The Mechanism of Environmental Protection Industry Stimulated by Financial Incentive Policy

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Abstract—The financial incentive mechanism of China’s environmental protection industry (EPI) is not complete at the present stage. It is of great significance for the development of EPI to study the action path and way of financial means. This paper analyzed the promoting effect of financial incentive to EPI, regarding the environmental protection market (EPM) as the carrier of EPI and adopting the method of system dynamics. The Supply and market concentration degree (MCD) are employed as characterization variables to study the effect of financial incentive under different preferential intensity. The research conclusion shows as following: The impact of financial incentive on the development of EPI is mainly embodied in capital investment; financial incentive has an obvious promotion on both Supply and MCD; the effect on Supply and MCD presents constant and decreasing scale effect severally.

Keywords—financial incentive; environmental protection industry (EPI); environmental protection market (EPM); system dynamics (SD); market concentration degree (MCD);

I. INTRODUCTION

The total Pollution control related investment from China's governance increased from 101.49 billion Yuan in 2000 to 921.98 billion Yuan in 2016, however the output of China’s EPI accounted for less than 3% of GDP in 2016, whereas the contribution rate of EPI in the United States and other developed countries have already reached more than 20%. It indicates that China's EPI still has considerable room for improvement. In August 2017, the general office of the state council issued “the opinions on promoting third-party treatment of environmental pollution”, aiming to solve environmental externalities caused by economic development, the cultivation and development of environmental protection industry (EPI) reflects the multi-dimensional demands of industrial upgrading, market deepening and environmental governance. China's EPI structure is not fully developed, Small and micro enterprises account for more than 90%, indicating EPI has not yet formed a significant scale effect and a reasonable level of market concentration degree(MCD), and the role of the market mechanism has not yet fully played. As the influence mechanism of financial incentive on EPI is still unclear, it is of great significance to examine the dynamic mechanism of the influence of financial incentive on EPI from the perspective of system theory, and to analyze the overall effect and trend of the development of EPI.

II. REVIEW OF RELATED LITERATURE

Financial incentive refers to economic activities supporting the development and upgrading of EPI, including financial services provided for project investment and financing, project operation and risk management of EPI. Finance incentive also includes institutional innovation that serves energy conservation and environmental protection projects, such as new transaction arrangements, incentives and financing models. Finance incentive can improve the efficiency of R&D and energy conservation of EPI, through diversified financing channels, preferential policies and service platforms. The function of the government’s industrial policies on EPI is mainly reflected in the following two aspects: first, guiding the flow of financial capital to the field of EPI, urging green financial institutions to establish a risk management mechanism, and promoting the diversified development of green finance; second, encouraging enterprises to increase investment in R&D through policy subsidies, promoting energy-saving and environmental protection technology and driving the transformation of innovative achievements of enterprises through preferential policies, so as to increase revenue and create a good development environment for EPI.

Financial incentive plays an important role in industrial development. Xiaoying HUANG (2017) applied DEA-Tobit method to analyze the financial incentive efficiency of China's EPI and its influencing factors, founding that the pure technical efficiency of financial incentive for EPI was low; growth of EPI is highly dependent on national policies and has great regional heterogeneity [1]. Qingzi HUANG (2016) constructed the GRA-VAR model and compared several policy tools in EPI by measuring their importance and influence, concluding that scientific and technological policy tools were the best, followed by economic policy tools and legal policy tools were the weakest to incent the growth of EPI [2]. Research results of Dejian LIN (2018) show that the effect of financial incentive to EPI is mainly manifested in capital investment, however, different types of financial incentive factors play different roles. The direct financial system dominated by capital market plays a more significant supporting role than the indirect financial system dominated by bank credit [3]. Qian WU (2018)
believed that green finance can effectively solve the problem of financial investment in EPI, drive economic progress, improve industrial internal structure and accelerate the development of EPI [4]. Xiliang LIU and Shuyang WEN (2018) did empirical analysis and proved that the financial machine Structural credit decision can significantly affect the quality of economic growth [5].

The above scholars have studied the impact and function of financial incentive on industrial development from different perspectives, however, there are few studies on the development of EPI incented by financial policies, this paper focuses on the effect of financial incentive on EPI.

III. SYSTEM DYNAMICS MODEL OF EPI

A. System Composition of EPI

As a policy-based emerging industry, EPI is more significantly affected by policy tools than other industries. Industrial policies must be embedded in the market and take advantage of the basic allocation function of the market to influence the system operation. The market is not in a mature state of established scale, but an endogenous variable growing with EPI synchronously and concomitantly. The growth of EPI is based on self-improvement of the market, and the development of environmental protection market (EPM) is driven by industrial growth. The development of EPI and the market are closely linked with each other. If only observing the output scale as a single indicator, it is impossible to examine the market in the structure and maturity of the variation trend, whereas the improvement and optimization of the market is the key variable of industrial upgrading and the core factor of ensuring the sustainable development of the industry. In this paper, the two indicators of market supply and market concentration degree (MCD) of EPI are employed as the representative variables to reflect the development level and status of EPI from two aspects of output scale and market structure.

EPM is deconstructed in two subsystems as follows: (1) Market demand subsystem. The market demand mainly includes industrial enterprises procurement and government procurement. The industrial enterprises procurement refers to the purchase of pollution control products and services by industrial enterprises with waste emissions in the production process which bring actual and potential adverse impacts to the environment. Under the constraints of environmental regulations, the industrial enterprises accept the purchase of pollution control products and services, In order to reduce their own investment and to improve efficiency. Government procurement refers to the purchase of pollution control products and services used to improve the public ecological environment by the government as the manager, represented by the annual Fiscal expenditure on environmental protection. (2) Market supply subsystem. The EPM supply is affected by MCD, the quantity of environmental protection enterprise, the price level and so on. MCD is employed to describe market structure, which is expressed by proportion of fixed assets of environment protection enterprises who are the top three sales in listed companies of EPI. The quantity of environmental protection enterprise is expressed registration quantity of enterprises whose main business is environmental protection products and services, describing the competitive status of EPM.

B. SD Model Construction

System theory emphasizes in the integrity, complexity, nonlinearity and interaction of systems, and studies the internal relations and evolution of the system by abstracting and simulating. System dynamics (SD) is a systematic research method combining path feedback, control simulation and quantitative analysis. In this paper, SD method was adopted to describe the development path and trend of EPM system under the influence of multiple external and internal factors, based on the relevant data of China’s EPI from 2007 to 2016(data obtained from the website of the national bureau of statistics, China environmental statistics yearbook and CSMAR database). The market is a very complex system, and this model cannot cover all the internal and external factors of EPM and their influences, however, we grasp the key factors and the main trend, through the fitting, simulation and test of the real data, so as to reflect the law more truly and fully.

Based on the above analysis, the construction of this research model is based on the following basic assumptions: (1) The basic model of EPM dynamic evolution system was constructed from the perspective of supply and demand balance, and the initial state of supply and demand balance in 2007 was assumed. (2) Two variables, Supply and MCD were used to analyze the development trend of EPI. (3) financial incentive are described in the form of index.

1) Parameter setting

Vensim PLE software is used for simulation, the simulation period is set to 10 years, and step length—DT is set to 1 year. The initial values of the horizontal variables (such as the QEPE, EPM supply and demand) were the statistical data in 2007, financial incentive is expressed in index (without units), other data units related to the quantity of revenue and expenditure are unified as 100 million Yuan. The simulation results are shown in Fig.1 below.

![Fig. 1. The dynamic model of EPI](image-url)
2) **Description of major variables** (see TABLE I)

| relevant variable | variable declaration |
|-------------------|----------------------|
| Environment Pollution Level (EPL) | Referring to Shizhong TIAN (2017) [6], the statistical average of pollution index |
| GNP | Gross National Product |
| Industrial Production scale | Added value of the secondary industry |
| Market Concentration degree (MCD) | fixed assets proportion of top three enterprises in EPI |
| Quantity of Environmental Protection Enterprises (QEPE) | quantity of enterprises whose main business is environmental protection |
| R&D Investment ratio | R&D investment/operating income of listed environmental protection enterprises |
| Growth Rate of Enterprise Procurement | Growth rate of ratio of environmental protection expenditure to operating income of listed industrial enterprises |
| Growth Rate of Government Procurement | Growth rate of total national fiscal expenditure on environmental protection |
| Self-raised Investment | Self-raised funds for fixed asset investment in EPI |
| Foreign Capital Investment | Foreign fixed assets investment to EPI |
| Quantity of Cumulative Standard | Total of local environmental protection standards issued |
| Tax Relief | Tax refund/payable tax of listed environmental protection enterprises |
| Loan to Total Investment ratio | loan of fixed assets investment/total fixed assets investment of EPI |

**C. Model Validation**

The model of SD is a simplified isomorphic one of real systems, whose purpose is to describe the operation characteristics of the system as a whole, in another word, the dynamic model cannot be duplicated exactly with the real system, therefore it is necessary to examine whether the model can accurately reflect the motion characteristics of the real system. The model structure suitability and model behavior suitability test can be employed to test. The dimensional conformance test in model structure suitability test is a built-in function of Vensim PLE software. Because automatic error and interruption, correction before running, the relevant error has been corrected. The method of parameter coincidence and trend coincidence was used to test the fit of model behavior. Some variables in Fig.2 are filled with actual data, and others are obtained by fitting the actual data through system model simulation, as TABLE II shown. Fit indicators of endogenous variables are acceptable mostly (above 75%), which indicates that the model can basically reflect the development reality of EPI.

**D. Analysis of Simulation Result**

In the model, the base period is defined as the system state when financial incentive was preset to 0. The financial incentive effect is manifested as the influence on the proportion of loan in investment of EPI. When the random fluctuation function is employed to control the financial incentive degree at the level of 0% ~ 80%, the incentive effect of Supply and MCD is shown in Fig.2 and Fig.3 below.

![Fig. 2. Impact of financial incentive on Supply](image)

![Fig. 3. Impact of financial incentive on MCD](image)

Financial incentive policies have a significant effect on improving the supply of EPI. At each incentive level, the incentive effect gradually appears after DT=1~2, and the growth rates are at 3.28%~3.60% respectively. With increasing financial incentive, the growth rate of Supply of EPM remains at a relatively stable level. The MCD shows a certain fluctuation trend in early simulation period at all incentive
levels, then the fluctuation is gradually digested in the later simulation period. Under increasing financial incentive, the growth rate of MCD is in 4.91% to 5.77%, with slow convergent trend.

IV. CONCLUSION ANALYSIS AND POLICY RECOMMENDATIONS

This article adopted related data of China’s EPI in 2007-2016, analyzed the incentive mechanism of financial policies, constructing the SD model of EPI. We can draw the following conclusion based on the above analysis: the effect of financial incentive has promotion on both the supply and MCD; the characteristic of incentive on Supply is constant scale effect; the incentive on MCD has the phenomenon of diminishing scale effect.

For the above results, this paper believes the reasons are as follows: From the perspective of the value chain, financial incentive plays a role at the beginning of the value chain in the EPI system, by stimulating environmental investment to indirectly promote supply growth. It can be understood as an indirect incentive to Supply, so the incentive on supply is mild and constant. On the other side, financial institutions tend to have a higher evaluation of major enterprises, believing that they are vigorous and have better repayment ability. For major enterprises have more convenience to obtain financial support, then have more opportunity to grow up, thus the MCD is increased correspondingly under incentive of financial policies.

Accordingly, the following proposal was put forward: first, the role of financial incentive cannot be ignored, it has the effect of ironing out shock and stabilizing market in the adjustment of market structure, so government should guide financial institutions to strengthen the link between industry and finance, deepen the application of the green credit assessment mechanism, and urge banking sector to increase financial incentive for environmental protection enterprises and projects. Second, government should support and encourage scientific and technological innovation and R&D investment by green finance support, and give certain financial policy preference to small and medium-sized environmental protection enterprises.

This paper investigated the unidirectional promotion effects of financial incentive to EPI, and it should be further studied that the interaction of various factors under different subdivision dimensions of policies.

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