

Research Article

Institutional Governance Influence Mechanism and Model of Regional Green Development in China

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Green has become the underpinning of High-quality development in China. Green development is inseparable from the support of institutional governance. This study uses MVC mode to build institutional governance mechanism, and constructs institutional governance system and model of regional green development. The empirical results show the following: institutional governance has great influence on industrial green development. From the perspective of China's provincial industrial green development, Shandong Province has been maintaining the first position of governance investment. Green governance is better in southern China than in the northern provinces. And the institutional governance intensity of each province is not evenly distributed. Therefore, China's industrial green development still needs to further strengthen the system governance of northwest and northeast regions. Finally, this paper aims to improve the green development level of China's regional industrial economy through the construction of institutional governance system. It provides institutional environment for the development of green innovation.

1. Introduction

Although China is a developing country, it has proposed to complete the transition from carbon peak to carbon neutral in the shortest time in the world. And the imbalance of industrial layout in territorial space is an urgent problem. So how to develop green industry has become a hot topic of discussion. More and more scholars are trying to tap into the role of institution, coupled with a sound environment, for innovation advancement. A new innovative institution may arise at the historic moment to develop industries and economy, when previous institutions make it difficult for enterprises to achieve the expected innovation income. Many scholars have found that [1, 2]: China's sustained economic growth has been achieved thanks to the synergy of institutional and technological innovations, which fails to be fully tapped into and has room to be utilized. The development of technological innovation entails a reasonable innovation system to be tested and perfected over time, the

specific model of which is shown in Figure 1. The country formulates clear standards for innovation and puts in place effective institutional measures, which makes the interests from innovation of enterprises respected. This will encourage enterprises to focus on the iteration of intelligent manufacturing technology innovation. Therefore, national institutional innovation can encourage the institutional advancement of enterprises. And national system has become an important means to regulate the orderly development of enterprise technological innovations. It enables enterprises to cooperate on the basis of pooling innovation resources and sharing knowledge to make technological innovations more efficient. Likewise, technological innovations can in turn influence institutional formulation. When the technology of intelligent manufacturing enterprises develops into a certain scale, internal institutional factors such as methods, regulations and articles of association can be formed. The inter-organizational structure within the enterprise is motivated to improve. In areas like

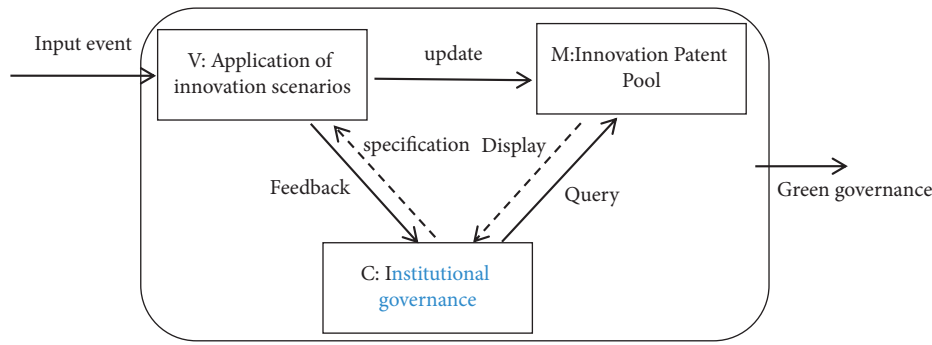


FIGURE 1: Institutional governance mechanism.

industry-university-research cooperation, regional innovations and cooperation and platform innovations, institutional and technological innovations can advance hand in hand, driving the rapid growth of enterprises in the space of territorial planning. The effect of innovation institutional governance on green development is becoming more and more significant, for example, the emergence of various sharing platforms, the integration of Didi with Kuaidi and the ever-smart sharing bikes. Aiming at the new demand of green development of China's industrial economy and strengthening the function of institutional governance, this paper constructs institutional governance mechanism and model to provide reference for improving institutional governance environment.

2. Literature Review and Theoretical Basis

2.1. Innovation Institutional Governance. Innovative governance are mainly applied in the management of related innovation practices. Innovation institutional governance are measures, rules, regulations and other institutions that encourage innovation activities to go green [3]. Enterprises, by following the institutional arrangements for innovation, make innovative governance become a normal part in production activities. This will help foster an environment for greening of industrial firms. With technological innovation becoming the continuous source sustaining enterprises' competitive advantage, enterprises varying in the ability of making innovations may make breakthroughs by virtue of institutional innovations [4, 5]. Technological innovations and the system of an enterprise are mutually reinforced [6]. They can be combined into a composite system [7]. Certainly, the system for innovation is both formal and informal. The informal one can sometimes have a higher positive impact on technological innovations than the formal one [8]. The system for innovation can have an impact on both a country and the organization of an enterprise. Different logics behind innovation systems stimulate the differentiated development of enterprise technological innovations [9]. The study found that integration of innovation institutional resources in the governance process, can better promote the speed and efficiency of enterprise technological innovations [10, 11]. When industrial companies go green, the first thing to do is the optimization of technological innovation structure.

Institutional innovation is key to transformation [12–15]. The system for innovation itself is constantly complementing and iterating content to adapt to the speed of technological innovation development. The innovation knowledge should be stored and unified innovation standards and norms should be set [16–20].

2.2. The MVC Model. Trygve of Xerox Palo Alto Research Center came up with the concept of MVC and applied it to the Smalltalk system in 1979. MVC is a combination of the initials of Model-View-Controller. Whether an organization is simple or complex, it can be divided into several modules. The MVC model is characterized by accomplishing two kinds of separation. It separates the business from the data, and the background from the front. It can make the complex environment and system achieve modular subdivision, and simplify the chaotic state. The three layers of the MVC model are closely related. View is at the top, Model at the bottom, and Controller in the middle. The upper end depends on the lower, which forms an interdependent relationship. There is no superiority or inferiority among them. They are in a synergistic relationship. There is an interaction window with the outside in enterprise innovation management. Innovation data changes only need to be modified within the corresponding module, without the need to cross into the other layers. This drives the innovation system to achieve modular subdivision and avoids process redundancy and resource waste, and promotes the innovation iteration and upgrading of enterprises [21]. The imbalance between the modules in the system is easy to occur, while with the control of the system module and based on the technical judgment required by the View module, this sort of technological breakthrough can be handed over to the organization that is studying relevant technologies. In this way, the allocation of innovation resources is optimized and the advantage of enterprises in fierce market competitions is safeguarded. Thus, a higher profit is secured [22]. The MVC model architecture is gradually being employed locally. The quality of service of enterprises is enhanced when customers are involved directly in the innovation process. This enhances enterprise service level [23]. The adoption of MVC model can make the innovation and production more closely connected. It will bring great convenience for enterprises to search for innovative resources and broaden knowledge base [24].

TABLE 1: Institutional governance framework.

Layers	Characteristics	Types of factors	Means of implementation
The layer of inherent institutional governance	Genetic inheritance of the system	National innovation strategy	National science and technology innovation program, national innovation-driven development strategy, national long-and-medium-term development programs in science and technology
		Enterprise innovation strategy	Differentiation strategy, cost leadership strategy, centralization strategy Integrated innovation strategy, enterprise group innovation strategy Diversified innovation strategy, cross-border innovation strategy
		Specifications for innovation Conventions for innovation	Formal Informal Start-up rules Interests, hobbies, innovation habits Cooperative innovation, progressive innovation
The layer of selective institutional governance	Complementation and adjustment of genes in the innovation system	Coordinated system	Regulations on industry-university -Research collaboration, regional coordinated innovation models
		Complementary system	Standard supplementary methods for technology introduction
The layer of variant institutional governance	Evolution and variation of system genes	System evolution	High-level talent introduction plan
		Variant system	Variation of enterprises' systems

3. Institutional Governance Mechanism Based on MVC Architecture

The MVC pattern as an architectural pattern is not only applied in the field of information technology and software, but also in the design and organization of other fields. According to the characteristics of the MVC model, this study modularized the institutional governance into three new levels. “V” represents the application module of innovative scene, “C” the innovation system module and “M” the innovation patent pool. The view module shows the innovation information to customers. This study uses the principle of MVC to construct the institutional governance mechanism. The model module continuously accumulates the innovative knowledge and technology of enterprises to form a patent pool. The controller module can be regarded as an organization that uses institutional governance to master green development data. The view module captured from the market demand to guide scientific, reasonable and orderly enterprise innovation activities. With the joint efforts of these three modules, the institutional governance mechanism promotes the green development of industry in the region. The complexity of industrial green innovation was reduced. So that the innovation activities were more intuitive presentation. The governance mechanism of MVC architecture can separate the risks of industrial green innovation from geographical regions. According to the dynamic information of provincial market, the factors with high innovation risk value are managed. This could improve the regional competitiveness. Clearly, Institutional governance mechanism can bring different types of innovation to the economic development of geographical space. However,

The strength of institutional governance mechanisms varies from region to region. For example, In Jiangsu, Guangdong and other regions, institutional governance and industrial green development are well coordinated. Institutional governance mechanism is shown in Figure 1.

MVC framework is used to help us better understand the role of institutional governance mechanism in China’s regional industrial green development. Institutional governance mechanisms effectively guide the direction of green innovation and optimize the structure of industrial innovation. As a kind of invisible control, institutional governance mechanism can transfer users’ needs to innovation knowledge base for matching. To sum up, the institutional governance mechanism can coordinate the industrial green innovation resources within the region and create a good atmosphere for green development.

4. The Construction of Institutional Governance System

4.1. The Layer of Inherent Institutional Governance. The system for innovation, through following the law of the market and principles guiding technological innovation development, forms a relatively stable critical state of the system in a certain period of time [7]. This state inherited the inherent nature and mandatory characteristics of the paternal system. The inherited factors of innovation system continue to standardize the current innovative attempts. The prominent form is that the institutional elements inherit the main content of the innovation system and continue to standardize and constrain organizational green innovations. The environment for enterprises’ innovative attempts is

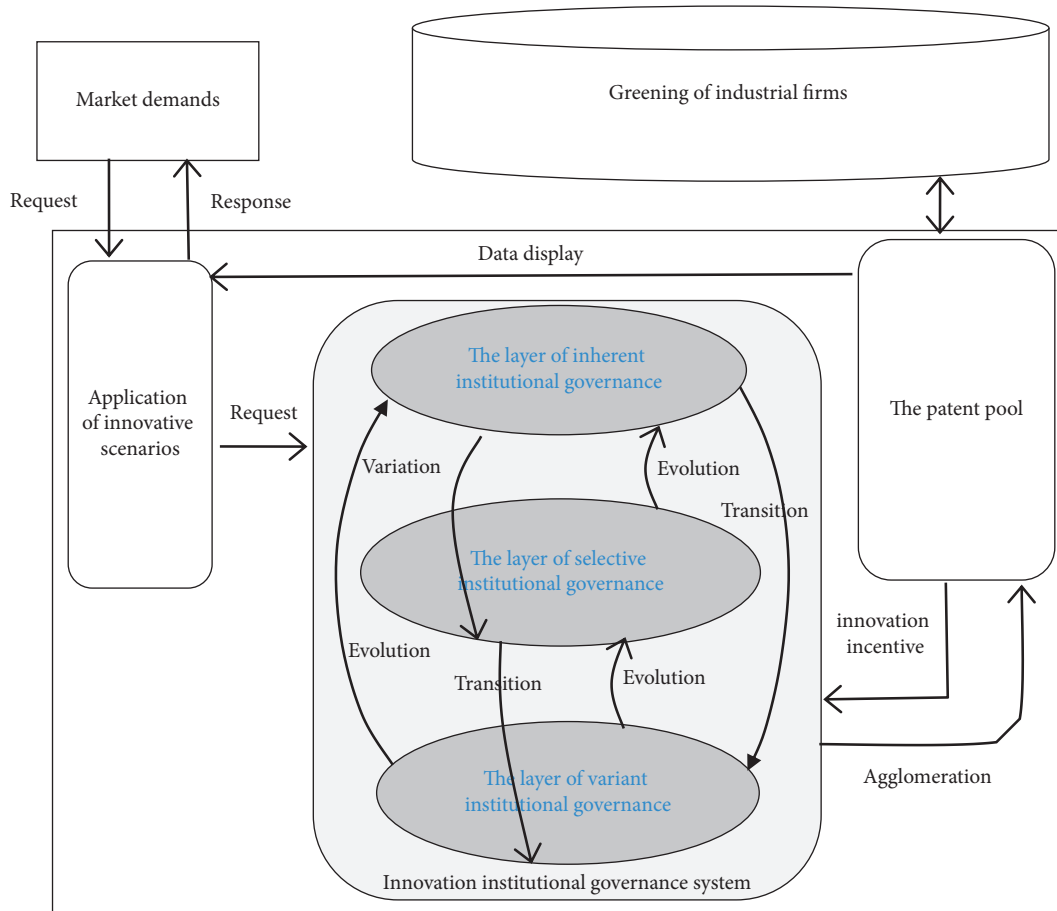


FIGURE 2: Institutional governance model.

stably maintained and the green technical knowledge of enterprises is broadly inherited. The details are shown in Table 1.

4.2. The Layer of Selective Institutional Governance. The adaptive system, first proposed by North, can be applied into systems that can adapt and control themselves in the process of technological and economic changes. The adaptive elements in institutional governance emphasized the allocation of innovation elements and resources, which made the structure of institutional governance systems responsive to the dynamic economic environment, thus helping organizations made adjustments to the institutional governance system based on environmental changes. Organizational innovation activities needed to adapt to rapid economic development. Enterprises often face uncertain risks in green innovation, so they needed to adjust the structure of the institutional governance flexibly and improve the adaptability accordingly. The economic development under the

new normal needed the institutional governance to play a compatible and regulatory role to better prepare organizations to tackle with risks involved in the green innovative process.

4.3. The Layer of Variant Institutional Governance. Institutional evolution gene is the evolution of current institutional gene with selection and pertinence. The implementation of new institutional arrangements produces variation, which can transform the potential influence of external environment into internal institutional behavior. The changing green innovation environment has brought difficulties to the institutional governance of provinces and cities in China. There were differences in the innovation institutional structure of existing provinces and cities. When a new green innovation technologies appeared, it was necessary to mutate the innovation institutional elements conducive to their own development for governance. If a region needed to develop green disruptive innovation and lacked institutional

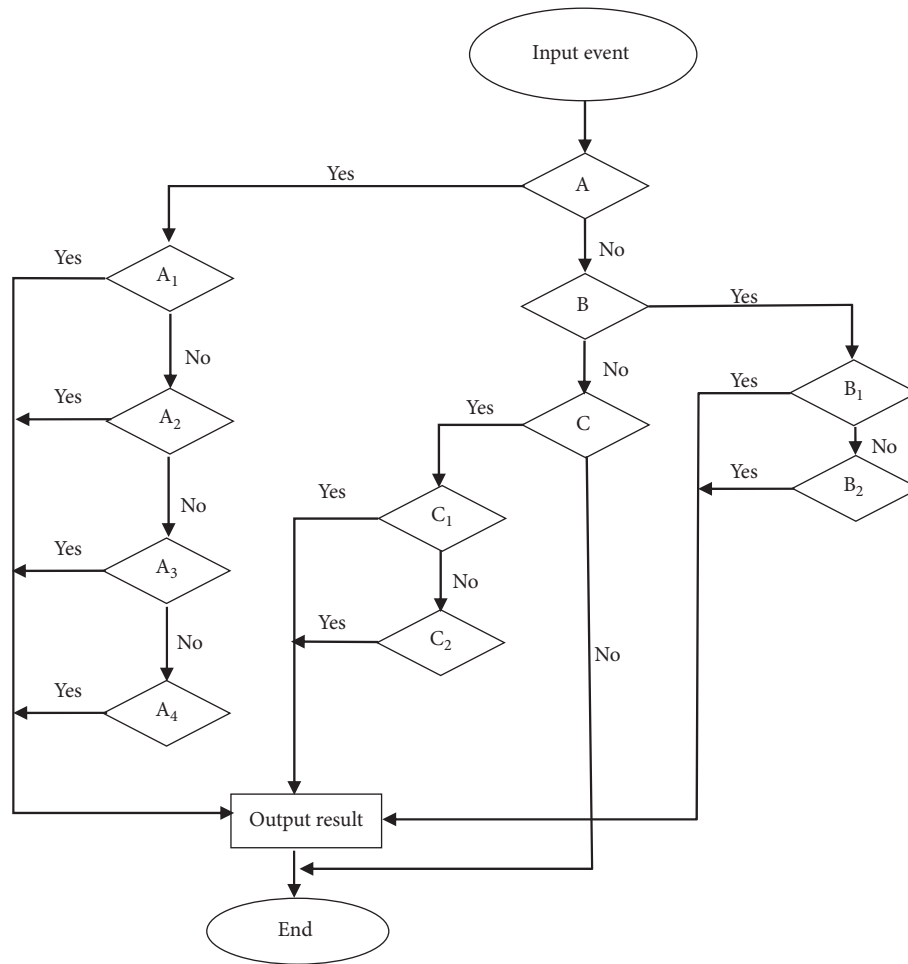


FIGURE 3: The structural model of institutional governance.

governance, it would lead to the imbalance of regional development within the scope of geographical space. In order to reduce the risks brought by innovation, regional governments need to adopt the variation of institutional governance. This could reduce the impact of changes in the external innovation environment on the organization. Therefore, this study constructs an institutional governance model. The detail is shown in Figure 2.

5. The Establishment of Institutional Governance Model

As a descriptive language for algorithms, Pseudo code is a comprehensive structure composed of natural language and class programming language, in which the described problems in the institutional governance system can be implemented through a programming language. A corner of “black box” in the innovation institutional governance system was conducive to open. It would increase the efficiency of green innovation in China’s industry. Based on Table 1, a flow chart showing the development of modules is formulated and a hypothesis is made. Supposing the genetic elements system to be variable A, the adaptive elements system to be variable B and the selective elements system to

be variable C, variable A_1 stands for national innovation-driven strategies, variable A_2 corporate innovation-driven strategies and variable A_3 specifications for innovation, and variable A_4 conventions for innovation. The rest variables can be done in the same manner and we get $B_1, B_2, \dots, C_1, C_2$. Due to the genetic characteristics of the system, the whole MVC model starts from A. Finally, the flowchart is formulated as shown in Figure 3.

According to the flowchart architecture, the corresponding pseudo code expression can be written in Algorithm 1.

The development of institutional governance system makes every link of green innovation in industrial enterprises standardized. The institutional resources can show governance effects in different innovation environments. The institutional governance mode can separate the predictable innovation environment from the unpredictable one. The efficiency of enterprise innovation is hence improved.

6. Analysis of the Influence of Regional Institutional Governance

This study analyzes the innovation institutional governance of China in the past 20 years. We can see from Figure 4. The

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Input: A: The layer of inherent institutional governance
A1: National innovation-driven strategy
A2: corporate innovation-driven strategy
A3: Innovation specifications
A4: innovation conventions
B: The layer of selective institutional governance
B1: Coordinated system
B2: Complementary system
C: The layer of variant institutional governance
C1: System evolution
C2: Variant system
Output: Innovation institutional governance system
Initialize: A&&B&&C≠∅
While {Innovation system can governance industry to develop green activities} do
  If A &&A1 = =true
  Then current Innovation system exists governance function
  print A1
  Else if A && A2 = =true
  Then current A2 system exists governance function
  print A2
  Else if A&& A3 = =true
  Then currentA3 system exists governance function
  Print A3
  Else if A && A4= =true
  Then current A4 system exists governance function
  Print A4
  Else Out of A&&Run the next system B
  If B && B1 = =true
  Then current B1 system exists governance function
  Print B1
  Else if B && B2 = =true
  Then current B2 system exists governance function
  Print B2
  Else Out of B&& Run the next system C
  If C&& C1= =true
  Then current C1 system exists governance function
  Print C1
  Else if C&& C2= =true
  Then current C2 system exists governance function
  Print C2
  Else Innovation institutional governance lost function
  End
End while

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ALGORITHM 1: Pseudo code description of the institutional governance model.

whole governance trend took the form of pulse wave. The biggest peak was in 2014. This was different from what we originally thought. The strength of the governance system did not get stronger over time. Therefore, this paper aims to further examine the changes of China's innovation institutional governance system. We chose three years: 2009, 2014 and 2019. We analyzed the degree of innovation institutional governance of each province in territorial planning. And we got Figures 5–7.

Figure 5 showed the degree of innovation governance intensity of Chinese provinces in 2009. Shandong Province had the best innovation system management. We found that Shanxi Province, Guangdong Province, Jiangsu Province, Zhejiang Province, the intensity of governance was higher. From the

whole land planning layout, the distribution of governance across the country was uneven. The innovation institutional governance of coastal cities is higher than that of other regions.

Figure 6 showed the distribution of innovation institutional governance intensity among provinces of China in 2014. By comparing the state in 2009, it was not difficult to find that the intensity of innovation governance in all provinces had improved. Shandong province maintained its No. 1 position. In addition to coastal provinces, the intensity of governance was higher. Hebei Province, Inner Mongolia Autonomous Region, Liaoning Province and other governance development is relatively good. From the layout of the whole land planning, innovation institutional governance could appear even development in local areas. From the

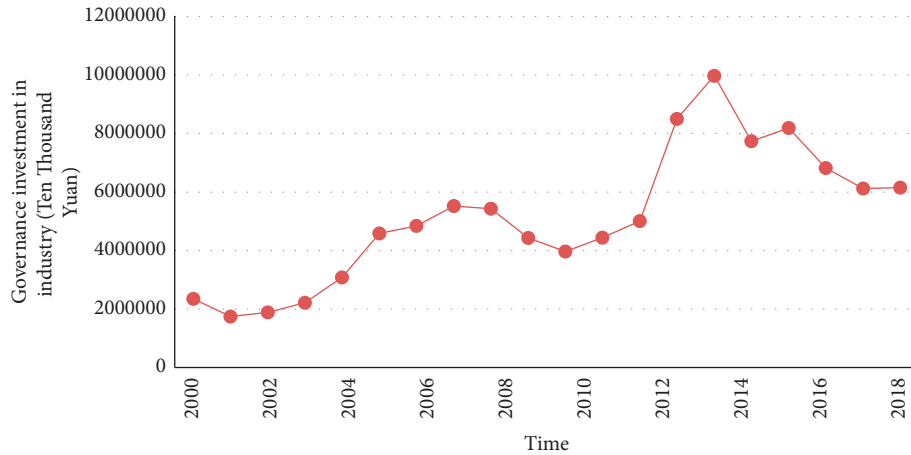


FIGURE 4: China’s investment in innovation institutional governance over the past 20 years.

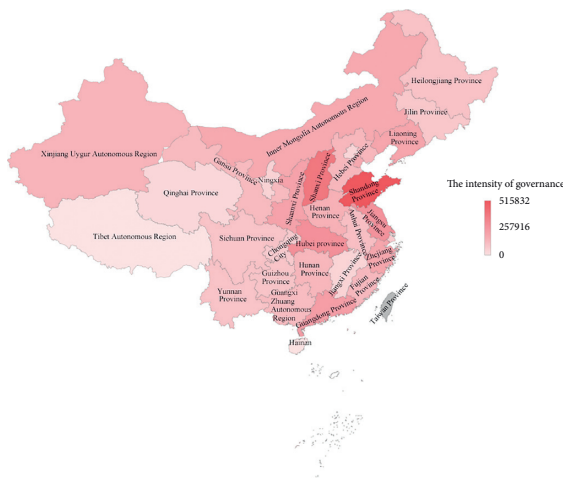


FIGURE 5: Intensity of governance investment by province in 2009.

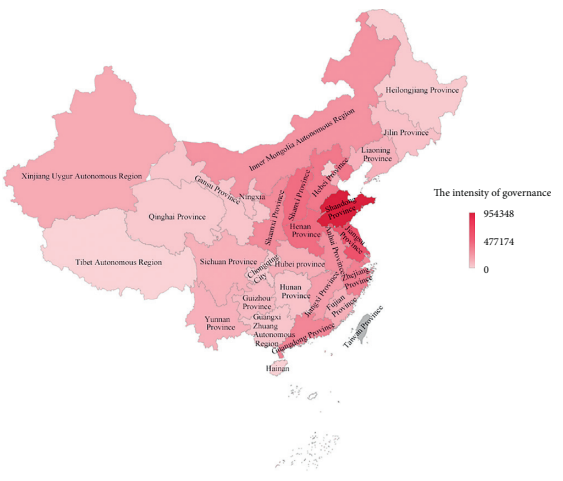


FIGURE 7: Intensity of governance investment by province in 2019.

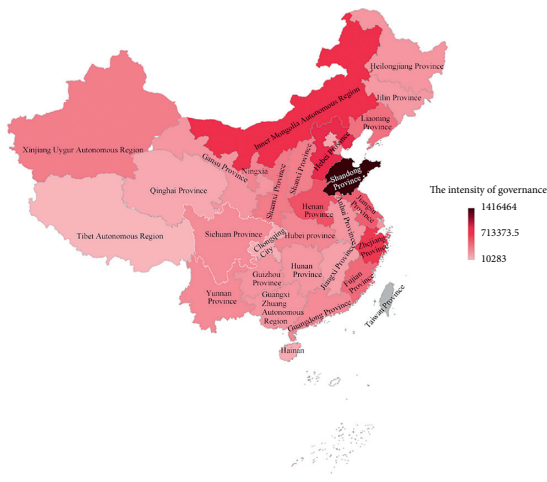


FIGURE 6: Intensity of governance investment by province in 2014.

layout of the whole land planning, innovation institutional governance could appear even development in local areas.

Figure 7 showed the distribution of innovation system intensity by provinces of China in 2019. We compared the state of 2014. Shandong continued to lead the country’s innovation institutional governance. The intensity of innovation governance in most provinces had been reduced. However, some regions, such as Shanxi Province, Shanghai City, Jiangsu Province and so on, still maintained an increasing trend in investment on innovation institutional governance. From the overall territorial planning and layout, the local areas around Shandong Province appeared a balanced state of governance. Therefore, in order to achieve the dual carbon target, the provinces needed to further strengthen the intensity of governance in the Northwest and Northeast.

7. Conclusion

To conclude, the institutional governance mechanism is constructed, and the model is analyzed to promote the regional green development. First of all, the genetic characteristics of inherent innovation system maintained the stability of national governance and saving costs. Based on elements of innovation systems and technological innovation genes from the past, managers of enterprises can draw lessons from the experiences of previous technological innovations and inherent innovation systems. Organizational managers could learn from this experience. This would promote the recombination of green innovation elements. This makes technological innovations of enterprises achieve orderly adjustment and optimization. This can stabilize the current pattern at minimal cost. Secondly, the choice of adaptive innovation system for governance had alleviated the risks brought by the change of market environment. The ability of green innovation development in industry needed to adapt to market changes. They could make flexible adjustment to promote green industrial development. Thirdly, the variant features of selective elements layer of the innovation system could governs the green development of industry. They can help cope with the change of external innovation environment. So it had an impact on the green technology innovation of enterprises. This Promoted standardization of green technology innovation. They can guide the selection of new variation elements development and technical standardization as well. The risks industry face in the governance process will be lowered, thus promoting healthy and orderly green innovations of industry.

Data Availability

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Conflicts of Interest

It is declared by the authors that this article is free of conflict of interest.

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