An Empirical Analysis of the Impact of Environmental Decentralization on Environmental Governance in China

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Abstract. Environmental problems are particularly prominent in the context of carbon neutrality. The root cause of the environmental dilemma lies in the system. Therefore, this article discusses whether China is an environmental federalist country based on the perspective of environmental management system changes, and portrays China based on the two dimensions of environmental management system and fiscal decentralization. Changes in the system of environmental decentralization. With the help of environmental affairs responsibilities, the overall environmental decentralization is divided into administrative decentralization, monitoring decentralization, and supervision decentralization. The number of environmental protection agencies and the coverage of environmental protection agencies are used to calculate the Chinese-style environmental decentralization index during 1993-2015. The current environment in the western region Decentralization is still at a relatively low level. Through empirical analysis, the results show that the level of environmental governance is negatively correlated with environmental decentralization, which reflects the strengthening of the degree of centralization under the framework of environmental decentralization in China, such as the implementation of vertical management reform of environmental protection agencies, which will further improve local governments. Environmental governance level.

1. Introduction
In recent years, environmental problems caused by insufficient environmental basic public services and improper environmental pollution control have emerged one after another. After the superstructure of the environmental protection system is built, its effective operation depends on the system executives, that is, the administrative personnel, and the administrative personnel the efficiency of the operating system depends on the design of the management system. For this reason, the environmental management system serves as a bridge between the system and environmental protection effects, and its design is crucial to environmental management.

To clarify the relationship between environmental management systems, it is necessary to explore the relationship between centralization and decentralization of power between the central and local governments. After the reform of the tax-sharing system, there has been a situation of upward shifting of financial power and decentralization of power between the central and local governments. At the same time, with the strengthening of fiscal decentralization worldwide, whether to adopt
decentralization in developing countries has led to a new debate, namely, whether decentralization is good for developing countries whose local institutions may be weak. As the largest developing country, China should pay attention to this point.

According to the "Decentralization Theorem", each public service should be provided by the jurisdiction that controls the smallest geographic area in order to internalize the benefits and costs of such clauses. Environmental management as a kind of public service should also satisfy this theorem, but environmental federalism is a very complex issue. It is far from enough to analyze environmental issues based on China's fiscal decentralization. It is subject to the special nature of environmental management. Environmental federalism is also affected by externalities, jurisdictional competition, tax interactions, and lobbying. Therefore, in this section, the theoretical evolution from fiscal federalism to environmental federalism will be elaborated and the essence of environmental federalism will be pointed out. This article will clarify the internal operation logic of China's environmental affairs on the theoretical basis, sort out the environmental management system, and construct a Chinese-style environmental federalism indicator system. Then, the measured environmental decentralization index and environmental management level are empirically analyzed to explore the impact of environmental decentralization on environmental management.

2. A review of the literature

Current research focuses on preferences, jurisdictional competition and externality. In terms of preference, it has been argued that centralization is sub-optimal if there is a preference for heterogeneity between jurisdictions (Peltzman and Tideman, 1972; Oates and Schwab, 1996). This is because strong differences between Governments can lead to significant losses in small jurisdictions (Burtraw and Porter, 1991; Dinan, etc., 1999). Oates (1999, p. 1120) writes: "Hopefully state and local governments will be closer to the people and will respond better to the specific preferences of their constituencies..." Adler (2005, p. 138) claims that "local control of environmental policy will result in environmental measures that are more likely to reflect the preferences and needs of those most affected." Or central policy uses coordination mechanisms to address the problem. Finally, in terms of jurisdictional competition, the theory is that there are different outcomes in this area, with the opposing party Cumberland (1979) arguing that because of "disruptive jurisdictional competition", de-empowerment can lead to a serious decline in environmental quality and so-called "bottom-to-bottom competition" may lead to too many environmental regulations. The Markusen, Morey and Olewiler (1995) models reveal the efficiency impact of cross-jurisdictional environmental regulatory competition in the Nash equilibrium framework. Opponents Oates and Schwab (1988) explained "competitors" in a model that showed the efficiency of environmental regulatory competition among the management of liquidity between communities of even real estate workers. Therefore, from an empirical point of view, empirical research focuses on the analysis of the consequences of decentralization in the context of the environment (Dinan, etc., 1999; List and Gerking, 2000; Fredriksson and Millimet, 2002; Millimet, 2003; Millimet and List, 2003; Fomby and Lin, 2003). Most of these studies fail to find empirical evidence of the "bottom-by-bottom competition" effect and empirical analysis is mostly a direct study of whether there is a phenomenon of top-level competition in countries with environmental power-esclocking, or whether financial power-thriving instead of environmental weight-esclocking analysis is empirical research, rarely directly using environmental power-thrivation and environmental quality to conduct direct research, and few scholars from developing countries have put forward empirical scope studies, and China, as the largest developing country, uses China's empirical data to assess the effect of environmental power-thrivation can provide advice for China's development. And improve the scope of world experience analysis.

The current literature research focuses on the approximate replacement of environmental federalism with fiscal de-empowerment indicators, depicting the behavior logic and results of local governments after the de-empowerment (Fu Yong, 2010; Zhang Ke, Wang Wei, Cui Xiaoyong, 2011), and some direct research The relationship between Chinese-style fiscal de-empowerment and environmental pollution, trying to tap into the mechanism of its role (Zhang Xinyi, 2014; Tan Zhixiong, Zhang
Yangyang, 2015) and then focusing on the strategic behavior of local governments' environmental protection expenditures (Zhang Zhengyu, Zhu Pingfang, 2010) and from the perspective of correcting negative externality, of course, there are parts focused on the legal aspects of environmental management system (Dong Hua, 2007).

3. The intension and institutional change of China's environmental power-thration

3.1. Intension Definition
Environmental decentralization refers to the degree of environmental management or the degree of decentralization of environmental affairs with basic environmental public services as the core.

3.2. Institutional changes in China's environmental power-thrationation
The development of our country's environmental management system has mainly gone through the following four stages:

Phase I (1973-1993): China is in the process of an over-decentralized environmental decentralization system. China adopts the contracting system model of excessive decentralization of financial power, that is, the central government relies on "reverse transfer payment", at this stage, China's environmental protection agencies have gone through the process from the beginning of legislation to wandering back and forth to independence.

Phase II (1994-2007): In the framework of environmental de-empowerment under fiscal centralization, central control over environmental affairs is strengthened. In 1994, the tax-sharing reform, the central government's financial power layer up, the power concentration, the voice of the increase, the decentralization of the power layer, the central government financial power is not equal. This stage and the first generation of fiscal federalism theory and income to adopt a centralized system, but the implementation of the power-between system, it is not difficult to see that the central control under the framework of the power-thorism has been strengthened.

Phase III (2008-2016): This stage is in the financial centralization of the central government under the environmental de-empowerment mechanism to strengthen local economic incentives and improve the legal status. At this stage, the central government enhances environmental protection through conceptual and economic incentives.

Phase VI (2016-present): Fiscal decentralization shows a significant strengthening of centralization under the institutional framework of environmental decentralization. In 2016, China launched a pilot vertical management, with provincial departments directly managing municipal monitoring institutions, solving the dilemma of low voice of local environmental institutions, and cracking the intervention of local protectionism in environmental monitoring and enforcement. Secondly, the central government strengthens the coordination of cross-basin areas, requires the improvement of air pollution prevention and control, the current regional air pollution prevention and control coordination mechanism is running well, but the coordination is weak, this stage, under the framework of environmental division, the use of vertical management, monitoring and monitoring power is centralized, indivisible environmental externality caused by local spillover effects are needed to cross-basin coordination mechanism to be resolved.

4. The measurement of environmental weighting index under the change of environmental management system

4.1. The measurement of the environmental weighting index
The division of power of the environment is not the division of power in legal sense, but the de facto division of power, the provision of basic public services and pollution prevention and control of these facts are carried out by public officials of the environmental protection department, drawing on the measurement method of environmental de-empowerment (Yu, Lu Hongyou, 2014), based on this we believe that we can not simply replace the division of environmental power with fiscal de-empowerment,
but should be based on the implementation of environmental affairs to divide the environmental division of power, from the provincial level according to the degree of implementation of the transaction analysis, Therefore, we select the main implementation aspects of local environmental protection departments: environmental administration and management services, environmental monitoring services and environmental monitoring services to measure the number of environmental rights. The implementation of environmental affairs depends on environmental protection agencies and personnel at all levels, so we will measure the degree of decentralization of environmental affairs from the number of environmental protection agencies and the coverage of environmental protection agencies, environmental protection agencies' coverage indicates whether the local environmental protection agencies implement the decentralization of authority, the number of environmental agencies reflect the degree of decentralization given to the local environment, we build a comprehensive environmental decentralization index measurement system in line with Chinese characteristics.

The calculation formula is shown in Table 1, and for this indicator, taking into account the expansion of public services is affected by economic growth, in order to solve this endo-natured problem, we use the weighting indicator to be reduced by the use of the 1-(GDPit/GDP). When combining the two indicators, our measurement data selected the panel data of 31 provinces from 1993 to 2015, which is based on the objective data of the facts, and if the standardized method is adopted, the variation information of the indicators will be eliminated, which does not reflect the differences between the provinces very well, so the use of erration processing can eliminate both the scale and the variability between the indicators.

### Table 1. Environmental Deorge - Indicators

| Metrics and types                        | Formula                                                                 |
|------------------------------------------|-------------------------------------------------------------------------|
| Environmental power-thration (ED\(^2\))  | \( E_{Dit} = \frac{(LEPP_{it}/POP_{it})}{NEPP_{it}/POP_{it}} \times [1 - (GDP_{it}/GDP_{t})] \) |
| Administrative division of powers (EAD\(^1\)) | \( E_{Ait} = \frac{(LEAP_{it}/POP_{it})}{NEAP_{it}/POP_{it}} \times [1 - (GDP_{it}/GDP_{t})] \) |
| Monitoring the power-thration (EMD\(^1\)) | \( E_{Mit} = \frac{(LEMP_{it}/POP_{it})}{NEMP_{it}/POP_{it}} \times [1 - (GDP_{it}/GDP_{t})] \) |
| Monitoring of the division of powers (ESD\(^1\)) | \( E_{Sit} = \frac{(LESP_{it}/POP_{it})}{NESP_{it}/POP_{it}} \times [1 - (GDP_{it}/GDP_{t})] \) |

**Variables and meanings:**
- \( LEPP_{it}, LEAP_{it}, LEMP_{it}, LESP_{it} \): Represents the first t-year environmental protection system personnel, environmental protection administrators, environmental monitors, environmental monitors;
- \( NEPP_{it}, NEAP_{it}, NEMP_{it}, NESP_{it} \): Represents the tth year of the national (including central and local) environmental protection system personnel, environmental protection administrators, environmental monitors, environmental monitors;\( POP_{it} \) Indicates the size of the population in the second year of the province of i, the size of the total population of the country in year \( POP_{t} \), \( GDP_{it} \) the gross domestic product of the second province in the second year, \( GDP_{t} \) and the gross national product in year \( t \)

### Table 2. Environmental Weighting - Environmental Agency Indicators and Variable Meanings

| Metrics and types                        | Formula                                                                 |
|------------------------------------------|-------------------------------------------------------------------------|
| Environmental power-thration (ED\(^2\))  | \( E_{Dit}^2 = \frac{(JG_{it})}{QH_{it}} \)                              |
| Administrative division of powers (EAD\(^2\)) | \( E_{Ait}^2 = \frac{(JG_{it})}{QH_{it}} \)                              |
| Monitoring the power-thration (EMD\(^2\)) | \( E_{Mit}^2 = \frac{(MIG_{it})}{QH_{it}} \)                             |
| Monitoring of the division of powers (ESD\(^2\)) | \( E_{Sit}^2 = \frac{(SIG_{it})}{QH_{it}} \)                             |

**Variables and meanings:**
- \( JG_{it}, AJG_{it}, MJG_{it}, SIG_{it} \): Represents the number of county-level environmental protection agencies, the number of county-level environmental protection administrative agencies, the number of county-level environmental monitoring institutions, and the number of county-level environmental monitoring institutions, respectively;
- \( QH_{it} \) Represents the number of county administrative divisions in the tth year of province i.
The calculation basis of entropy theory is sample observation, which empowers the research object from the angle of objective data. You can make the results of the weights more reasonable. Here's how:

Set to the entropy value of the jth evaluation indicator, according to the calculation formula of the entropy value,

$$e_i = -\frac{1}{\ln n} \sum_{i=1}^{n} f_{ij} \ln f_{ij}, \text{ where } e_j > 0$$ (1)

$$f_{ij} = \frac{x_{ij}}{\sum_{i=1}^{n} x_{ij}}$$ (2)

For the characteristic proportion of the first indicator in the i system, for the data for the indicator j in the ith system, for the total of all system data for the indicator j as shown in equation 3:

$$w_j = \frac{1 - e_i}{n - \sum_{j=1}^{n} e_i}$$ (3)

The entropy right calculated from this is the weight of the indicator.

| Table 3. Environmental weighting |
|----------------------------------|
| **Environment power** (ED)       | ED = 0.79 * ED^1 + 0.21 * ED^2 | ED represents the total environmental de-ed |
| Administrative Division of Powers (EAD) | EAD = 0.79 * EAD^1 + 0.21 * EAD^2 | The EAD represents the total administrative division of authority |
| Monitoring de-empowerment (EMD) | EMD = 0.79 * EMD^1 + 0.21 * EMD^2 | EmD represents the total monitoring of the degree of de-importance |
| Monitoring de-empowerment (ESD) | ESD = 0.79 * ESD^1 + 0.21 * ESD^2 | The ESD represents the degree of monitoring de-empowerment |

4.2. The results of the calculation

By selecting the China Statistical Yearbook, the number of environmental protection agencies, GDP, POP and other indicators in the China Environmental Yearbook, this paper calculates the overall weighting of the provinces from 1993 to 2015 - the number of personnel of environmental institutions (as shown in the table below), the indicators of the number of personnel of administrative and environmental institutions, the indicators of the number of people of environmental agencies, the number of monitoring of the degree of authority - the number of personnel of environmental institutions; Environmental agency coverage index (as shown in Table 4), administrative authority - environmental agency coverage index, monitoring authority - environmental agency coverage index, monitoring weighting - environmental agency coverage index;

| Table 4. Overall Weighting - Environmental Agency Coverage Metrics |
|---------------------------------------------------------------|
| Place/year | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 |
| National   | 1.06 | 1.05 | 1.09 | 1.10 | 1.07 | 0.96 | 0.88 |
| Beijing    | 0.91 | 0.89 | 0.76 | 0.70 | 0.65 | 0.66 | 0.45 |
| Tianjin    | 1.68 | 1.62 | 1.07 | 1.03 | 0.98 | 3.43 | 2.56 |
| Hainan     | 1.31 | 1.36 | 1.51 | 1.50 | 1.26 | 1.28 | 1.11 |

Note: For layout reasons, only a small number of calculations are available in this section.

4.3. The results of the calculation

It is calculated that the average environmental deregulation in China for the period 1993-2015 was 1.027, indicating that the average size of local environmental management institutions during this period was higher than that of the central environmental management institution.
5. The empirical analysis of environmental power-es and environmental governance

Using the provincial panel data from 2001 to 2015, the empirical analysis of environmental de-empowerment and environmental governance is carried out, and the static panel data model is established by reference to Xue Gang and other (2012) analysis methods:

\[ EG_{i,t} = \alpha_i + \beta_1 ED_{i,t} + \beta_2 TP_{i,t} + \sum \alpha_i CT_{i,t} + \epsilon_{i,t} \]  

(4)

Where \( i \) indicates the region, \( t \) indicates the year. \( EG \) represents the explanatory variables, i.e. the level of local environmental governance, \( ED \) and \( TP \) represent regional environmental de-empowerment and regional transfer payment, and \( CT \) represents other control variables that affect the level of pollution in the region, indicating the individual effects of the model.

5.1. Variable selection

5.1.1. Explained variables. According to the responsibilities of local environmental institutions, the level of local environmental management is mainly reflected in environmental quality, pollutant control and ecological environment, so this paper selects sulfur dioxide per capita (\( E_{SO_2} \)) emissions on behalf of environmental quality, selects the rate of harmless disposal of household waste on behalf of the basic public service level of the environment, chooses the sewage charge as an indicator to measure pollutant control, and then uses the entropy method to determine the weight of these three indicators into environmental management level indicators.

5.1.2. Explain variables. In this paper, the environmental weighting index (ED) calculated in the last section is chosen as the explanatory variable, which is somewhere between the two sides brought about by environmental weighting, so the impact of environmental weighting on environmental governance is uncertain and needs to be judged by empirical results.

5.1.3. Control variables. In order to make the estimates more scientific and accurate, consider introducing the following variables as control variables, taking into account the factors affecting the level of local environmental governance:

After the tax-sharing reform, China is in a kind of financial power incentive environment power-sharing framework, because the central government to local government transfer payments will affect the enthusiasm of local environmental governance, so this paper introduces transfer payment degree (TP) as a system control variable, the symbol is expected to be positive, that is, the higher the transfer payment of the higher the level of regional environmental governance.

Other control variables in this paper include: level of economic development (pgdp), proportion of secondary industry (indu), level of information technology (tech), urbanization rate (urban), level of human capital (human), degree of regional openness (open).

5.2. The source of the data

All the data in this paper are from the China Environmental Yearbook, the China Environmental Statistics Yearbook, the China Statistical Yearbook, and the China Science and Technology Statistics Yearbook, and all the indicators indicated by the monetary units are price de-factors based on the 2001 price index. The time interval is 2001-2015.

5.3. Empirical analysis

In this article, the panel data model is estimated using S tata, and in order to eliminate the deviation from the model estimate caused by the absolute value gap of the variable, we perform a dnational transformation of the variable.

The Hausman test of the model shows that model 1 and model 3 are suitable for establishing a fixed effect model. The difference between model 1-model 3 is that the explanatory variables are sulfur dioxide per capita, the harmless disposal rate of household waste, and the sewage charge
### Table 5. Regression Results

| VARIABLES | (1) |
|-----------|-----|
|           | EG  |
| C         | -0.733*** |
|           | (-4.58) |
| And       | -8.665*** |
|           | (-4.52) |
| ln_city   | 5.622**  |
|           | (2.90)  |
| n_pgdp    | -16.39*** |
|           | (-6.26) |
| ln_indu   | -3.367  |
|           | (-0.98) |
| ln_urban  | 4.120   |
|           | (0.79)  |
| ln_open   | -2.686  |
|           | (-1.68) |
| ln_tech   | -381.9** |
|           | (-2.97) |
| ln_human  | 4.828**  |
|           | (3.30)  |

Observations: 447

The number of sections: 31

The number of sections: 31

| t statistics in parentheses | *p < 0.05, **p < 0.01, ***p < 0.001 |

According to the results of regression in the table, environmental de-empowerment is negatively related to the level of environmental governance, and is significant at the level of 0.001. In 2001-2015, China-style environmental de-empowerment showed a trend of strengthening the degree of centralization, that is, the environmental de-empowerment decreased slightly, that is, the central control over local environmental governance increased under the framework of environmental de-empowerment, and the logic reflected behind the negative correlation between environmental de-empowerment and environmental governance level was that the increase of local environmental control led to an increase in local pollutant control, which led to an increase in the level of local environmental governance, that is, the collection of sewage charges increased, the rate of environmental waste harmless treatment increased. On the other hand, the positive correlation between institutional control variable transfer payment and the level of environmental governance implies the positive effect of the increase of transfer payment on local environmental governance.

### 6. Conclusions and policy recommendations

Based on the system of China’s environmental administration, this paper points out that environmental federalism originates from fiscal federalism and is more complicated by externality, jurisdictional competition, tax interaction and lobbying. This paper first depicts the institutional changes of Chinese-style environmental federalism from 1993 to 2017 according to the two dimensions of environmental administrative system management and financial division. Chinese-style environmental federalism has experienced the upward trend of financial power and the increasing trend of centralization under the framework of environmental power-escing, which implies that environmental governance not only needs the management of local governments to be divided, provides environmental public services to meet the preferences of jurisdictions, but also needs further centralization to solve the local spillover effects of the environment, and the environmental vertical management reform in 2016 means that Chinese-style environmental federalism enters a new era.

For the concrete implementation of environmental management in China-style environmental federalism, this paper, according to the inherent logic of environmental affairs implementation, divides
the overall environmental division of power into administrative division, supervision and de-empowerment, monitoring and de-empowerment by using the number of environmental protection agencies and the coverage of environmental protection institutions to measure the Chinese-style environmental federalism de-empowerment index from width and depth during 1993-2015. From the point of view of annual change, the Chinese-style environmental division of power in recent years has shown the trend of centralization, for the three kinds of power-thy-thing, the administrative power-dissision of monitoring and power-thorization, reflecting that china's administrative division of environmental management by local governments to assume is reasonable, but also help to provide more to meet the preference of the jurisdiction of basic environmental public services, and for the monitoring of the division of powers and supervision of the environmental quality of local enterprises, should avoid excessive weight-between. From the point of view of the east and west, after nearly 20 years of reform, the huge gap in environmental management between the three ministries in the efforts of the central government gradually reduced the gap, get a relatively balanced result, but at present the environmental power in the west is still at a relatively low level, and for the east and central regions, its monitoring power is high, behind the prevalence of local environmental protectionism. Through the empirical analysis of environmental de-empowerment and local environmental governance level, it is further verified that the environmental functions that need to be monitored and supervised need to be properly centralization, which also fits with the current environmental vertical management reform in China, and should be given a higher environmental de-empowerment for the functions of local environmental governance.

Based on data measurement and regression results, by region, we believe that the central government should further strengthen the monitoring and de-empowerment of the eastern and central regions on the basis of the current vertical management, so as to ensure that the monitoring data are true and effective, while the western region should still increase its support for environmental protection. From the point of view of the three powers, administrative decentralization should be decentralized, and in the future it is necessary to establish a fiscal and taxation system matching the division of environmental affairs power with the financial matching mechanism, and by further improving the ecological transfer payment system, not only do a good job of vertical transfer payment to the local government, but also improve the horizontal transfer payment system of cross-regional environmental governance; Step up, the implementation of the provincial environmental protection agencies monitoring and monitoring vertical management, to avoid the prevalence of local environmental protectionism, change the local GDP assessment mechanism, for environmental air quality monitoring, do a good job of the central government on monitoring the rise of the right to manage, in-depth environmental air quality monitoring system reform, for environmental monitoring, the central government can increase the central ministry of environmental protection supervision, and further improve the cross-regional coordination mechanism.

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