Analysis of Green Finance Promotion Barriers in Underdeveloped Areas - Evidence from System Engineering

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Abstract. As a hot topic in the world, the promotion of green finance in underdeveloped regions has many obstacles with complex levels and different attributes. This paper combined relevant surveys and expert opinions to determine the barriers to the promotion of green finance in underdeveloped areas, used the ISM (Interpretative Structural Modeling) to sort out the hierarchical structure and action paths of the factors, and applied MICMAC (Matriced Impacts Corises-multiplcation Appliance Classement) to determine the key focus objects. The research results show that: the system of obstacles to the promotion of green finance in underdeveloped areas consists of 15 factors, which can be divided into three levels: the surface layer, the intermediate layer and the bottom layer. Among them, low policy effectiveness, low utilization rate of advantageous resources, single green financial products and services, lack of professional talents, and frail resultant force of ecological poverty have strong dependence and low driving force. The solutions to these factors depend on other factors' solution. Insufficient government guidance, incomplete construction of information sharing platform, and unbalanced development of productivity have relatively high driving forces, which are the most fundamental hindering factors and should be focused on.

Keywords: Underdeveloped regions, green finance, Obstacle identification, ISM-MICMAC.

1. Introduction

With growing global concern for environmental protection, climate change and sustainable development, policymakers and researchers have recently focused on green finance [1]. Green finance as one such innovative concept is facing opportunity and challenge about societal value creation without harming the environment. In order to develop the green features of the financial industry in its operation [2], it is necessary to solve the obstacles under the promotion of green finance, especially to speed up the promotion of green finance in underdeveloped areas. At present, the academic community has basically formed a consensus on the benefits of promoting green finance. Promoting green finance is conducive to economic growth, further solving the problem of development imbalance between regions, and narrowing the gap between less developed and developed regions. However, the research shows that there are still many factors hindering the promotion of green finance in less developed areas. Therefore, when systematically considering the way in which green finance should be promoted, we should first identify the hindering path.

In recent decades, researchers have conducted numerous studies and in-depth discussions of the issue. The past decade has seen the rapid development of green finance in many fields. Lee Chi-Chuan et al. [3] find that implementing a green finance policy can further enhance the impact of green finance development and environmental protection. Ren et al. [4] argue that an increase in carbon intensity inhibited the expansion of non-fossil energy use, impeded the investment flow to green projects, and ultimately led to a deterioration of green finance development. Therefore, improving ecological industry is also one of the ways to activate green finance. Besides, existing studies have documented that green finance cannot be effectively linked to industrial structure adjustment restricts

the coordinated development between green finance and economic growth, and causes green finance support to economic growth not obvious [5].

Despite this progress, problems and challenges remain. Recently, there are diversified ways to develop green finance in less developed areas, but the identification path of its promotion is still fuzzy, which hinders the in-depth development of green finance promotion. Thus, we need to establish a systematic framework for path recognition to facilitate future research. Firstly, our paper constructs 15 indicators which affect the promotion of green finance from four dimensions. On this basis, ISM is used to ascertain the hierarchical structure between factors, which can clarify the logical relationship between indicators. In parallel, MICMAC is used to classify the factors, which is conducive to puts forward development suggestions targeted. Overall, this study analyzes the promotion of green finance from the perspective of obstacles. In theory, the article provides a guide for further studies. The results of the study will assist undeveloped regions on the key issues to consider in adopting, developing and granting green finance.

2. Construction of green finance promotion obstacle index system in underdeveloped regions

2.1. Government

First of all, the lack of government guidance is one of the reasons affecting the promotion of green finance. Recent evidence suggests that China's financial system is dominated by indirect finance, resulting in the government attaches great importance to green credit policy [6]. However, there are still insufficient guidance in other aspects, such as the lack of specific implementation process of the green fund, green insurance is mainly based on pilot policies. In addition, as a long-term systematic project, green finance must be supported by sufficient funds to achieve good results [7]. Thirdly, the lack of synergy between green finance policies and local economic development has resulted in a certain amount of resource waste and inefficient investment. Moreover, the development of local green finance has not yet formed systematic planning and unified standards compared with the national level [8].

To sum up, obstacles to the promotion of green finance at the government level constructed in this paper include insufficient government guidance (X_1), inadequate financial support (X_2), low policy effectiveness (X_3), and unacted local incentive system (X_4).

2.2. Economy

Generally speaking, due to the low level of financial development in less developed areas, the scale of financial agglomeration is small and the level of local industrial structure is not rich [9]. Therefore, they are more inclined to accelerate their own development speed, so that the possibility of green development demand of local enterprises is low. In terms of resource utilization, due to insufficient cognition, lack of equipment and technology, resource utilization is low [10]. It is significant to calculate energy input according to different years, so that reasonably dispatch and deploy it as far as possible to maximize its utilization rate. Similarly, an efficient information platform is an important guarantee to dredge the channels of information exchange, enhance the degree of information disclosure, and improve the quality of green finance participants [11]. At the same time, it is necessary to improve the Internet penetration rate in underdeveloped areas and develop diversified green financial products [12].

Hence, in this paper, factors hindering the promotion of green finance at the economic level include low level of financial development (X_5), low utilization rate of advantageous resources (X_6), incomplete construction of information sharing platform (X_7), and single green financial products and services (X_8).

2.3. Society

Surveys have shown that talents (X_9), industrial power (X_{10}), productivity development (X_{11}) and publicity work (X_{12}) are important social factors to promote the development of green finance.

It is generally believed that the core factor for the long-term development of green finance is the absorption and training of professional talents. Therefore, it is necessary to strengthen the absorption and training of professional personnel and build a talent team. Besides, the scale of local industry is not high, lack of leading enterprises to drive. Among them, the development of key green industries such as ecological industry and cultural industry has been restricted to a certain extent, which has affected the financing attraction of social funds such as financial institutions, enterprises and residents [13]. What's more, the lag in the development of productive forces has led to a lack of development impetus, which is unable to promote high-quality regional development and efficient allocation of economic factors. Additionally, most studies show that the awareness of green finance still needs to be strengthened, and the publicity and popularization of green finance concepts, policies and products are not enough and lack of internal impetus. If less developed areas raise the awareness of green consumption and actively publicize the concept of green development, it will elevate green development to a strategic height, so as to promote the local brand of green finance and establish a good public image of green development [14].

2.4. Ecology

As a financial innovation supporting the development of national economy, green finance can promote the improvement of the ecological environment in the surrounding areas [15]. Meanwhile, ecological environment, as the basis for realizing sustainable economic development, also acts on the promotion and application of green finance.

Since the weak environmental innovation ability in most underdeveloped areas, the realization effect of green finance is not ideal. In addition, a sound ecological poverty alleviation mechanism is an important guarantee for industrial vitality and an important basis for the promotion of green finance [16]. Therefore, it is necessary to establish a diversified cooperation mechanism of government guidance, market operation and public participation to form the promotion power of green finance [17].

All in all, obstacles to the promotion of green finance at the ecological level established in this paper include powerless environmental innovation (X_{13}), weak support of ecological poverty alleviation mechanism (X_{14}), and frail resultant force of ecological poverty alleviation (X_{15}).

The barrier index system of green finance promotion constructed in this paper is shown in Table 1.

Table 1. Obstacle Indices

Secondary index	Three-level index	Indicator description	Index label	Reference
Government	Insufficient government guidance	Government policy has focused on one aspect of green finance, while others have not been widely developed.	X_1	[6]
	Inadequate financial support	Due to the limited leverage and guiding function of current financial funds, it is necessary to improve the connection between green finance and financial support.	X_2	[7]
	Low policy effectiveness	The synergy between green financial policy and local economic development is not high, resulting in a certain waste of resources and inefficient investment.	X_3	[7]
	Unacted local incentive system	Recently, only the macro incentive system at the national level has been established, and there are problems such as different standards and weak operability at the local level.	X_4	[8]
Economy	Low level of financial	The low level of financial development leads to small scale of financial agglomeration, not rich level of	X_5	[9]

	development	industrial structure, and low possibility of green development demand.		
	Low utilization rate of advantageous resources	Due to the lack of clarity on advantageous resources and equipment associated to improve resource utilization in underdeveloped areas, local resource advantages have not been well utilized.	X_6	[10]
	Incomplete construction of information sharing platform	There are still problems such as lack of perfect and unified green finance standards and lack of corporate information disclosure in most underdeveloped areas.	X_7	[11]
	Single green financial products and services	One of the reasons that hinder the promotion of green finance is the insufficient development of relevant green financial products, and the agricultural digital technology financial services do not fully cover the majority of residents in underdeveloped areas.	X_8	[12]
Society	Lack of professional talent	In most underdeveloped areas, it is difficult to introduce, retain and develop talents.	X_9	[12]
	Deficient industrial power	Due to the lack of impetus for local industrial development, it is impossible to promote economic development, which further hinders the development of green finance.	X_{10}	[13]
	Unbalanced productivity development	The lag in the development of productive forces has led to a lack of development impetus, which is unable to promote high-quality regional development and efficient allocation of economic factors.	X_{11}	[13]
	Insufficient publicity work	In view of the development of green finance at present, the lack of publicity and popularization of green finance concepts has resulted in a lack of internal impetus for development.	X_{12}	[14]
Ecology	Powerless environmental innovation	It is a win-win choice to improve the ecological environment while developing a green economy. If localities can enhance environmental innovation and coordinate the rational use of ecological resources, they can form a joint force for the development of green finance.	X_{13}	[15]
	Weak support of ecological poverty alleviation mechanism	The overall low ecological compensation standard dampens the enthusiasm of local people to protect and utilize the environment.	X_{14}	[16]
	Frail resultant force of ecological poverty alleviation	There is no coordination mechanism among various departments in the region, which makes it difficult to promote the work of green finance in a systematic, integrated and systematic way.	X_{15}	[17]

3. ISM method

Due to the intricate relationship between the various factors in the green finance promotion index system constructed in this paper, quantitative processing is difficult to achieve, so this paper intends to use the Interpretative Structural Modeling (ISM) for analysis.

ISM was proposed by American professor John N. Warfield in 1973, and it is a method for grading the interaction relationship between specific objects [18]. By constructing a correlation matrix, the complex system is gradually decomposed into interrelated elements in the system, and a hierarchical multi-layer structure model is constructed to further obtain the influence degree of each factor in the model. ISM is suitable for solving structural chaos and complex relationship between factors. It is

mainly used for system engineering analysis and is one of the most widely used processing tools for solving complex structural relationship problems [19]. The calculation steps of ISM are as follows:

Step1: Development of adjacency matrix.

Judging the relationship between *n* factors extracted by the expert team, constructing an adjacency matrix (A), using S_i *(i=1, 2, ..., k)* to represent these influencing factors, and determining the adjacency matrix according to formula (1) Element S_{ij} in A. Among them, *ij=0,1,2,3……,k.*

$$A_{ij} = \begin{cases} 1, \text{If } S_i \text{ has effects on } S_j. \\ 0, \text{If } S_i \text{ has effect on } S_j. \end{cases} \quad (1)$$
$$\text{Among them, } ij = 0,1,2,3,...,\text{k}.$$

Step2: Development of reachability matrix

On the basis of the adjacency matrix (A), apply Boolean algebra operation rules (ie: 0+0=0; 0+1=1; 1+1=1; 1×0=0; 0×1=0; 1×1=1) and calculate the reachability matrix (M) according to formula (2):

$$\begin{aligned} & k \le n-1 \\ & M = (A+I)^k \\ & (A+I) \ne (A+I)^2 \ne ... \ne (A+I)^k = (A+I)^{k+1} \end{aligned} \quad (2)$$

In the formula: *I* is the identity matrix; *k* is the number of transformations of the reachable matrix; *n* is the order of the matrix.

Step3: Level Partitions

According to the reachable matrix M, the reachable set $P(S_i)$ and the preceding set $Q(S_i)$ are obtained. Among them, the reachable set $P(S_i)$ needs to include all the matrix elements including 1 in the row corresponding to Si in the reachable matrix, and the antecedent set $Q(S_i)$ needs to include all the matrix elements including 1 in the column corresponding to S_i *i*n the reachable matrix. Finally, the elements contained in each layer are determined according to formula (3).

$$\text{L} = \left\{ (S_i) \| P(S_i) \cap Q(S_i) \right\} \quad (3)$$

Some concepts are involved in this process. The reachable set represents the set of all nodes that S_i can reach, denoted as $P(S_i)$; the antecedent set represents the set of all points that can reach node S_i, denoted as $Q(S_i)$; common set, denoted as *L*.

Step4: Construction of digraph and ISM hierarchical model

According to the element sequence of L_i, a schematic diagram of the multi-level transfer structure can be drawn. The factors of adjacent levels and the same level are connected by directed edges, and finally a hierarchical structure model of related factors is obtained.

4. MICMAC approach

Matriced Impacts Corises-multiplcation Appliance Classement(MICMAC)is a method proposed by Duperrin and Godet to analyze the relationship and interaction between factors in the system [20]. It is often used to identify highly dynamic and highly dependent factors in the system. It is generally used to analyze the importance of elements in the system and match corresponding solutions in complex environments. After determining the hierarchical structure among the factors, this paper uses MICMAC to determine the dependence and driving force of the model on the basis of obtaining the reachable matrix (M), deeply divides the status and role of the influencing factors, and puts forward targeted countermeasures and suggestions . MICMAC analysis process is as follows:

Step1: Calculation of driving force and dependencies

Based on the accessibility matrix M, the driving force F_i and dependence E_j of each influencing factor are calculated according to formulas (4) and (5) in the MICMAC principle. Among them, the dependence is the sum of the columns corresponding to "1" for each factor on the reachability matrix, and the driving force is the sum of the rows corresponding to "1" corresponding to each factor on the reachability matrix.

$$F_i = \sum_{j=1}^{k} S_{ij} (i = 1,2,\ldots,k) \tag{4}$$

$$E_j = \sum_{i=1}^{k} S_{ij} (j = 1,2,\ldots,k) \tag{5}$$

In the formula, S_{ij} is the risk factor in the reachability matrix M, i is the row where the risk factor is located, and j is the column where the risk factor is located.

Step2: Plotting the MICMAC cluster classification diagram

For a certain factor S_{ij}, the driving force F_i is used as the ordinate, and the dependence E_j is used as the abscissa to draw points, and the relative position of all influencing factors can be drawn in the first quadrant. At the same time, divide the first quadrant into 4 regions, representing 4 different types of factors: independent factors, linked factors, autonomous factors and dependent factors.

Independent factors refer to factors with strong driving force but weak dependence, which are generally located in the bottom layer and the lower layer of the transition layer in the ISM, and are very critical to the system. Linkage factors refer to factors with strong driving force and dependence, which are extremely unstable. Changes related to these factors will have an impact on other factors, which in turn will have an impact on itself. Autonomous factors refer to factors with weak driving forces and dependencies, which are relatively easy to control. Dependent factors refer to factors with weak driving force but strong dependence, which are easily affected by other factors in the system, mostly located in the upper layer of the direct layer and the transition layer in the ISM, and generally belong to the final risk factor.

5. Calculation and analysis

5.1. ISM calculation and analysis

In this paper, 12 experts (including 4 university researchers, 4 enterprises and 4 governments) who are engaged in or have a lot of research on green finance are invited to score the correlation between the obstacles to the promotion of green finance in underdeveloped regions. According to the hindrance factors of green finance promotion in less developed regions and their correlation, the adjacency matrix A=(a_{ij})N×N is constructed. When element X_i affects element X_j, matrix element $a_{ij}=1$; When element X_i has no effect on element X_j, matrix element $a_{ij}=0$. The 15 influencing factors listed in Table 1 and their direct binary relationship with each other form A matrix of order A, which is the adjacency matrix of impeding factors to the promotion of green finance in underdeveloped regions. is shown in Table 2:

Table 2. Matrix A

	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15
X1	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0
X2	0	0	0	1	1	0	0	0	1	0	0	0	0	0	0
X3	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
X4	0	1	0	0	0	1	0	1	0	0	0	0	0	0	0
X5	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0
X6	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
X7	0	0	0	0	0	1	0	0	0	0	1	1	0	0	1
X8	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
X9	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
X10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
X11	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
X12	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
X13	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
X14	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
X15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

The adjacency matrix is brought into SPSSPRO for ISM calculation, and the adjacency multiplication matrix is obtained through the adjacency matrix. Then the matrix is multiplied by itself until the matrix no longer changes, and the reachable matrix is obtained. The hierarchical decomposition of the model is carried out through the reachable matrix, and the hierarchical situation and hierarchical structure diagram of the model are finally obtained. The output results are shown in the in Table 3. The hierarchy diagram of ISM is shown in Figure 1:

Table 3. Reachable matrix M

	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15
X1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1
X2	0	1	1	1	1	1	1	1	1	1	1	1	0	0	1
X3	0	0	1	0	1	1	1	1	1	1	1	1	0	0	1
X4	0	1	1	1	1	1	1	1	1	1	1	1	0	0	1
X5	0	0	1	0	1	1	1	1	1	1	1	1	0	0	1
X6	0	0	1	0	1	1	1	1	1	1	1	1	0	0	1
X7	0	0	1	0	1	1	1	1	1	1	1	1	0	0	1
X8	0	0	1	0	1	1	1	1	1	1	1	1	0	0	1
X9	0	0	1	0	1	1	1	1	1	1	1	1	0	0	1
X10	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
X11	0	0	1	0	1	1	1	1	1	1	1	1	0	0	1
X12	0	0	1	0	1	1	1	1	1	1	1	1	0	0	1
X13	0	0	1	0	1	1	1	1	1	1	1	1	1	0	1
X14	0	0	1	0	1	1	1	1	1	1	1	1	0	1	1
X15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1

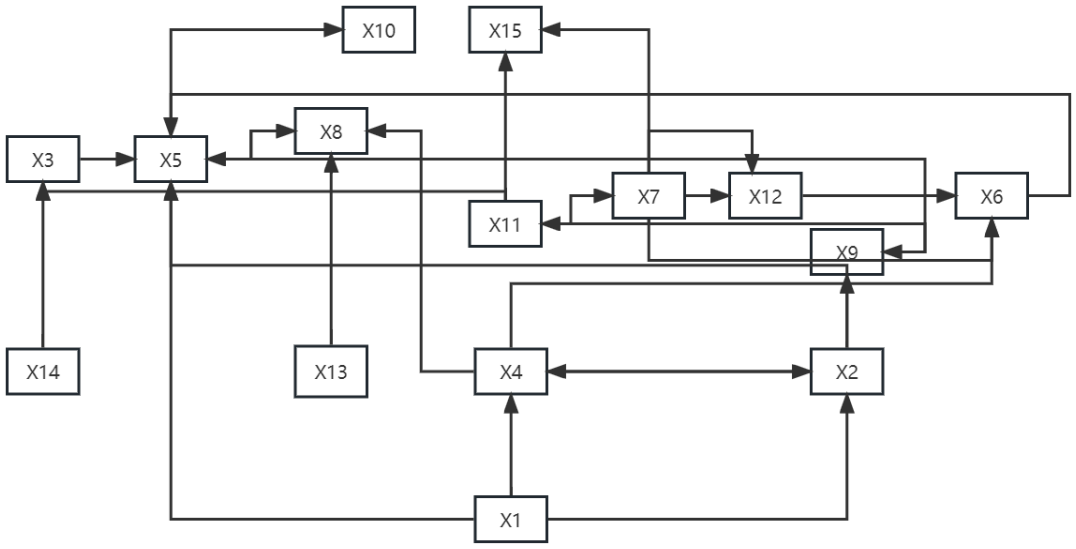

Figure 1. Hierarchy chart

According to the direct degree of relationship transmission, the inter-layer relationships of each factor in the hierarchical structure chart are divided as follows: Level 1 is divided into surface factors, Level 2-3 is divided into middle layer factors, and level 4 is divided into bottom factors [2].

5.1.1. Surface factors

The surface direct obstacle factors are the most direct factor hindering the development of green finance in less developed regions. They are also the highest-level factors, which are located at the top level of ISM hierarchy chart. These include: "local industries lack the driving force to promote poverty alleviation", "ecological poverty alleviation is not strong" and other factors, covering the social and ecological dimensions. Surface factors are the results of intermediate factors.

5.1.2. Intermediate factors

The 2–3-layer factors in the hierarchical structure chart of ISM are the intermediate layer factors that hinder the promotion of green finance in underdeveloped areas. They mainly cover the four dimensions of government, economy, society and ecology, and play a role of transmission and transition by connecting the surface direct obstacle factors and the deep root obstacle factors. Based on the accessible path, the layer factors gradually evolve from low level to high level, and its transition and continuity not only affect the surface direct factors, but also have a strong dependence on the deep root factors.

5.1.3. Bottom factors

The bottom factor is at the bottom, and it is the factor that has the greatest influence on other levels in the hierarchy chart. Generally, it is rarely influenced by other factors, namely "insufficient government guidance". This factor directly or indirectly acts on other factors and is the most basic condition that hinders the development of green finance in underdeveloped regions. Therefore, strengthening government guidance is crucial to promote green finance development in less developed regions.

5.2. MICMAC Calculation and Analysis

Based on the MICMAC model constructed in Chapter 4 and combined with the results in Table 3, the driving force D_i and dependency R_j of each obstacle factor are calculated respectively. Draw a scatter diagram of the factors hindering the development of green finance in less developed areas, as shown in Figure 2. Therefore, factors are divided into four categories: independent factor, dependent factor, linkage factor and spontaneous factor, which are respectively reflected in the distribution of factors in the second, fourth, first and third quadrants of the scatter diagram. This model can

intuitively represent the degree of mutual influence among the impediments to green finance development in less developed areas.

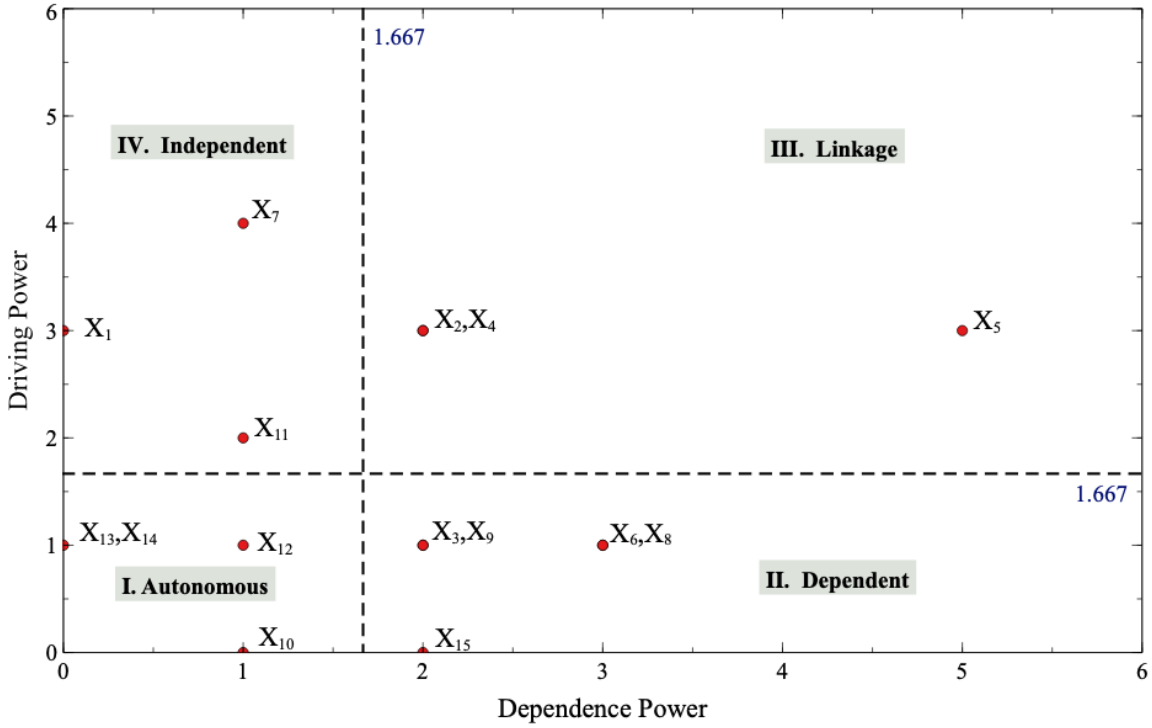

Figure 2. Power map

5.2.1. Autonomous cluster

As can be seen from the scatter diagram in Figure 2, factors such as insufficient driving force of local industries to drive poverty alleviation, inadequate publicity of green finance, weak ability of environmental innovation and weak support of ecological poverty alleviation mechanism are located in the third quadrant, which belong to spontaneous cluster. These factors have low dependence and driving force, are relatively independent, and are easier to master compared with other factors. Therefore, the targeted treatment of such factors should be considered first in decision-making.

5.2.2. Dependent cluster

Factors such as low policy efficiency, low utilization rate of advantageous resources, single green financial products and services, shortage of professionals, and weak resultant force of ecological poverty alleviation are located in the fourth quadrant, belonging to the dependency cluster with high dependence and low driving force, indicating that these factors are more affected by other factors, but less affected by other factors. It has a direct impact on the development of green finance in less developed regions.

5.2.3. Linkage cluster

Factors such as lack of financial support, unimplemented incentive system of green finance and low level of regional financial development are located in the first quadrant and belong to linkage cluster. These factors have high dependence and high driving force and are easy to be affected by other factors as well as other factors. They are key links hindering the development of green finance in less developed regions with strong linkage.

5.2.4. Independent cluster

Factors such as insufficient government guidance, imperfect data and information sharing platform construction, and unbalanced productivity development are located in the second quadrant, belonging to independent clusters with high driving force but low dependence. When its change, it will have a

great impact on the whole system, but it is less affected by other factors, belonging to the root factor. It is the essential influencing factor of green finance development in less developed regions.

6. Conclusion

Based on the relevant literature and expert scoring opinions, this paper identified 15 factors as obstacles to the promotion of green finance in underdeveloped regions, constructed the logical level of the ISM model to divide the obstacles, clarified the path between the main factors, and applied MICMAC Identify the factors with strong drivers, so as to determine the key focus. The specific conclusions are as follows.

(1) Deficient industrial power and frail resultant force of ecological poverty alleviation are superficial factors hindering the promotion of green finance in underdeveloped areas, while insufficient government guidance is a deep-seated obstacle.

(2) Divide blocking factors into independent factors, linkage factors, autonomous factors and dependent factors. Among them, low policy effectiveness, low utilization rate of advantageous resources, single green financial products and services, lack of professional talents, and frail resultant force of ecological poverty have a strong dependence on and low driving force, indicating that the resolution of these factors depends on the resolution of other factors. Insufficient government guidance, incomplete construction of information sharing platform, and unbalanced development of productivity have relatively high driving forces, which are the most fundamental factors hindering the promotion of green finance in underdeveloped regions, and should be focused on.

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