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The heterogeneous paths to improve eco-environmental quality in China: A fuzzy-set qualitative comparative analysis

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Abstract: A good eco-environment is a fundamental public good and the most inclusive form of well-being. Scientifically designing an effective environmental policy instrument system to improve eco-environmental quality is a common concern of the government and academia. Based on data from 31 provinces in China, this paper explores practical approaches to improve eco-environmental quality from the perspective of regional endowment heterogeneity. First, GIS is used to measure changes in eco-environmental quality from 2015 to 2020, and then the fuzzy-set qualitative comparative analysis is used to assess the configuration influence of environmental policy instruments. The results show that no single environmental policy instrument can constitute a necessary condition for improving eco-environmental quality; There are six paths to improve eco-environmental quality in the four regions of China. Different regional endowments lead to different eco-environmental quality improvement approaches, and the rights transaction of ecological resources is the most common environmental policy instrument. This study provides a reference for designing heterogeneous and effective systems of environmental policy instruments to improve eco-environmental quality in different regions.

Keywords: Eco-environmental quality; Environmental policy instruments; Fuzzy-set qualitative comparative analysis (fsQCA); Heterogeneous paths.

1. Introduction

The eco-environment is the sum of various natural factors of human society and its surroundings, which is the basis of human survival and development [1]. As a typical public good, the eco-environment includes the indivisibility of utility, the non-exclusiveness of benefit, and the non-competitiveness of consumption [2]. Its quality improvement relies on the participation and efforts of numerous parties, which requires the government to implement various environmental policy instruments for overall adjustment and guidance.

Since the reform and opening up, China’s environmental policy instrument system has developed from singleness to multiplicity, broadly divided into four stages. In the initial stage (1978–1988), most of the environmental policy instruments were typically characterized by administrative orders, such as the “Three Simultaneous System” and the “Deadline Rectification Policy”; however, their effect was not pronounced.

During the development period (1988–1998), command-and-control instruments were still dominant; market instruments, such as the pollution charge system, began to appear, and the eco-environmental quality improved. The strategy of sustainable development was implemented in the improvement period (1998–2011), and the development of the environmental policy instruments system entered a new stage in 1998. The market instruments were placed in a more critical position, and voluntary environmental policy instruments, represented by the ISO14000 environmental management standards, also emerged; thus, the eco-environmental quality was improved. The environmental policy system took shape during the promotion period (2012 to present). The single environmental policy instrument is no longer the mainstream; instead, the environmental policy system was formed together with industrial and financial policies. At this stage, China’s eco-environmental quality improved significantly.

In the past, China experimented with different environmental policies and gained significant experience in designing environmental policies; however, few studies have examined the configuration performance of the policy instruments, especially in China. Therefore, based on accurate measurement, this paper explores the effectiveness of different environmental policy combinations in improving eco-environmental quality in different regions. The authors strive to make it practical and replicable, thus contributing to global environmental governance.

The following are some potential contributions of this essay: (1) The fsQCA method was used to study the issue of improving eco-environmental quality, exploring eco-environment improvement paths with asymmetric and complete equivalence. (2) To draw replicable and generalizable conclusions about improving eco-environmental quality, regional differences were fully considered by selecting a region identification method that is widely applicable to most regions globally. (3) New environmental policy tools emerging in practice, such as the nature reserves, the rights transaction of ecological resources, and public-private partnership (PPP), were incorporated into the study to enrich the research system of the environmental policy tools system.

The paper is structured as follows. In the literature review, the paper introduces the research status of environmental policy instruments and constructs a theoretical analysis framework. Then, the fuzzy-set qualitative comparative analysis (fsQCA) was used to test the eco-environmental quality improvement approaches of 31 provincial regions in mainland China. The results of the fsQCA will be discussed and summarized in the next part, and the paper concludes with theoretical and practical significance and its limitations.

2. Literature Review and Framework

2.1. Literature review

Policy instruments are specific methods to address social problems' policy goals and are centered on effectively taking collective action [3]. Different scholars have diverse views on the classification of policy instruments. Bemelmans-Videc et al. [4] identified three types of policy instruments: regulation, economic instruments, and information. McDonnell and Elmore [5] divided policy instruments into command, incentives, capacity building, and system change. The Canadian scholars Howlett et al. [6] proposed a more reasonable and convincing classification, organizing policy instruments into three types according to the degree of government intervention: mandatory instruments with the highest degree of government intervention, hybrid instruments with the medium degree of government intervention, and voluntary instruments with the lowest degree of government intervention. Based on this theory, Chinese scholars considered China's public policies and practices, gradually developing a classification of policy instruments with Chinese characteristics. Among these scholars, Luo and Zhu [7] suggested classifying environmental policy instruments into regulatory instruments based on solid government control, economic incentive instruments based on market mechanisms, and social policy instruments mainly relying on social subjects.

The current research on environmental policy instruments is mainly on the comparison of policy instruments and their different effects. For example, Metcalf [8] found that adopting a reasonable carbon price mechanism (e.g., carbon tax and carbon emissions trading) produced more significant emission reductions than the control-command policy instrument. Zhu and Chen [9] studied the eco-environment of China's ecological focus areas, finding that the ecological transfer payment notably improved its eco-environmental quality. Yang and Zhao [10] found that the government's disclosure of environmental information can improve the eco-environment quality; however, the impact varies from region to region.

The increasing complexity and uncertainty of environmental problems and the limitations of a single policy instrument require a set of combined environmental policy instruments to maximize their effectiveness [11]. The set of policy instruments to achieve a specific policy goal is also referred to as a policy package [12]. The overall impact of different policy instrument sets on policy implementation varies; the interaction between policy instruments could produce strengthening and complementary effects or merely a superposition. In contrast, inappropriate policy combinations may even produce negative results. In recent years, the idea of creating a system of complementary and interdependent policy instruments to improve the overall effectiveness of policies in a specific field has gained recognition [13]. For example, Nissinen et al. [14] investigated the policy package from an empirical perspective, confirming its prominent role in reducing pollutant emissions in the housing, passenger transportation, and food industries, thus minimizing the negative impact and strengthening the complementary and synergistic effects between policy instruments.

Previous studies classify and compare environmental policy instruments with textual analysis or use regression analysis to investigate the net effect of implementing specific policy instruments on improving eco-environmental quality. Additionally, some studies found that some environmental policy instruments have obvious regional heterogeneity in improving eco-environmental quality. These provide an essential reference for this study; however, several shortcomings remain. First, the interaction of policy instruments is so insufficient that it ignores the complexity of the comprehensive effects of the combination of policy instruments. Second, the profound description of a single case refining the eco-environmental quality improvement approach for a certain region makes it difficult to avoid the endogenous promotion risk and dispel the study's reliability and validity. Third, the small amount of survey data fitting the eco-environmental quality situation can lead to insufficient precision. Therefore, it is of great practical significance to accurately measure the regional eco-environmental quality, identify the regional characteristics and development stages, select the combination of environmental policy instruments reasonably, and explore the combination of multiple approaches to improve the eco-environmental quality.

2.2. Framework

This paper's research framework is based on the above studies, as shown in Fig. 1. Based on studies on eco-environment influencing factors, the paper selected relevant indicators from natural and human dimensions to distinguish the study area by combining the accessibility of independent variable indicators [15]. The authors choose the initial eco-environmental quality to represent the regional natural factor and the economic development as the regional human factor. On this basis, environmental policy instruments are divided into three types: regulatory policy instruments, economic policy instruments, and social policy instruments.

2.2.1. Regulatory policy instruments

Regulatory policy instruments are based on the coercive power of the government and mainly refer to the government's improving eco-environmental quality through regulation. The most common type is legislation or regulations limiting enterprises' pollution emissions [16]. Furthermore, many studies have shown that irrational land use structure is a significant cause of eco-environmental quality deterioration [17]. In China, this problem is addressed by establishing nature reserves and strictly controlling the exploitation of protected land resources. This paper uses administrative penalties and the establishment of nature reserves as subdivision types for regulatory policy instruments.

2.2.2. Economic policy instruments

Economic policy instruments internalize environmental pollution externalities by combining economic agents' "cost-benefit" with economic regulation and market mechanisms. According to Coase's theorem, if there are determined property rights of the eco-environment and low transaction costs, the externality problem can be solved by the market [18]. In ecological resource equity trading, China's carbon emission trading market has developed rapidly. In October 2011, the first pilot project was carried out in seven provinces and cities, and the national carbon market transaction was launched in 2021. Compared with the carbon emission trading market, the development of energy use rights, emission rights, and water rights trading is relatively slow; however, national pilot projects exist, and provinces are also actively exploring on their own. Simultaneously, Pigou [19] argues that the government can correct externalities through taxation or subsidies. The government pays the positive externalities as a public agent, including fiscal transfers [20] and payments to enterprises with positive externalities. For negative externalities, producers must incorporate resource and environmental costs into production costs, compensating for the public costs of resource and environmental exploitation by taxing users on pollution and increasing firms' demand for pollution control and cleaner production[21]. However, because complete environmental taxation statistics are lacking, this paper chooses fiscal transfer payment and rights transaction of ecological resources to characterize economic policy instruments.

2.2.3. . Social policy instruments

Social policy instruments refer to achieving ecological improvement goals promoted by diversified subjects based on voluntary mechanisms. For example, the higher the degree of public supervision and participation in local government environmental governance, the higher the public demand. The stronger the supervision over the local government's behavior is, the more it is beneficial to ecological improvement [22]. At the same time, social organizations can also undertake government procurement of services in resource and environmental governance, including energy saving and emission reduction brought by scientific and technological innovation and the role of technological innovation in environmental governance [23]. In this paper, the authors choose Public-Private Partnership (PPP), public supervision, and green technological innovation as the subdivision types of regulatory policy instruments.

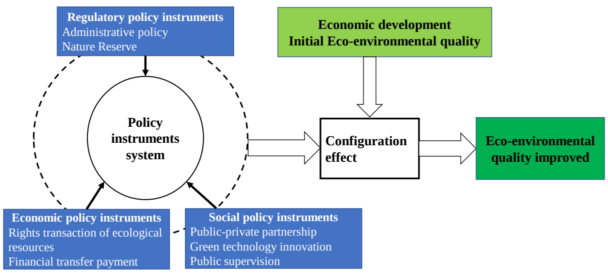

Fig. 1. Framework

3. Methodology and sample

3.1. fsQCA

With the combination of categories and degrees of set affiliation, fsQCA has both qualitative and quantitative properties. It is based on set theory and Boolean algebra to study how combinations of conditions affect the outcome [24]. The membership score of 0~1 reflects the degree of membership to a specific condition. Among them, 0 represents a full nonmember ship, and 1 represents a full membership. Unlike clear sets, the basic idea is to allow the scaling of set scores; thus, partial membership is allowed. The authors check whether the outcomes are valid through *Consistency* and *Coverage* during configuration analysis [25]. *Consistency* is a sufficient condition to investigate the extent to which conditions or combinations can form outcomes, while *Coverage* refers to the extent to which the set passing the consistency test explains the outcomes [26]. The *Consistency* and *Coverage* values are between 0 and 1. The calculation formulas are:

$$Consistency\ (X_i \leq Y_i) = \sum[\min(X_i, Y_i)]/\sum(X_i) \quad (1)$$

$$Coverage\ (X_i \leq Y_i) = \sum[\min(X_i, Y_i)]/\sum(Y_i) \quad (2)$$

In formula (1) and formula (2), X_i is a sufficient condition for Y_i, and the representation on the set is that subset X belongs to the target set Y. This paper chooses fsQCA to discuss the improvement paths of the eco-environment quality, mainly based on the following considerations. First, the paths to improving eco-environmental quality are not unique, and the combination of different policy instruments may affect "different paths leading to the same goal," which cannot be explained by traditional measurement methods. Second, the interaction between policy instruments is also the focus of this paper. If only qualitative analysis is adopted, it would be challenging to avoid subjective bias; however, the traditional regression analysis focuses more on the net effect between variables, which is difficult to explain the multiple causals and concurrent problems of improving eco-environmental quality. Third, an asymmetry exists in improving eco-environmental quality; for example, the environmental administrative penalty can improve eco-environmental quality. Traditional statistical methods believe that eco-environmental quality cannot be improved without environmental administrative penalties. Actually, developing green technology can still improve eco-environmental quality. fsQCA considers the advantages of qualitative and quantitative analyses, focusing on multiple causal concurrent problems [27]. It is helpful to scientifically identify the combination of policy instruments that can effectively promote eco-environmental quality and conclude a practical approach to improve it.

3.2. Sample

Eco-environmental quality improvement can be studied at the national and provincial levels or the smaller spatial scale of prefecture-level cities, counties, and towns. The larger the spatial scale, the more emphasis is placed on the macro characteristics of the research object; the smaller the spatial scale, the more emphasis is placed on the microscopic characteristics of the research object. This article refers to the requirements of the fsQCA research method for case selection [28]. First, the number of cases is within the range of 10~60, meeting the requirements of medium-scale samples. Second, each research sample can reflect the improvement of eco-environmental quality, and its condition variables are similar and comparable, meeting the requirements of case homogeneity. Third, the selected cases should include "positive cases" of improving eco-environmental quality and "negative cases" of not improving eco-environmental quality. These two cases should meet the requirements of the cases' maximum internal heterogeneity. Finally, data from 31 provinces in mainland China during the "13th Five-Year Plan" period were selected as research cases.

3.3. Variables and data

3.3.1. Outcome variable

Eco-environmental Quality Index (EQI): This paper measures the improvement degree of regional eco-environmental quality by comparing the difference between the EQI of 31 provincial administrative regions in China in 2015 and 2020. Compared with traditional research that selects a few statistical indicators to represent the regional eco-environmental quality, the calculation of EQI value relies on geographical remote sensing, making the results more accurate and improving research reliability. The regional eco-environmental quality improved if a region's EQI value increased during the investigation period. According to the Technical Criterion for Ecosystem Status Evaluation issued by the Ministry of Ecology and Environment of the People's Republic of China in 2015, the EQI formula is listed below:

$$EQI=0.35\times BRI+0.25\times VCI+0.15\times WNDI+0.15\times(100-LSI)+0.1\times(100-PLI) \quad (3)$$

In formula (3), BRI is the biological richness index, VCI is the vegetation coverage index, WNDI is the water network density index, LSI is the land stress index, and PLI is the pollution load index. Because the statistical standard of pollution emissions in the China Statistical Yearbook has been changed, each region's average air quality index in the current year is used to represent the PLI after normalization. The vegetation coverage index adopts the NDVI synthetic data of MOD13, including the average value of the maximum NDVI of the July and August pixels. To ensure the comparability of data in different years, the authors select the maximum value of various data types in 2 years for normalization, and other index calculation methods shall be strictly implemented following the standards. The data of BRI, VCI, WNDI, LSI, and PLI in different provinces are sourced from the Resource and Environmental Science Data Center of the Chinese Academy of Sciences.

3.3.2. Condition variables

(1) Economic Development (ED): The authors compensate for the lack of a single indicator by referencing the existing research and selecting four sub-indicators: per capita gross domestic product, per capita completion of fixed asset investment, per capita total retail sales of consumer goods, and per capita total import and export of goods. After normalization, the weighted average is used to calculate the regional economic development. The data on per capita gross domestic product, per capita completion of fixed asset investment, per capita total retail sales of consumer goods, and per capita total import and export of goods in different provinces are sourced from the National Bureau of Statistics of China.

(2) Initial Eco-environmental Quality Index (IEQI): To represent the initial regional eco-environmental quality, the authors selected the EQI value of each region in 2015. The EQI value varies from 0~100. The closer the EQI value is to 100, the better the regional eco-environmental quality will be.

(3) Administrative Penalty (AP): The authors select the number of environmental administrative penalty cases in each province from 2016 to 2020 to illustrate the adoption of administrative penalties. The data on the number of environmental administrative penalty cases in different provinces are sourced from the National Bureau of Statistics of China.

(4) Nature Reserve (NR): The authors select the proportion of the nature reserves in each province to illustrate the implementation of the nature reserve establishment. The data on nature reserve areas in different provinces are sourced from the National Bureau of Statistics of China.

(5) Rights Transaction of Ecological Resources (RTER): the indicator is described by the sum of assigned values of the number of national and provincial pilot projects for carbon emission rights, emission rights, water right, and energy use rights trading in each province. The authors assign a value of 1 to each national RTER pilot region, and a value of 0.5 to each provincial RTER Pilot region [29]. The final total score is used as the application of the policy instrument for RTER in the region. The data of national RTER and provincial RTER in different provinces are sourced from policy documents issued by the State Council of China and its provinces.

(6) Public-Private Partnership (PPP): The authors select the number of PPP projects in the implementation stage related to eco-environmental quality improvement in each region to represent the usage of such policy instruments. The data on the number of PPP projects in different provinces are sourced from China Public Private Partnerships Center.

(7) Financial Transfer Payment (FTP): The authors select the proportion of the local government's environmental protection expenditure in the total financial expenditure to reflect the implementation of the fiscal transfer payment policy. The data on the local government's environmental protection expenditure and the total financial expenditure in different provinces are sourced from the National Bureau of Statistics of China.

(8) Green Technology Innovation (GTI): Patent applications take 1~2 years, and not all applications will be approved; therefore, the total number of green patents approved in each region during the study period is selected to represent the regional green innovation technology development level. The data on the total number of green patents approved in different provinces are sourced from China National Intellectual Property Administration.

(9) Public Supervision (PS): The authors adopt the environmental policy instrument of public supervision based on the total number of environmental proposals of the CPPCC and NPC in various regions from 2016 to 2020. The data on the total number of environmental proposals of the CPPCC and NPC are sourced from the National Bureau of Statistics of China.

According to the region endowment (ED, and IEQI in 2015), and the change of EQI values of 31 provinces in mainland China from 2015 to 2020, four different region types are distinguished (Fig. 2). The eco-environmental and economic coordination region represented by Guangdong and Zhejiang, the eco-environmentally lagging region represented by Shandong and Nei Mongo, the economically lagging region represented by Yunnan and Guangxi, and eco-environmentally and economically lagging region represented by Gansu and Qinghai. In Fig. 2, the coordinate of the bubble corresponds to the EQI and economic development of each province in 2015. The size of the bubble corresponds to the changes in the EQI of each province from 2015 to 2020. The larger the bubble area, the higher EQI of the province was improved. Different colors are used to distinguish different region types. Regions with coordination of eco-environment and economy are marked green, eco-environmentally lagging regions are marked yellow, economically lagging regions are marked blue, and eco-environmentally and economically lagging regions are marked orange.

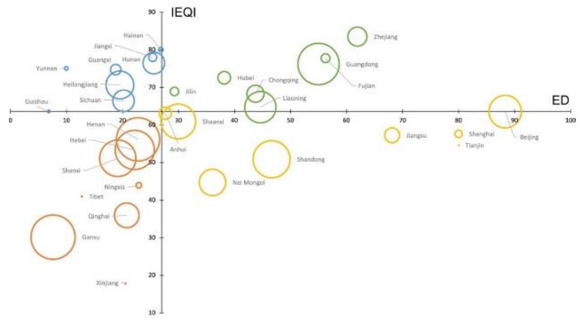

Fig. 2. The EQI changes of China's 31 provinces from 2015 to 2020 based on IEQI and ED in 2015.

3.3.3. Variable calibration

The data should be calibrated to convert the original data of each variable into a set membership between 0 and 1. Regarding the processing method from Garcia-Castro and Francoeur [30], the authors set three collective membership critical values—full membership (0.95), intermediate point (0.5), and full nonmembership (0.05)—and take the values of each variable at 25%, 50%, and 75% as the calibration reference.

The authors then set the original consistency, PRI (positive reduction in nonconformity) consistency, and case frequency thresholds to 0.8, 0.5, and 1, respectively [31]. After the fsQCA method is used to calculate, the truth table is derived, and the obtained configuration results are analyzed.

4. Results and discussion

4.1. Necessity analysis of univariate

If the consistency of a univariate is greater than 0.9, the univariate can directly illustrate the results[32]. The univariate necessity test results (Table 1) show that the condition variables do not constitute the necessary conditions for improving the eco-environment quality. Therefore, the improvement of eco-environment quality is the result of the joint action of multiple factors, which needs further investigation with the help of condition variable configuration analysis.

Table 1 Univariate necessity test results.

Conditions	Outcome	
	Consistency	Coverage
ED	0.508	0.527
~ED	0.562	0.549
IEQI	0.501	0.517
~IEQI	0.581	0.570
RTER	0.712	0.640
~RTER	0.365	0.418
FTP	0.635	0.636
~FTP	0.434	0.439
GTI	0.609	0.614
~GTI	0.466	0.468
AP	0.615	0.648
~AP	0.494	0.476
PPP	0.619	0.621
~PPP	0.505	0.510
NR	0.544	0.543
~NR	0.528	0.536
PS	0.622	0.601
~PS	0.494	0.476

Note: "~" and "*" are relational symbols in set theory, respectively representing "NEGATION" and "AND".

4.2. Configuration analysis of condition variable

The calculation results can be divided into complex, intermediate, and parsimonious solutions according to whether the logical remainder is included. The intermediate solution only contains the logical remainder that conforms to the theoretical direction, the expectation of empirical evidence, and balances rationality and simplicity; thus, it is often used as the basis for theoretical analysis [31]. This study's intermediate solution results show that there are 6 paths to improve eco-environmental quality (Table 2), and the consistency of all paths exceeds 0.8, indicating that the above paths are highly sufficient to improve eco-environmental quality. The solution consistency and solution coverage of the configuration are 0.931 and 0.361 respectively, which are higher than the basic requirements of QCA research; that is, the solution consistency is higher than 0.8, and the overall coverage is higher than 0.3[34].

Table 2 Intermediate solution for the positive outcome.

Configurations		Causal Paths					
		Eco-environmental and economic coordination region		Ecologically lagging region		Economically lagging region	Economically and ecologically lagging region
		A1	A2	B1	B2	C1	D1
Regional Endowment	ED	•	•	•	•	○	○
	IEQI	•	•	○	○	•	•
Policy Instruments	AP	○	•	•	○	•	•
	NR	•	•	○	○	•	○
	RTER	•	•	•	•	•	•
	FTP	•	•	○	•	○	•
	PPP	○	○	•	•	•	•
	GTI	○	•	•	•	•	•
	PS	•	○	•	○	•	×
Raw Coverage		0.066	0.048	0.047	0.053	0.060	0.167
Unique Coverage		0.045	0.033	0.032	0.026	0.040	0.140
Consistency		0.866	0.884	0.869	0.953	0.816	0.967
Solution Coverage		0.361					
Solution Consistency		0.931					

Note: "●" and "○" indicate the existence and absence of a core antecedent condition, respectively. "×" can indicate either existence or absence of antecedent conditions.

4.3. Robustness test

Table 3 Robustness test results.

Configurations		Causal Paths				
		Eco-environmental and economic coordination region		Ecologically lagging region		Economically and ecologically lagging region
		A1	A2	B1	B2	D1
Regional Endowment	ED	•	•	•	•	○
	IEQI	•	•	○	○	•
Policy Instruments	AP	○	•	•	○	•
	NR	•	•	○	○	○
	RTER	•	•	•	•	•
	FTP	•	•	○	•	•
	PPP	○	○	•	•	•
	GTI	○	•	•	•	•
	PS	•	○	•	○	×
Raw Coverage		0.066	0.048	0.047	0.053	0.167
Unique Coverage		0.045	0.033	0.032	0.026	0.140
Consistency		0.866	0.884	0.869	0.953	0.967
Solution Coverage		0.944				
Solution Consistency		0.321				

Note: "●" and "○" indicate the existence and absence of a core antecedent condition, respectively. "×" can indicate either existence or absence of antecedent conditions.

The current research mainly adopts the specific methods of set theory and uses one or more specific methods to test the robustness, such as adjusting the calibration threshold, changing the frequency of cases, changing the consistency threshold, and eliminating cases [35]. Since the number of cases in this paper is small and the cases in each region are essential, the authors choose to increase the consistency threshold to 0.85 for the robustness test. After the test, one path with C1 is selected, and the results (Table 3) show that the solution consistency becomes 0.944, the solution coverage becomes 0.321, and there is no significant change in the overall outcome, indicating that the research results are highly reliable [35].

4.4. Discussion

The information in Table 1 shows that no single variable constitutes a necessary condition for the outcome variable at the measurement level; however, the in-depth analysis from Table 2 revealed that RTER appears in all 6 paths, indicating that it constitutes a necessary condition for improving eco-environmental quality to achieve the outcome variable. RTER's main feature is that the government conducts top-level ecological design from a macro perspective, delimits the right to use and manage ecological resources, and promotes the protectors of the eco-environment to benefit, users to pay, and those who damage to compensate through the market-oriented operation mode, a policy instrument applicable to all regions to improve eco-environmental quality.

From table 2, we can easily find that the paths for effective improvement of eco-environmental quality are very different in the four regions of China. The different characteristics of the paths for effective improvement of eco-environmental quality in four regions are illustrated as follows.

4.4.1. Eco-environmental and economic coordination region (Region A)

Region A is economically developed and has good eco-environments, mostly located in eastern China. The terrain is mainly plains and hills, home to rich natural resources, a high level of industrialization, and a high degree of social development. When economic development reaches a certain level, the good eco-environmental demand increases. The local government attaches importance to the coordinated development of the eco-environment and economy and has completed green development transformation earlier.

The corresponding configuration is A1 and A2 to effectively improve eco-environmental quality in region A (table 2). Guangdong and Zhejiang are the typical provinces of A1 and A2 respectively. After the Boolean algebra minimization operation, the eco-environment improvement paths A1 and A2 are merged into "NR * RTER * FTP *~PPP"; that is, the combination of regulatory instruments and economic instruments plays a leading role in region A. Specifically, region A has sufficient finance, and the government attaches great importance to ecological development. The eco-environmental quality can be improved by limiting ecological function areas and making reasonable compensation through financial transfer payments. At the same time, owing to the high degree of social development in region A, the market participants are willing to participate in the rights transaction of ecological resources, and there is less resistance to implementing the RTER pilot regions, which is also an important policy instrument in practice. It is worth noting that PPP was not adopted in the table; it may be that the eco-environments of region A are already at a high level, and there is little demand for protection and restoration.

4.4.2. Ecologically lagging region (Region B)

Region B has developed economies, but poor eco-environments and economic development are transitioning from extensive growth to intensive growth. The eco-environmental problem needs to be solved urgently in region B.

The corresponding configuration is B1 and B2 to effectively improve eco-environmental quality in region B (table 2). Shandong and Nei Mongo are the typical provinces of B1 and B2 respectively. After the Boolean algebra minimization, the eco-environmental quality improvement paths B1 and B2 are merged into "~NR* RTER * PPP * GTI"; economic and social instruments play a leading role in region B. Furthermore, the environment of region B has been damaged, and its self-repair ability is poor. Eco-environmental quality improvement through natural reserves is ineffective. Therefore, it is necessary to develop green technology and use PPP to conduct eco-environment restoration projects and combine the ability of manual regulation with the ability of natural restoration. Simultaneously, there are many enterprises with high pollution and high energy consumption in region B, and the policy instruments for RTER are also well suited to such areas.

4.4.3. Economically lagging region (Region C)

Region C has nice eco-environments but backward economies, which are home to rich natural resources and pleasant scenery. Owing to the limitation of landform and location factors, the degree of development is low, and the slow economic growth lessens environmental pollution.

The corresponding configuration is C1 to effectively improve eco-environmental quality in region C (table 2). Yunnan and Guangxi are the typical provinces of C1. The eco-environment improvement path C1 shows that "AP * NR * RTER * PPP * GTI * PS*~FTP"; three policy instruments need to appear jointly in region C, which is limited by financial ability. Therefore, it is not easy to implement financial transfer payments in region C, and all other policy instruments have been adopted. Methods of developing the economy without sacrificing the environment should be considered. Therefore, local governments in region C, on the one hand, avoid environmental damage in economic development through macro-command control and setting resource quotas; on the other hand, they also explore the path of green development through PPP, encouraging green innovation and public supervision.

4.4.4. Economically and ecologically lagging region (Region D)

At present, Region D has difficulties in the economy and eco-environment. They are mainly located in the middle and upper reaches of the Yellow River and Yangtze River and have more than half of China's key national ecological function areas. Such areas have fragile eco-environments, frequent natural disasters, complex terrain, and inconvenient transportation, and their economic development is greatly restricted by poor natural conditions.

The corresponding configuration is D1 to effectively improve eco-environmental quality in region D (table 2). Gansu and Qinghai are the typical provinces of D1. The eco-environmental quality improvement path D1 shows that "AP*~NR * RTER * FTP * PPP * GTI"; three types of policy instruments need to be adopted in region D. Like region B, it is challenging to improve eco-environmental quality by establishing natural reserves; however, compared region C, region D has more ecological key functional areas. Furthermore, although local financial funds are insufficient, the central ecological transfer payment is adequate. Additionally, the possible reason PS was not adopted in region D is that the social development level in such areas is low and the people's environmental awareness is not strong.

5. Conclusion

Based on the theory of public goods, this paper uses the fsQCA method to investigate the ideal path to eco-environmental quality improvement under different regional endowments in mainland China from 2015 to 2020. The main conclusions are as follows.

First, eco-environmental quality improvement requires multiple policy instruments. The single variable necessity test result shows that none of the antecedents has become necessary for improving eco-environmental quality, providing a basis for subsequent theoretical research and policy formulation.

Second, the economic policy instruments are applicable in all regions, among which the RTER is the most representative. Although the aforementioned variables do not constitute the necessary conditions for outcome variables at the measurement level, they are policy instruments worth promoting at the practical level.

Finally, regional heterogeneity can lead to the differentiation of eco-environmental quality improvement. The empirical results show six paths to improve eco-environmental quality in four regions of China from 2015 to 2020 and different regions have different combinations of policy instruments for eco-environmental quality improvement. Economic policy instruments appear in all regions. In addition, regulatory policy instruments appear in the improvement paths of eco-environmental quality in region A, social policy instruments appear in the improvement paths of eco-environmental quality in region B, and three types of policy instruments appear in the improvement paths of eco-environmental quality in region C and region D. Thus, local governments need to adopt the combination of policy instruments according to local conditions.

Nevertheless, this article has several limitations. First, regarding the variable selection, due to data availability, some policy instruments have not been included in the empirical analysis herein. Therefore, more policy instruments such as green finance and the digital economy should be considered in future research. Second, in terms of the research scope, owing to the limitations of the fsQCA method, this paper only considers a combination of policy instruments within the region and ignores the interaction and impact of policy instruments among regions. For example, the ecological compensation payment of developed regions to underdeveloped regions should be discussed in future research. Third, this paper mainly focuses on policy collocation in the macro-field without involving micro-personal behavior.

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