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Green Governance: New Perspective from Open Innovation

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Abstract: Environmental problems caused by human behaviors have become increasingly serious in recent decades, thereby driving global green governance issue to become an important research agenda. The proper governance structure design and governance mechanism arrangement can effectively coordinate the relationship between human and nature. Literatures have provided mixed evidence of harmonious development of economy, society and environment. However, few studies have examined the balance of interests between human appeal and natural environment from the perspective of governance. Open innovation activities can effectively deal with the externalities of resources and environment and then relatively balance the economic value and green value of organizations, which is an effective green governance mode, reflecting the characteristics of the main subject composition and mechanism operation of green governance. This paper attempts to build a green governance framework for the cooperation based on sustainable development among enterprises, governments, social organizations, the public and the nature. This paper examines the synergy between human and nature by presenting a framework, including related theories of green governance, innovation subjects, innovation mechanisms and innovation mode. Each country and region could use the suggested framework to develop green governance guidelines that are suitable for the environmental carrying capacity of their own countries or regions. Enterprises could use the suggested framework to develop green development strategies to coordinate the economic values and green values.

Keywords: green governance; open innovation; innovation subject; innovation mechanism; innovation mode

1. Introduction

The three stages that human civilization has experienced are the primitive, farming and industrial societies. Each stage of human development is closely related to nature. After entering the period of industrial civilization, mankind gradually formed a self-centered master mentality and changed nature at will, thereby intensifying the conflict between humanity and environmental carrying capacity. Environmental problems, such as global warming, tight resource constraints, environmental pollution and ecological degradation, have become increasingly serious, thereby prompting people to rethink and understand the status of mankind in nature and the relationship between economic development and the environment. In 2009, Rockstrom et al. [1,2] put forward the concept of Planetary Boundary, which has shown that human activities—economic growth, technology, consumption—are destabilizing the global environment. In September 2015, the United Nations (UN) held a “summit on Sustainable Development” and passed the 2016–2030 Global Sustainable Development Goals (SDGs). UN set up a set of integrated SDGs, consisting of 17 goals and 169 sub-goals from three key

dimensions of economy, society and environment, to guide the sustainable development of all regions including developed and developing countries in the next 15 years (2016–2030) [3]. In December 2015, 195 representatives reached a historic agreement in Paris, France [4]. Through the Paris Agreement, humans had recognized that the natural ecology could be devastated and a new green governance of “harmony between mankind and the nature” should be perceived.

Since the concept of sustainable development was formally proposed, scholars have conducted a series of studies, including the study on economic growth and the sustainability of social equity [5,6], sustainable development and resource environment carrying capacity [7], human development and the sustainability of environment ecosystem [8] and put forward DPSIR model of the sustainable development efficiency [9]. Governance, as an institutional arrangement, is used to reconcile the conflicting stakeholder relationships, which is benefit to the joint action among stakeholders [10]. Although scholars have gradually realized that human pursuit of capital and wealth is the biggest obstacle to sustainable development, few studies have paid attention to the coordination between human wishes and natural environmental from the perspective of governance. As an important part of the green governance framework, proper governance structure and governance mechanism can restrain human’s self-interested behavior and provide possible ideas for breaking the existing research dilemma of sustainable development.

Innovation is the main driving force for the sustainable development of human civilization and economic society. In recent years, with the continuous improvement of globalization, global development has brought great challenges to mankind [11] and issues such as the goals of the UN human sustainable development agenda have triggered the think on the innovation and development paradigm. The technological innovation paradigm, which focuses solely on technology and economy, has its limitations in dealing with the process of global change. The innovation paradigm begins to extend to broader scientific research and in addition to achieving scientific and technological progress and economic growth. It further conforms to the development goals of ecological value and social satisfaction and realizes sustainable transformation. Eco-innovation was first put forward by Fussler and James [12] in 1996 in their book “Eco-Innovation: A Break Thorough Discipline for Innovation and Sustainability,” which refers to new products and processes that can significantly reduce environmental impacts and add value to enterprises and customers. Since then, scholars have proposed different opinions. For example, OECD [13] defines eco-innovation as “Such behaviors intentionally or unintentionally bring about environmental improvements when compared to other alternative, such as new or significantly improved products (or services), production, marketing, organizational structure and institutional arrangement and so forth”. Eco-innovation aims to achieve a win-win situation for the economy and the environment but mainly focuses on the enterprises. From the perspective of specific innovation processes, the increase in costs and the externalities of the resource environment may lead to a lack of motivation for innovation, damaging the interests of stakeholders. Open Innovation was formally proposed by Chesbrough in his book “Open Innovation, the New Imperative for Creating and Profiting from Technology” in 2003. In his opinion, open innovation refers to the process of comprehensively utilizing the inflow and outflow of external knowledge and internal knowledge and integrating internal and external innovation resources into the process of R&D and commercialization [14]. Open innovation means not only the use of knowledge outside the boundaries of organizations (Inbound Open Innovation), such as suppliers, customers, universities, governments and competitors but also the external use of internal knowledge (Outbound Open Innovation). According to Chesbrough’s open innovation theory, innovation activities can cross the traditional boundaries of an organization and no longer depend entirely on the organization’s own strength, improving innovation performance and effectively reducing innovation cost at the same time. As the result of a joint decision and action process of governance, open innovation is to integrate and effective utilization of resources in essence, respond to the externality of resources and environment problems and balance the economic interests and social responsibility, which provides a possibility to explore the multiple subjects, synergetic mechanism and open innovation mode of green governance.

Green governance is an emerging field, attracting more and more attention from scholars and gradually becoming focus of policy making of governments. However, the development of green governance is often constrained by the unclear definition of responsibilities of various subjects and the desire for capital of countries, enterprises and individuals. As a result, the current practice of green governance is often limited to the spontaneous green production, green management, green supply chain and green administration of a single subject. Green governance based on open innovation is to break organizational boundaries, coordinate the relationship between multiple governance subjects, build the synergetic mechanism based on trust and contract and explore the governance mode of open innovation to achieve the goal of sustainable development of human and nature. And the establishment of a conceptual framework for green governance is challenging, as it requires application of relevant theories to green governance, identification of all subjects who affect and are affected by green governance, design of governance mechanism and selection of governance mode. Figure 1 presents a conceptual framework for green governance based on new perspective from open innovation and related theories, innovation subject, innovation mechanism and innovation mode. Following the literature review, Sections 4–6 of this paper further describes green governance components of the suggested framework.

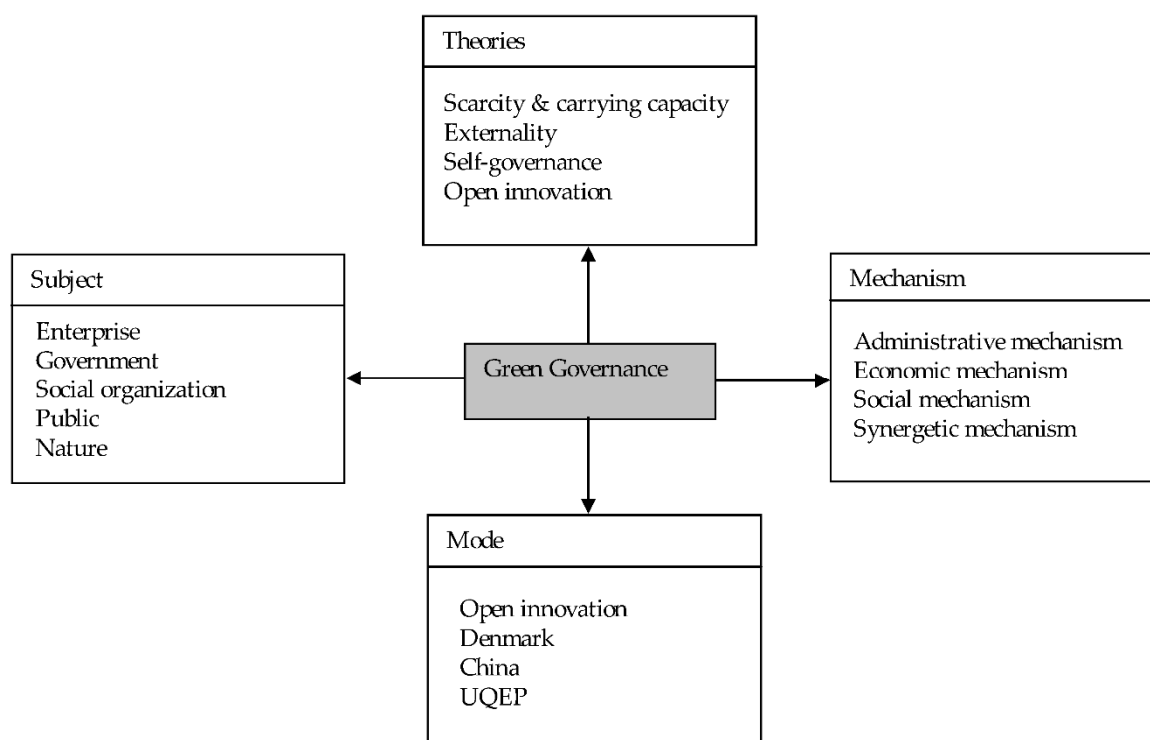


Figure 1. Green Governance Framework.

This study provides policy and practical implications and contributes to the extant green governance literature in several ways. First, this paper is an attempt to explore the possibility of realizing the sustainable development of economic society from the dual perspective of human needs and the carrying capability of natural environment, which is helpful to harmonize the contradiction between humankind and natural environment. Second, the suggested green governance framework could guide countries and regions to promote sustainable socio-economic development through innovative models, technologies and methods in accordance with their ecological environmental carrying capacity. Finally, future research can use the framework to study the construction of green governance index, compare the level of green governance in various countries and regions, further exploring the impact of green governance on social economy.

2. Materials and Methods

2.1. Materials

The analysis materials of this paper mainly come from three aspects. First, related literatures of green governance, such as the definition of green governance and evolution of relevant researches on green governance. The second is official documents, such as United Nations (UN) “Transforming our world: The 2030 agenda for sustainable development,” UNFCCC “Adoption of The Paris Agreement” and UNEP “Towards a green economy: Pathways to sustainable development and poverty eradication”. Third, research and network data, such as green governance practices of Denmark and China’s Jiaying and Utah-Qinghai Eco-Partnership (UQEP).

2.2. Methods

This paper mainly uses the combination of literature analysis and theoretical analysis. The starting point of green governance theory is to establish the boundaries of mankind and nature and form a globally abided-by rule through the design of a top-level system, thereby realizing the harmonious coexistence of mankind and nature within the environmental carrying capacity. The emergence of green governance means that a new governance model is developed, which posing new challenges to the traditional human-centered development ideology. Although the appropriate governance structures and mechanisms can inhibit human self-interest behavior effectively, many problems still remain. For example, the following questions should be answered: How are the main subjects and structure of green governance identified and what are their responsibilities? What are the effects of various governance mechanisms? How is green governance behavior shaped and what is an effective governance mode? The issues arising from these questions lack a systematic theoretical analysis framework, thereby resulting in many limitations in the theoretical and practical aspects of green governance. Therefore, this paper first summarizes the characteristics of green governance research by combing the connotation of green governance and related literatures of green governance research and puts forward the necessity of building a green governance framework. Secondly, on the basis of analyzing the theories of resource scarcity, environment carrying capability, externality and self-governance, this paper puts forward the importance of open innovation theory in the construction of green governance framework and then construct green governance mode from the perspective of theories, innovation subjects, innovation mechanism and innovation mode of green governance.

The remainder of this paper is organized as follows: Section 3 provides the literature review. Green governance related theories are presented in Section 4. Section 5 describes innovation subjects of green governance. Innovation mechanisms of green governance are presented in Section 6. Section 7 presents innovation mode of green governance. Discussion and conclusions are presented in Section 8.

3. Literature Review

3.1. Definition of Green Governance

The existing research on green governance remains rare and is generally based on ecological theory. The definition of green governance provided by scholars is also considerably different because of the various research objectives. These definitions can be divided into three categories.

Firstly, governance is considered the same as management. Dieng and Yvon [15] held that green governance is the government’s visionary, strategic and participatory sustainable management of natural resources.

Secondly, governance is equated to governance structure. Padilha and Verschore [16] asserted that green governance comprises five structures: common objectives, norms, involvement, resources and communication.

Thirdly, green governance is defined as sustainable development. Post et al. [17] held that green governance is a long-term economic, social and environmental sustainability.

From a systematic perspective, the preceding studies lack a systematic discussion of the definition of green governance in combination with governance and green implications. To understand the meaning of green governance, the current study suggests that two aspects should be considered comprehensively: (1) What is governance and what are the attributes and characteristics of governance? (2) What does green indicate? What are the vulnerability factors that should be addressed?

Although governance is an interdisciplinary concept, scholars' understanding of the connotation and attributes of "governance" are generally consistent. Scholars have a relatively unanimous view that governance is an institutional arrangement that is used to reconcile conflicts amongst stakeholders, thereby encouraging them to adopt joint actions to achieve scientific decisions. Evidently, coordination, cooperation and scientific decision-making are the core attributes of governance. Li et al. [10] indicated that governance often has the following attributes: (1) Governance is different from management and based on coordination instead of control. (2) Governance involves multiple interrelated stakeholders, including private and public sectors and economic organizations. (3) Governance emphasizes the balance of interests and scientific decision-making. (4) Governance is a continuous interaction and aims to maintain the continuity of relationship.

The term "green" has numerous definitions. Green is a symbol of life and the background color of nature. Therefore, green is often used to refer to economic, social and environmental systems, which can further represent the relationship between humanity and nature. Presently, the following fragility factors are observed in the relationship between mankind and nature. Firstly, the relationship between mankind and nature is neither a strict constraint nor a completely effective game rule because the latter is a non-speaking participant. The typical principal-agent characteristics lead to the existence of a wide range of human opportunism and require appropriate methods to suppress it. Secondly, green is the fairest public goods. A good ecological environment is an important material basis for human survival and development. If the ecological environment is destroyed, then human production and life will be directly impacted, thereby requiring the construction of human fate community, strengthening international and regional cooperation and enabling stakeholders to share "green" in a fair and reasonable manner [18]. Thirdly, green actions have strong externality, which involves the entire subjects of the economic-social environmental system (e.g., government, enterprises, social organizations, the public and the nature). These subjects are independent and decentralized in decision-making. The pursuit of self-interest maximization can easily lead to inconsistencies between the participants' behavior and the overall goal. Accordingly, such pursuit requires coordinating the interests, demands and responsibilities amongst the different participants.

Therefore, from the perspective of scientific decision-making and the long-term development of the relationship between mankind and nature, governance should be combined with green and the concept of green governance should be introduced in a timely manner. This study combines previous scholars' understanding of green governance and defines this concept as follows: green governance coordinates the conflict between human and nature through the design of a set of institutional arrangements or mechanisms, thereby ensuring the scientific decision-making of global green governance actions and ultimately maintaining the continuous and stable operation of the economic-social environmental system.

3.2. Evolution of the Relevant Researches on Green Governance

Studies on green governance have also emerged and become an international frontier issue because environmental issues have become a global concern. The formation of green governance view is a gradual evolution process that includes four stages, namely, the traditional development view, sustainable development view, "green plus" and green governance.

During the period of primitive civilization, mankind survived in nature with awe and fear. In the farming civilization, mankind maximized nature and developed resources to obtain materials and other benefits. During the industrial civilization, the industrial revolution led to an increasing tension between mankind and nature despite of the resulting huge leap in productivity. At that time, many

economists studied the relationship between economic development and natural resources based on resource scarcity theory (i.e., “traditional development view”). Malthus [19] mainly focused on the relationship amongst population, resources and the environment. He believed that if the population is not controlled, then it will increase at a geometric rate, whilst living materials will merely increase at an arithmetic rate. If humans continue to consume large amount of and disregard the limited natural resources, then the balance between mankind and nature will be destroyed, thereby leading to an eventual catastrophic reduction in population. Ricardo [20] proposed the view that technology could relatively compensate for the scarcity of resources (i.e., “relative resource scarcity theory”). He believed that technological progress can solve the conflict between humanity and nature. However, one fact cannot be disregarded is that technological progress may also cause environmental problems. Mill [21] combined the views of Malthus and Ricardo and believed that a country’s natural resources, population and wealth should remain at a stable level that must be distant from the limits of natural resources to prevent the lack of food and disappearance of natural beauty. By the 1870s, the neoclassical economics represented by Marshall and Pigou began to explore methods to achieve Pareto optimality (based on resource scarcity theory) under the condition of resource scarcity and different resource allocations.

In a knowledge economy society, people began to understand the relationship between mankind and nature in a considerably rational manner. Thus, the concept of sustainable development was introduced. As early as 1713, Hans had proposed the principle of sustainable development in “*Sylvicultura Oeconomica*”. In 1972, the United Nations Environment Conference was held in Stockholm, Sweden, where over 1300 representatives from 113 countries discussed the global environmental problems caused by economic development. This conference eventually passed the “United Nations declaration of the human environment”. Although the concept of sustainable development was not proposed explicitly in the conference, the view of sustainable development was clarified. In 1987, the United Nations passed the document titled “Our Common Future”, which was drafted by the World Commission on Environment and Development and proposed the concept of sustainable development. This document explained that sustainable development “meets the needs of the present generation without compromising the ability of future generations to meet their needs”. In 1992, the United Nations Conference on Environment and Development was held in Rio de Janeiro, Brazil and passed the “Rio Declaration” and “Agenda 21”, thereby indicating that the concept of sustainable development has achieved world consensus. This conference promoted sustainable development from theory to practice. The core of sustainable development is the harmony between mankind and nature [22]. Compared with the “traditional development view”, “sustainable development view” advocates that economic development should completely consider the carrying capacity of natural resources and remain an anthropocentrism development concept that placing development in a prominent position.

In recent years, the global natural environment has received continued attention and the international community has successively proposed the concepts of green economy, green growth and green development. In the reports of various international organizations, green economy, green growth and green development are used as the same concept apart from subtle semantic differences. In 1989, Pearce proposed the concept of green economy for the first time in the book titled *Blueprint for a green economy* and suggested that the economy and environment influence each other [23]. However, this book only uses this term to discuss environmental policies without proposing the concept of green economy. The actual concept of green economy was proposed by the United Nations Environment Program (UNEP) in 2007 and is considered “an economy emphasizing on people, nature and the creation of high-paying jobs”. In 2011, UNEP amended the definition to “an economic development model that improves human welfare and social equity whilst greatly reducing environmental damage and ecological scarcity” [24–26]. The concept of green growth, which initially appeared in 2005 at the United Nations in the Asia-Pacific Economic and Social Committee (UNESCAP) minister of environment and development conference, is defined as “an environmentally sustainable economic process to promote the development of low carbon and benefit all members of society”. In 2011, the

Organization for Economic Co-operation and Development (OECD) further modified and deepened the concept of green growth as follows: “The green growth ensures that natural assets could continue to improve resources and environmental services in human society, whilst promoting economic growth and development at the same time”. The World Bank defined green growth as “achieving efficient, clean and flexible production processes without slowing down economic growth” [27]. The concept of green development has yet to form a unified definition. In the “China in 2030: Building a Modern, Harmonious and Creative Society”, the World Bank and Joint Research Group of the Development Research Center of the State Council believed that green development refers to “economic growth that is free from excessive use of resources, carbon emissions and environmental damage, promoting growth by creating new green product markets, green technologies, green investments and changing consumer and environmental behaviors”.

In summary, the existing studies on green governance have the following characteristics. In the initial stage, green governance has not been separated from the studies on development concept, which show that scholars use the expression “development view” instead of “governance”. During the “green plus” stage, relevant studies begin to emphasize the harmony between human and nature, although the game playing between humanity and nature has yet to be analyzed in the governance system. From the perspective of research hypothesis, the assumption of economic man, which places “man” outside of nature, has begun to change and gradually evolves into the “ecological social economic man” hypothesis that considers the interests of non-human life species and ecosystem. From the perspective of the development of research paradigms, traditional research cannot cover the connotation and extension of green governance and cannot provide sufficient conceptual and theoretical basis. As an effective model for resource reintegration and effective utilization [14], open innovation can meet the economic and ecological attributes required by green governance at the same time, providing a new perspective for green governance. Thus, it contributes to the literature by presenting green governance theories, innovation subjects of green governance, innovation mechanisms of green governance and innovation modes of green governance as well as their implications for green governance as depicted in Figure 1.

4. Relevant Theory Implications for Green Governance

The relationship between human and nature is mainly reflected in two aspects: one is that economic system and social system obtain resources and energy from resource and environmental system; the other is that social system and economic system discharge wastes into resource and environmental system. The goal of green governance is to reasonably coordinate the relationship between human beings and nature, that is, to enable the balanced development of economy, society and environment at the same time. Elkington [28] first proposed the triple bottom line theory. In the business field, he discussed that enterprises need to meet the balanced development of economic prosperity, environmental protection and social welfare while pursuing their own development. Stefan et al. [29] introduced the triple bottom line theory into supply chain management, arguing that sustainable supply chain management requires comprehensive consideration of the three dimensions of economic, social and environmental goals of sustainable development. The triple bottom line theory lays a theoretical foundation for the rational coordination of the relationship between human and nature in the field of green governance and the balanced development of economy, society and environment.

Resource scarcity theory points out that if human beings do not realize the scarcity of natural resources and still consume a lot of resources, it will destroy the balance between human and nature [19,20]. Environment carrying capacity refers to the population scale and social and economic activity intensity that can be carried by the resource and environment of certain geographical region under the premise that the natural ecological environment is not harmed and a good ecological system is maintained. Vogt [30] first proposed “ecological imbalance”, which refers to the ecological change caused by human overexploitation of resources and the environment. He explicitly proposed the concept of regional carrying capacity to reflect the capacity of the population and economic

development that can be carried by regional resources and environment. Meadows et al. [31] used a system dynamics model to quantitatively evaluate resources, environment and population growth worldwide. They built a “world model” through an in-depth analysis of the relationship amongst population growth, industrialization development, depletion of non-renewable resources, deterioration of the ecological environment and food production. They also believed that global growth will reach its limit at a certain time because of food shortages and environmental damage. The theory of resource environment and environmental carrying capacity indicate that the degree of resource scarcity and environmental carrying capacity have changed with the development of economy. People’s demand for a better life will gradually replace the demand for survival and people will start to pay attention to the ecological function and social function of resource and environment.

Natural environment is public goods, which is typically non-competitive and non-exclusive. This feature enables any organizations and individuals to use public environmental resources cost-free and unrestricted. Meanwhile, it also means that organizations and individuals can destroy the environment to maximize their own interests without costs, thus resulting in negative externalities. Once the public goods are produced, rational members will choose to “free ride” and hope that other members will pay for public goods. Thus, individual rationality and collective rationality are in conflict, thereby causing collective action to face difficulties [32]. The negative externality of environmental pollution distorts the optimal allocation of natural resources, which makes the optimal output generated by organizations, especially enterprises consuming natural environmental resources, higher than the optimal output of society. In other words, the pollution level of natural environment of enterprises exceeds the optimal environmental pollution level required by social development. Therefore, green governance should avoid the “governance failure” caused by similar “collective action dilemma”.

In view of resource scarcity and externality, scholars have proposed different solutions successively. One is to emphasize the integrity and systematism of resources and overcome the problems of externality and free ride through the government’s strong intervention. The second is to provide sufficient economic incentives to market players through reasonable property rights arrangement, motivating them to develop and utilize resources and improving the efficiency of resource allocation. Ostrom believed that neither centralized government control nor complete privatization can effectively solve such problems. The government lacks sufficient information on public resources and public affairs and faces the problems of low efficiency and high cost of supervision, adjudication and sanctions. The non-competitiveness of the use of public services and public resources determines that private ownership is frequently impossible. Many successful public resource systems have broken through the rigidity of government and market. Ostrom et al. [33] found through a large number of case studies that community residents, as participants of democratization, can put social interests above personal interests and long-term protection of natural resources above short-term interests of individuals by self-agreement, self-regulation, self-enforcement and corresponding punishment measures. However, there are some problems in practice, such as the lack of local government support for the community management system, the insufficient community governance capacity and the difficulty in ensuring the majority of residents to participate in the entire development process.

Many subjects are involved in green governance, including government, enterprises, social organizations and individuals. Moreover, all actors aim to maximize their respective interests. They want to use natural environment to the maximum extent, although no one is willing to pay for them, thereby leading to frequent free-ride behavior. For example, a few enterprises pass on the cost of environmental pollution caused by development to society, whilst other enterprises disregard the negative consequences of the environment in the areas of investment development, production and sales and provision of goods and services and lack of investment in improving the ecological environment. A few governments fail to protect the environment, thereby resulting in the inefficiency or even failure of green governance. Social organizations are limited because of their weakness. The public only takes an approach to express their demands when their environmental

rights are violated to overcome this collective action dilemma. Schmidtheiny [34] argued that the inter-organizational partnership formed for the purpose of environmental protection has become a very popular mode of inter-organizational cooperation, which includes enterprises, governments and social organizations devoted to ecological protection. In such an external environment, it will be possible to establish an open and innovative green governance mode aimed at promoting ecological sustainable development. And green governance theory should coordinate with the different interests of the main subjects through an effective governance structure and governance mechanism; unify the owner, users and protectors of the ecological environment and natural resources and create positive and interactive relationships thereafter to achieve collaborative governance.

5. Innovation Subjects of Green Governance

Stakeholder analysis is an effective tool for the discussion of green governance subjects. This tool can answer a series of questions on the participation of governance subjects and the driving force and effectiveness of participation. Various organizations and social groups are involved in green governance, including the enterprises, government, social organizations and the public. These stakeholders influence green governance through the relationship of equality, voluntariness, coordination and cooperation, and the subjects jointly promote the realization of the goal of green governance. In the context of open innovation, multiple subjects identify each other and jointly catalyze green governance innovation methods with large-scale potential, which ultimately leads to effective solutions to resource and environmental problems. Nature, as a participant of green governance, is also an important governance subject, which generally represented by the government or the interest subject that contributes the most to promoting sustainable development. Due to the diversification and complexity of governance subjects [35], green governance cost has become more complex, including decision cost, supervision cost and incentive cost that are formed in the process of green governance.

5.1. Enterprises: Key Actors

Enterprises are consumers of raw materials and providers of jobs [36]. As producers of major products, they are important subjects and key actors in the green governance framework. If enterprises neglect environmental protection and resource efficiency in the operation process, then they will suffer pressure from stakeholders, such as governments, competitors, shareholders and employees. Pressure from stakeholders is the driving factor for enterprises to actively promote green governance [37–41]. Enterprises can substantially reduce the negative impact of business activities on the environment and increase their competitive advantage by implementing “best practices” activities for green governance [42,43].

Global resources become increasingly scarce, whilst science and technology have not yet reached new heights, thereby “breaking boundaries and comprehensively integrating” has become the only way for human society to practice sustainable development. Both the development strategy and resource and environmental protection strategy of enterprises have common requirements for improving resource utilization efficiency, which provides basis for enterprises to practice green governance. From the perspective of open innovation, green governance is not the resource reuse after the comprehensive treatment of waste generated by enterprises but the flow and reuse of resources formed in the early production and production process through system design, knowledge sharing or exchange. Firstly, enterprises should improve the framework of corporate governance and management system based on green governance view to ensure that no harm is caused to the environment in all aspects of enterprise production and operation. For example, the board of directors can establish a green governance professional committee to effectively supervise and control green governance behavior. Secondly, enterprises should define green governance responsibility and obligations of staff at all level in the company’s strategic development, establish salary incentive mechanism and promotion mechanism to improve the environmental competitive advantage and encourage everyone to participate in environmental governance initiatives and effectively. Thirdly,

enterprises should aim at sustainable development in all aspects of production and operation, such as production process, organizational structure, decision-making process and terminal governance, with a purpose of reducing the environmental impact of production and increase enterprises' and customers' value [12,13]. Fourthly, enterprises should actively explore the solution of environmental conflicts and seek ecological cooperation to achieve the redistribution of natural resources among organizations through the exchange of material, energy and knowledge, capital or technical resources [44,45].

5.2. Government: Policy Providers

In the context of green governance, open innovation means that cooperative production and co-delivery are not only products and services but also policies. Under the traditional public administration system, the government is omnipotent and with absolute control right. The implementation of government power is from top to bottom. The government uses its dominant position and political authority to make and implement policies to conduct one-way and mandatory management for public affairs management. Given the increasing complexity and abruptness of public affairs, the government's behavior has gradually changed from command and control to guidance and negotiation [46]. In this case, the government plays its leadership and strategic functions to ensure social harmony and economic development.

From the perspective of open innovation, government leadership and strategic function are mainly embodied in the provision of policies in green governance. Firstly, government should establish and improve organizational structures and distribution system of rights and responsibilities that are consistent with green governance objectives and share with the public the government's ideas, vision, goals and priorities in green governance practices and even the strategic planning related to public stakeholders. Secondly, government should promote environment-friendly policies (e.g., designing and drafting relevant laws and regulations of green governance that are consistent with the environment carrying status in political, economic and social activities). Thirdly, government should provide corresponding platforms, standards and systems for other governance subjects in green governance activities, to protect the legitimate rights of participants in green governance and safeguard the diffusion and transformation of green technologies. Recent studies have shown that the active role of the government can effectively prevent the spread of water pollution in green governance. Kahn and Zheng [47] determined that the water pollution in the border areas of the provinces that catered to the new policy regulations and changed the rules reduced the water pollution to different degrees.

5.3. Social Organization: Initial Supervisors

The government and the market will inevitably suffer from failures under certain circumstances because of the inherent limitations. Therefore, Osborne and Gaeb [48] explained that social organizations can provide many services to the society and undertake some social affairs that government departments and enterprises could not do well.

Social organizations provide complementary resources such as relevant technologies, knowledge and information and mainly play the role of initiative supervisors in the green governance activities. They actively undertake the transfer of related functions from the government and completely use their professional advantages. They are closely contacted with other governance subjects to play the role of supervision, evaluation, coordination, education, training and guidance in green governance. In specific practices, environmental protection social organizations can guide and urge enterprises to assume responsibility of green governance initiatives through persuasion (environmental protection is beneficial to enterprises), requirements (environmental protection is the responsibility of enterprises), direct confrontation and destruction (green aggressive actions) and other actions. For example, Greenpeace protested against Shell Petroleum's sinking of the Brent Spar oil rig into the Atlantic Ocean 150 miles from the coast of Scotland. Greenpeace launched environmental campaigns to call for consumers to boycott Shell's oil products, thereby achieving an excellent governance effect.

In addition, social organizations can also use diversified channels such as media, internet and mobile communications to create a cultural atmosphere of green governance, build a platform for communication and cooperation between the government, enterprises and the public, increase the reporting and exposure of illegal cases and actively guide the public to participate in green governance. This is mainly due to the following reasons: on the one hand, the news media is the middleman who disseminates information to the public, reducing the information asymmetry between governance subjects such as enterprises and their stakeholders [49]. On the other hand, the media plays a role of social construction, influencing how the public evaluates the behaviors of the subjects concerned [50].

5.4. *The Public: Extensive Participants*

Open innovation promotes the transfer and sharing of knowledge and resources and enables the public to gain greater freedom. An increasing number of public members have begun to consciously and systematically express their concerns on environmental pollution and their strong demands for green governance. They are the most extensive participants in green governance.

The foundation for the public to promote green governance practices lies in the existence of effective channels for the expression of citizens' interests. They participate in green governance mainly by means of "vote by hand", "vote by foot" and "appeal". Particularly, the public can influence the formulation of green governance policies through the "vote by hand" mechanism [51,52]. Thereafter, they can also use the "vote by foot" mechanism to select the green public goods and green resources provided by the government. Residents have the right to move freely. Resident migration takes away human capital and reduces investment and consumption in the local region, thereby ultimately affecting the local fiscal revenue [53]. When the public goods and public services provided by the government fail to satisfy the preferences of the residents, they opt to "vote by foot" to pressure the local governments [39,41]. Lastly, the public can directly petition appeal or launch public opinion to the government through "appeal" to achieve the effect of green governance.

5.5. *Nature: Regulate Participant*

Generally speaking, resource environment has triple value attributes: economic value, ecological value and social value. Firstly, economic value, as an important production factor, together with labor, capital, technology and so forth, can promote economic development. Secondly, ecological value, as the basis of the ecosystem, directly determines the structure, function and efficiency of various ecology systems, constituting the resource and environmental carrying capacity of economic and social development. Thirdly, social value can provide employment opportunities for social development and promote the sustainable development of social welfare.

In order to meet their own needs, all stakeholders want to maximize the value of the resource and environment. However, due to the scarcity of the resource and environment, the limited carrying capacity, the multi-use of one party means that the other party is less used; because it is non-exclusive, it is often overused or abused. Therefore, the government needs to establish rules and regulations to ensure the rational development and utilization of resources and environment. Firstly, the resource and environmental management system is required to be more complete and the state and local laws and regulations should be improved. At the same time, the formulation of standards and norms should be strengthened and the legal principles and regulations should be embodied to make the implementation more grounded. For example, the EU Water Framework Directive (WFD), as the EU's main environmental water law, requires an environmental policy that reflects the quantity, quality and ecological content of integrated water resources in a common policy framework and establishes an integrated water resources management framework for the EU [54]. Secondly, the government should carefully analyze the interests of the main subject of green governance that promote the sustainable development of resources from the perspective of maximizing social welfare, giving priority to ensuring the interests of this party and compensating the interests of other parties to ensure the sustainable development of resources and environment.

6. Innovation Mechanisms of Green Governance

Governance activities are supported by common goals and may not necessarily come from legitimate or formally prescribed responsibilities. Therefore, the governance mechanisms of different organizations can vary [55]. Governance mechanisms include government governance mechanisms and non-government governance mechanisms. The administrative governance mechanism proposes the government-centered organizational behavior, the essential characteristic of which is “compulsory”. However, the economic governance mechanism proposes that the profit organizations are the major subject of the organizational behavior and its essential characteristic is “profit”. The self-governance mechanism proposes that the behavior of non-profit organizations is considerably important, whilst the essential characteristic of self-governance mechanism is “voluntary” [18].

In green governance activities, the administrative governance mechanism is mainly embodied; the government comprehensively uses administrative tools, policy measures and other policy tools. The government uses jurisdiction and sanctions to enable other governance subjects (e.g., enterprises) to comply with the rules and regulations enacted by the other relevant departments [56]. The economic governance mechanism works mainly through the market mechanism (such as fiscal taxation) based on the fact that enterprises are driven by interest and social responsibility, internalizing the cost of green governance, such as environmental taxes, deposits–refund system, environmental subsidies, user fees, emissions trading, licensing transactions and ecological compensation mechanisms. The social governance mechanism indicates that social organizations and the public should accept and publicize green governance and solve environmental externalities through non-governmental and non-market-based approaches (e.g., propaganda, decision-making and supervision mechanisms).

Influenced by political, economic and cultural factors, a few emerging markets and countries in transition have long been dominated by administrative governance in the practice of green governance. By the end of 2015, China’s environmental protection authorities at all levels had issued 97,000 administrative penalty decisions and fined 4.25 billion Yuan, an increase of 34% over 2014. In 2015, 1.77 million enterprises were inspected, 191,000 illegal enterprises were investigated and dealt with, 20,000 were shut down, 34,000 stopped production and 89,000 were closed. However, the influencing factors of green governance, such as economic, social and cultural values, changed and new problems have emerged in the environmental field. For example, the degree of environmental pollution has been deepening and responsible subjects of environmental pollution are more difficult to define; cross-border pollution has become increasingly serious and environmental disputes arising from cross-border pollution are endless) [57]. Consequently, the government-led administrative governance mechanism shows certain drawbacks and limitations and is unable to continue to effectively respond to these changes.

Therefore, since the cooperative subjects are independent stakeholders, their opportunistic behavior will increase the instability of the cooperation network. Under the framework of green governance, any governance subject does not have all the knowledge, resources and capabilities to solve complex governance problems. The market, hierarchy and network may fail, thereby requiring the coordination of three different governance mechanisms [58]. The government, enterprises, social organizations and individuals cooperate in many ways, such as government subsidies, market pricing and social rewards, by constructing network collaboration platform. The cooperation can not only help promote the free flow of resources (such as technology) in the network node but also is beneficial to form mutual trust and win-win cooperation atmosphere, thus promote the realization of green governance objectives.

7. Innovation Mode of Green Governance

Since Schumpeter proposed the theory of innovative economics, scholars first began research and exploration from the perspective of economics of technological change [59] and the relationship between industrial research and technological innovation [60]. Such researches focused on the effect of technological innovation on economic growth and social competitive advantage [61] and the core

issues of value acquisition in the innovation process [62]. Among them, typical innovation paradigms such as user innovation [63], subversive innovation [64] and open innovation [14], emerged one after another. Dosi [65] defined innovation as “models and modes that solve specific technical problems with selected natural science principles and a large number of innovative problems rely on the definition of paradigms”. Baldwin and Von Hippel [66] distinguished the concepts and practices of the open innovation and the closed innovation. Compared to closed innovation, open innovation focuses on knowledge interaction inside and outside the enterprise, emphasizing that enterprises can improve their technology level and competitive advantages by opening up organizational barriers, acquiring knowledge from the outside (inwardly opening) and internally exporting knowledge (outside opening) [14]. The core is that innovation activities do not rely entirely on the power of the organization itself but on the re-integration and effective utility of resources.

From the theoretical analysis of green governance, the starting point is to take into account the resources and environment carrying capability and human needs. Since that the environment is public pool resource and has strong externalities, which makes it involved in almost all the social and economic activities. Solving the problem of ecological environment becomes a systematic project. It needs to adhere to the “diversified governance” order view and identify the relevance of each subject in the governance system. Meanwhile, it also requires to overall consideration of the interests, appeal and responsibility of all subjects and build governance structure, mechanism and mode based on the sharing of governance rights. Open innovation deeply affects all the subjects of green governance, such as enterprises, governments, social organizations and the public and bring some new methods and new paths to green governance. It helps to promote the collaborative innovation of diverse groups, to cultivate spontaneous sharing and trust each other from the relationship between human and nature, with the goals of green governance.

On the one hand, under the framework of open innovation, it is possible to create a green organization with green governance goals. The consideration of economic factors by multiple stakeholders hinders the development of enterprises to green organizations. In the context of advocating green governance, managers will consciously lead enterprises to develop towards ecological sustainability but sometimes these enterprises’ actions will result in losses of economic benefits such as R&D investment and increased costs. When members of the organization realize that other competing companies will not follow the ecological transformation they lead at the expense of profit, they will not risk placing themselves in a position of competitive weakness [62]. The green governance mode based on open innovation enables enterprises to obtain the required innovation resources indirectly from external systems, so that the enterprises can reduce the cost caused by resource input in the process of innovation and effectively reduce the proportion of natural resources used in the production process, resulting in ecological value. In addition, in order to curb the trend of ecological crisis, the government prevents the organization from further damage to the external environment by enacting laws and regulations on green governance or by economic leverage such as collecting emission taxes. If an enterprise based on open innovation can produce the expected ecological value in the operation process, it may obtain certain policy conveniences.

On the other hand, under the open innovation framework, multi-center collective action based on green governance goals becomes possible. An important attribute of open innovation is sociality. Organizations based on open innovation are able to achieve the purpose of innovation through social exchange. Therefore, it is inevitable for organizations to communicate and cooperate with other organizations in external systems. Open innovation not only can reduce cost and improve the efficiency of innovation, also can create the ecological value of the additional benefits. When the organization managers are aware of such advantages of open innovation, they will consciously publicize the ecological significance of innovation model in the process of employee training, allowing staff to build up the green governance concept. In turn, the concept of green governance will affect the employees’ individual green life and green consumption. Besides, the open innovation green governance mode not only produces ecological value but also promotes the formation of an ecological

protection atmosphere between organizations, which in turn leads to a multi-faceted exchange based on reciprocal equality and sustainable development. A cooperative approach to environmental protection between enterprises, governments and social organizations has been formed [67].

The implementation of green governance does not mean that the carrying capacity of the ecological environment is used to restrain the economic development of high quality and high efficiency. Instead, it further promotes the sustainable development of the economy through the participation of multiple governance subjects and the open innovation mode, realizing the sustainable development of human and nature. Some open innovation models that consider both economic and ecological values have been steadily carried out and green governance practices have been continuously promoted. Mainly includes:

- (1) Some countries and cities are striving to put open innovation into practice. Denmark has long profiled itself as a leader in sustainable solutions within energy, climate adaptation and environment [68,69]. Denmark mainly focuses on the “brand of green space” strategy, combining the power of the government, enterprises and the public to promote green governance. On the one hand, the government formulates relevant environmental protection laws and regulations to provide external guarantee for the construction of green space [70]; on the other hand, the government also promotes its environmental protection measures to the outside through international environmental protection cooperation” [70]. Driven by the green development strategy, the enterprises are not only pushed by the internal green debt but also pulled by the competition from other enterprises in the society, actively carrying out technical innovation in accordance with the green governance standards. The Danish public has responded positively to the government’s call for green environmental protection and conducted positive interactions with the government and enterprises through green living, green travel and green consumption. In recent years, social organizations have played a key role in the improvement of green governance in Jiaxing, China. An environmental protection federation and many subordinate social organizations have been established, including the public inspection team, expert service team, eco-green publicity team, environmental rights protection center and environmental society. The eco-green publicity group has reached the rural areas, enterprises, schools, communities and government institutions to implement publicity activities on environmental protection and ecological civilization. The environmental protection center mainly provides consultation services on environmental laws, regulations and policies and represents a few environmental litigation cases. The main function of the public inspection mission is to enable the public to participate in the environmental governance and acceptance of enterprises with poor environmental credit, enterprises with serious violation of environmental pollution law and major pollution control enterprises.
- (2) Some regional cooperation is advancing. The Utah-Qinghai Eco-Partnership (UQEP) is a non-profit organization supported by the National Development and Reform Commission of China and the US Department of Energy. UQEP is a relationship that is “committed to building relationships, protecting intellectual property and developing green technologies”. The organization is based on the fact that Utah and Qinghai provinces are both located in the western part of the country between mountains and salt lakes. US Secretary of State Kerry described it as “using the intelligence and innovation of the private sector, universities and civil society to promote economic development, energy security and environmental sustainability”. At present, Qinghai Province has invested tens of millions of RMB in the UQEP project and has advocated that all functional departments and major cities in Qinghai actively support the UQEP project through strengthening organization and coordination and further expand cooperation in other fields, including the individual level. UQEP has also worked with scientists at Purdue University to improve the quality of water used in Qinghai Province, for example, through the use of an advanced version of Purdue’s “Slow Sand Filtration” system [71].

8. Discussion and Conclusions

8.1. Discussion

With the emergence of problems such as climate warming, resource constraints, environment pollution and ecological degradation, the environment problem has become a common topic of global concern. Good ecological environment has become the basic condition and common demand of economic and social development in any countries. Green development and ecological environment protection have become the common goal of the whole world. While the perception of “green” also presents an evolutionary process, which fully reflects human’s pursuit of green governance. The cognitive process has evolved from the original simple concept of color into a concept of development, experiencing from “ignoring environment” to “attaching great importance to environment and sustainable development” and then to the whole process of “green plus”. Therefore, the key of green governance lies in the realization of human transformation from the unilateral consideration of human needs to the bilateral consideration of resource and environment as equal subject. This requires the government, enterprises, social organizations and the public to treat nature equally in the process of governance, considering the scarcity of natural resources and the carrying capacity of the environment.

As special public goods, the ecological environment and natural resources determine that green governance is essentially “public affairs activity” with the participation of governing subjects, the implementation of governance means and the synergy of governance mechanisms. Some economists think that the governance of public goods will encounter the problem of “tragedy of the Commons” and individual rationality may lead to the collective “prisoner’s dilemma”. Ostrom [72] argued that the “collective action” theory in the past was a single-center governance model and that there were inherent weaknesses in simply recommending government-led solutions to global problems because of the free-ride problem. Ostrom [72] proposed a polycentric alternative for effective monitoring among stakeholders in various regions and countries. The polycentric approach can reduce opportunistic behavior, allow citizens to form small collective consumption units, encourage face-to-face discussions and reach consensus and thus more effectively provide urban goods and public services [72,73]. Ostrom’s theory provides a good framework for analyzing the issue of green governance but there are two deficiencies in this framework. Firstly, it overemphasizes the role of autonomous organizations and governance, such as individuals, families, enterprises and communities, while ignoring other governance mechanisms. Secondly, it neglects the network features among the governance subjects. A dynamic and complex open innovation network system has been formed among the governance subjects, such as enterprises, governments, social organizations, individuals and nature, which needs to be combined with the open innovation theory to build the analysis framework of green governance.

Open innovation not only helps promote enterprises to realize economic and ecological values [14,67] but also facilitates the cooperation of enterprises, governments, social organizations and the public based on sustainable development, making the green governance collaborative mode possible. We attempt to examine the synergy between human and nature by presenting a framework, including related theories of green governance, innovation subjects, innovation mechanisms and innovation mode. There are three implications of the suggested framework in this paper for countries, regions or enterprises that try to improve the level of green governance. First, the green governance framework proposed in this paper is based on the open innovation perspective, which provides an idea for the organization committed to green and sustainable development. The main goal and objective function for business organizations is to maximize the economic value and ecological value by open innovation. Second, the green governance mode based on open innovation can not only integrate a wide range of stakeholders but also accomplish the sustainable development tasks that the monopolistic entity cannot accomplish alone and it can also bring synergy effects to sustainable development. This mode should gradually become the action strategy of each country and region’s green governance practices. Third, the power of social organizations is relatively weak, whilst most

environmental groups lack the sufficient capacity to win public support for their actions, thereby causing the phenomenon of “social organization failure” in the process of green governance and failing to play their role in green governance. Therefore, social organizations should establish and improve the social governance structure and mechanism, establish the governance structure with the board as the core, including investors/donors, volunteers, supervisors, independent directors, management and other subjects and improve the decision-making mechanism, reputation mechanism, accountability mechanism, information disclosure mechanism and mutual supervision mechanism.

8.2. Conclusions

Green governance is proposed to harmonize the relationship between human beings and nature and further promote the demand of building a community of shared future for mankind. Although the research on green governance has attracted considerable attention, the lack of theoretical framework and scientific logical expression has limited the research and application of green governance theory. Based on the perspective of open innovation, this paper focuses on relevant theories to green governance, innovation subjects of green governance, innovation mechanisms of green governance and innovation mode of green governance to build a green governance framework. In this context, enterprises can overcome the disadvantage of the maximization of shareholder value and pursue the maximization of social and ecological value through open innovation. And each governance entity participates in green governance activities through negotiations and binds their respective comparative advantages to achieve their respective goals.

Each country, region and organization may be at different stages of green governance, the suggested green governance framework can be used not only by countries, regions and organizations with weak foundation of green governance but also by countries, regions and organizations with good green governance experience. This paper provides policy, practical and research implications for legislators, regulators and standard-setting bodies and businesses for the development of green governance principles, green strategies and green information disclosure guidelines.

As an informal governance mechanism, trust can promote all-round exchange of information, increase the possibility of acquiring knowledge, convince members that their partners’ promises are reliable, that they can fulfill their obligations and have the confidence to establish a partnership with the integration of interests and risks [74]. Although this study reveals many advantages of the open innovation theory in explaining and constructing the green governance framework, its ecological promotion effect is also influenced by factors such as the level of trust in the cooperative relationship, providing further exploration clues and expansion space for follow-up studies.

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