. Most other bank characteristics do not show significant differences. Shareholders did not react negatively to the announcement of the adoption of the Equator Principles. Adoption of the Equator Principles is used to signal responsible conduct. [13]

The research on the correlation between green finance and industrial structure disclosures the relationship between green financial structure and industrial structure. Whether financial structure influences economic growth is a crucial policy issue. If one form of financial structure is more conducive to economic growth than

another, then economic policy must take it into account. It is, therefore, hardly surprising that the distinction between bank-based and market-based financial systems, and their relative importance to economic growth, has been the focus of the relevant theoretical debate for over a century [14] [15] [16]. They may not form a suitable sample to investigate the relative contribution of one financial system over another in the growth process [17] [18]. E. Shaw pointed money and its relative prices affect real aspects of the development process. It draws attention to financial markets for the role that they can play in making growth paths steeper for relatively poor economies and more stable. The lagging economy confines itself to poverty partly by imposing upon its markets patterns of financial, fiscal, and international economic policy that, in effect, instruct market participants to keep aggregate levels of income and wealth where they are. It depends on the plan, mandate, ration, license, and privilege to optimize resource and use [19].

4. Conclusion

Green development focuses on the eco-environmental, low-carbon development and green economic system. Upgrading industries into green industries needs optimize industrial structure. For the sake of better coordinate the shift, green finance plays a key role and exerts powerful affect on economy analysis. The development of green finance has positive effects on the upgrading of industrial structure in China. At the same time, it needs the efforts of both the government and the market to set green finance standards to promote the innovation and service level. The standardization of green finance optimizes financial resource allocation and constrains high pollution industries. To keep sustainable development, the environmental cost of financial projects should be calculated. In general, green finance is beneficial to industrial development and consolidates financial institutes' rational decisions. Not only do right things, but also do things right. Merging financial structure with industrial structure relies on the economic growth orientation. In the future, the development of green finance needs to constrain the size of high pollution and low-efficient industries in the secondary industry and accelerate the development of the tertiary industry, such as information technology industry, to achieve both the goals of economic growth and environmental protection simultaneously.

Green finance and eco-environment are closely related; in fact they are mutually dependent. The government has an important role to play in this by using green financial instruments to internalize environmental effects into market prices so that firms and consumers make more sustainable production and consumption decisions, respectively. In the book *Environmental Finance: A Guide to Environmental Risk Assessment and Financial Products*, S.Labatt pointed out that [2] Environmental Finance provides a thorough, objective discussion of the environmental risk issues facing financial institutions and how to effectively manage both the challenges and opportunities they present. Today, environmentally irresponsible firms run the risk of hurting their bottom line as well as their image. As a result, environmental risk is reshaping the way insurance companies underwrite to corporate clients, banks lend, investors invest, and firms operate. Financial institutes developed new environmental financial instruments to help the firms protect their bottom line against changes in environmental legislation and the impact of adverse ecological change. Financial institutes should join forces with industrial firms to explore the emerging field, develop environmental policies and products, and then

discover the changes in the financial services sector to respond to the environmental challenge. Presently, it is urgent for governments and financial regulatory institutes with respect to green finance development and industry structure upgrading to create innovative green finance policies and products such as tradable carbon emission permits, weather derivatives, green bonds, and many other market-based instruments in response to every type of environmental problems from air, water or soil pollutions. The financial consequences of environmental risk will continue to grow, if nothing done. The responsibility, liability, and accountability of industrial firms are to hedge these risks and come out on top with green finance.

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