Assessing Chinese governance low-carbon economic peer effects in local government and under sustainable environmental regulation

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Abstract

The current study developed a systematic analytical framework to explore the logic of forming the cohort effect of green governance and green development in China in the new era. Based on provincial panel data from 2008 to 2018, this paper examines the existence, scope, and induced control of the green governance peer effects using a spatial econometric approach. The study found that the following: (1) Influenced by the top-level design of the central government and the contradictory governance of regional development, the local governments form the peer effects in green governance activities. The existence of spatial relationships makes local governments dependent on a solid financial support system and a basis for industrial transformation, thus counteracting regional competition for green governance. (2) The green governance peer effects tend to decay with increasing geographical distance but do not disappear across regional boundaries under either spatial interaction framework. (3) Considering the impact of green governance policy systems and regional heterogeneity, the green governance peer effects decrease in the eastern, western, and central regions in that order. (4) Further, the influencing factors show that the green governance peer effects arise from intra-local government competition under the decentralization of power between the central and local governments. The competition for scales and the relative performance appraisal system reinforces the peer motivation of each subject. (5) The strong correlation of green governance willingness indicates that local governments cannot escape from will-led emotional behavior, and personal interests and governance motivation further drive the formation of pseudo-rational decisions, ultimately leading to irrational group decisions.

Keywords Green governance · Peer effects · Local government · Systematic analysis framework · Environmental foundations · Incentive logic

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Introduction

The potential transformation between clear-waters-green-mountains and mountains-of-gold-and-silver reveals the dialectical unity between ecological protection and economic development (Mohsin et al. 2021). Enhancing green governance effectiveness can strengthen the strategic determination of ecological civilization construction, balance the dynamic relationship between protection and development, and penetrate the core demand of ecological benefits in economic, political, social, and cultural benefits. General Secretary Xi Jinping pointed out that it is only by continuously improving social governance and firmly practicing green development that we can improve the system of ecological civilization. In this context, the green governance system that has emerged has become an essential part of promoting the modernization of the national governance system and

governance capacity, as well as achieving synergy between economic, political, social, cultural, and ecological development with the integrated optimization of the spatial layout of production, living, and ecology. With the receding of the crude economic growth method from the historical stage, the increasing pressure of ecological legacy and the increasingly sharp contradictions of economic adjustment have given local governments more constraints for transformation, and an essential direction for local governments to break through the development dilemma is to strengthen green governance (Ozoike-Dennis et al. 2019), (Khosravi et al. 2019), (Kordej-De Villa and Slijepcevic 2019).

However, green governance cannot be achieved overnight, and lags in economic, political, social, and cultural development can lead to ineffective governance (Shi and Liu 2019). At the same time, the urgent need for local governments to transform blurs the details of governance and weakens the integrating power of green governance. In this context, the study of green governance is anchored at the level of local government dynamics, which not only helps to discover the sources, dispersion, and correction mechanisms of ineffective green governance but also has important theoretical significance for the formation of a new pattern of modernization for the harmonious development of man and nature. At the same time, it provides innovative ideas for local governments to regulate their governance activities and achieve high-quality development and effective governance. The enthusiasm of local governments for green governance indicates that China's economy is entering a new era. At the beginning of the new development stage, as the pivot of the five development concepts, green governance is given a new direction in the top-level design for local governments to govern: through green governance, green development leads to the construction of a resource-saving and environment-friendly society and achieves a coordinated development that can be carried by resources and the environment.

(Zhai 2016) re-optimize the allocation of resource factors with innovative development, give new green supply under new technologies and new business models, and eliminate grey and black production capacity (Liao et al. 2019). Strengthen the trend of deep economic integration into the world with open development and a shared development approach to guide the green extension of the industrial chain (Zhou 2019). The successful experiences of Zhejiang and Jiangsu are even more proof that green governance makes an essential contribution to the high-quality development of the Yangtze River Economic Belt. As the transition progresses, green governance is being extended to the Yellow River and Pearl River basins to create ecological corridors for green development and enhance the effectiveness of ecological and environmental governance, further promoting balanced regional development and enhancing the content of development. Measuring the marginal contribution of

green governance to the economy and society has received considerable attention in studies on green governance (Zhou et al. 2018; Duan et al. 2020). However, several economic issues worth exploring have been overlooked: (1) under the premise of the central government's strong emphasis on the new development concept, local governments have less room to make decisions freely, and under the intervention of "competition with the ruler," the individual behavior of local governments is more profoundly influenced by peer behavior (Deng and Zhao 2018). This phenomenon makes green governance seem the "key straw" for local governments to escape development bottlenecks. However, what kind of external environment has fostered green governance? What is the scope and influence of green governance cohorts? (2) The value and significance of green governance are self-evident, but what motivates the strong will of local governments for green governance and how to achieve control and guidance of green governance clusters deserve further investigation. Because of this, this paper proposes to construct a systematic analytical framework to examine the formation environment of the green governance holistically peer effects of local governments under the system of high-quality economic development and to analyze the spatial scope of the green governance peer effects based on the perspective of spatial interactivity. This paper explores the behavioral motives of local governments' green governance from the fiscal decentralization system, green development system, performance appraisal system, and business investment reform to clarify the incentive logic of local governments' green governance.

Our contribution lies in several ways. (i) We have measured the environmental basis and incentive logic of green governance of local governments through a systematic analytical framework constructed to explore the logic of the formation of the cohort effect of green governance. It helps to clarify the sources and adjustment mechanisms of inefficient green governance and further empowers high-quality green development in China in the new era. (ii) Based on provincial panel data from 2008 to 2018, the current study examines the existence, scope, and induced control of the green governance peer effects using a spatial econometric approach and introduces a knowledge management perspective to examine further the roots and direction of the peer grouping behavior of local governments. Based on this, this paper argues that the formation process of the green governance peer effect should be optimized from the correction and adjustment of the environmental basis and incentive logic of green governance. (iii) Empirically, we measured the competition for scales and the relative performance appraisal system, which reinforces the peer motivation of each subject, whereas the critical incentive logic drives the peer effects of governance dynamics under fiscal decentralization and competition for personal interests under official promotion. We

measured that the fiscal decentralization intensity of regional interest orientation with green development at its core still needs to be enhanced. Moreover, this paper analyses the motivational logic of local governments' green governance from the perspective of governance dynamics, regional interests, individual interests, and unique preferences.

The rest of the paper is organized as follows. The "Systematic analysis framework and research hypothesis" section contains the systematic analysis framework and research hypothesis. The "Data and methodology" section contains data and methodology. The "Results and discussion" section discusses results and discussion, while the "Conclusion and policy implications" section concludes the study.

Systematic analysis framework and research hypothesis

The environmental basis for green governance in local government

As a collection of economic activities and institutions, green governance by local governments is at some level embedded in the local economic, social, and other environmental foundations (Deng and Zhao 2018; Sudipta et al. 2018). Because of its economic activities, green governance in practice shows its dependence on the economic base (Rosenberg and Moore 1990). From the front side of governance activities, the critical effectiveness of green governance on economic construction is reflected in shaping a new pattern of development, accelerating the cultivation of a complete green domestic demand system, and leading a self-sustaining and self-reliant industrial system with a green technological revolution. Ultimately, by optimizing and upgrading industrial chains, supply chains, and value chains, the quality of people's lives will be improved, and the economy will develop in a high-quality manner (Sun et al. 2017). These developments are dependent on an efficient government debt financing mechanism, and a robust financial support system is key to strengthening the effectiveness of government services (Soogwan and Byungkyu 2014). The source of the financial resources of local governments and the financial security of their strategic tasks is the better local economic base (Liu et al. 2020). Therefore, green governance and economic development show a relationship of economic growth-fiscal expansion-enhanced green governance practices-economic growth, characterized as a virtuous system of interdependence and mutual circulation. Researchers in this filed have also shown that differences in economic productivity tend to diverge as differences in economic scale decrease and that a more significant economic scale contributes to more efficient economic growth (Nan 2020). The extension of the size of the hidden economy will also reduce the tax burden, making

local governments more fiscally resilient and demonstrating greater fiscal sustainability (Zhang and Gai 2018).

Moreover, the coupling relationship between industrial transformation and economic growth also proves that the increased strength of industrial transformation drives high-quality economic growth (Li and Li 2016). Furthermore, rapid economic growth ultimately lays the groundwork for the reality of green development and green governance (Jyrki et al. 2019).

As part of a modern environmental governance system led by the government, green governance, with enterprises, social organizations, and the public, the key to its effective formation and normative action comes from the social and environmental foundation (Heidi 2016). In terms of the depth of governance activities, the essence of green governance is to promote the modernization of the national governance system and governance capacity, and the anchor point is to lead the modernization construction with the new development concept (Ding 2017). These activities are dependent on the region's infrastructure (Jiao and Wan 2020), sustainable competitiveness (Hosseini et al. 2021), and level of education (Huang and Huang 2020). Among them, the improvement of infrastructure construction and the optimization of the layout of the main functional areas promote the adjustment of the spatial pattern of green governance and the mode of development. At the same time, sustainable competitiveness builds an institutional mechanism for the mutual coordination of resource development and ecological protection, the core capacity of the new regional industry, new dynamic energy, and new infrastructure.

Incentive logic of green governance for local governments

As an important platform for local governments to effectively control and respond to grassroots governance, green governance has a strong local government imprint and character (Lian and Yin 2020). Moreover, local governments' strong motivation to promote green governance is essentially a microcosm of the evolving pattern of competing interests of local governments under central-territorial decentralization. As a result of the legacy of sloppy development, local governments, as relatively independent and autonomous interests with claims, have taken on the burden of absorbing heavy debts and polluting projects in the past few years. With the restructuring of the fiscal and taxation system under the comprehensive deepening reform, the power of local governments is in a state of contraction (Zhang and Li 2020). Moreover, as China's economy enters a new era, it has gradually begun to build a complete institutional mechanism for the market-based allocation of factors and a socialist market economy.

In clarifying the relationship between the government and the market and strengthening the space for forwarding deployment and governance, local governments have been given more discretionary power and have gradually seen their authority loosen (Liang and Gao 2017). Green governance activities inherently address the legacy of ecological problems and expand the marginal efficiency of capital through the effectiveness of green innovation, increasing the resilience of economic development and reversing the negative impact of heavy debt. Green governance activities, inherited from the top to solve the legacy of ecological problems, and through the effectiveness of green innovation to expand the marginal efficiency of capital, enhance the resilience of economic development, reversing the negative impact of heavy debt. Enlighten the bottom to achieve resource allocation optimization with the five development concepts to solve the deep-seated structural contradictions and problems in economic development. On the one hand, through the power of action empowered by green governance, local governments have effectively provided more and better public goods, expanded their fiscal tax base, and occupied a favorable position in the context of the tax-sharing system, thus continuing to retain a relaxed climate of power. On the other hand, green governance addresses the root causes of the contraction of local government power, safeguards the central deployment in the modernization of government governance, responds to the central government strongly and positively, and avoids the risk of another adjustment of the fiscal and taxation system and the system of powers.

In general, the primary motivation for local governments to vigorously pursue green governance is to gain more governance agency under the fiscal decentralization system. Moreover, beyond the profit drive, green governance as a unique institutional arrangement that integrates multiple resources such as land, finance, and markets has led to an additional preference for green governance by local governments: to optimize the business and investment environment based on green governance and to expand the government's social influence. Furthermore, through the empowerment of green activities, the revaluation and adjustment of land, financial, and market resources allows local governments to obtain more foreign investment (Xiang 2020) and thus gain favorable incentives in the central-territory game. The green optimization of the business environment allows local governments to obtain more promises of preferential policies in a "green context," which to a certain extent strengthens the social influence of local governments (Frances and Harrie 1991).

Systematic analytical framework for the cohort effect of green governance

This paper combines green governance formation's environmental foundations and incentive logic to form a systematic framework for green governance analysis, as shown in Fig. 1. In this regard, the environmental basis of green governance sets the scale of green governance inputs and indirectly influences the scale of green governance outputs through the influence and empowerment of each input element. The output element of green governance ultimately satisfies the incentive logic of green governance, a natural response motivated by the governance dynamics of local governments, regional interests, personal interests, and particular preferences. The inputs and outputs of green governance form the research pathway of green governance efficiency, which is the external expression of the core content of green governance. This paper thus develops a research line of thought on the environmental basis of green governance formation the external manifestation of green governance - the incentive logic of green governance.

An important direction of research in this paper is to explore possible peer effects in the green governance activities of local governments. The theoretical framework of the peer effect has its origins in social interaction research (Heimer 2016), which has classically led to theoretical doctrines such as the herd effect and the cluster effect. At some level, the peer effects are a theoretical extension of the herd effect or cluster effect (Li and Zhong 2020), but there are apparent differences between the three in terms of the subject of the effect. The herd effect occurs mainly among individuals in society, such as farmers (Zhang and Zhou 2019) and investors (Zhou et al. 2019), with a precise individual dimension, which manifests itself in the interaction between individual rationality and collective sensibility. In contrast, the subjects of the cluster effect are mostly organizations in society, such as industries (Su et al. 2019) and enterprises (Zhao 2015), characterizing the spontaneous agglomeration behavior of organizations to achieve their interests or specific goals through economies of scale. The cohort effect is more likely to be characterized by similar behavior in organizational decisions by multiple subjects due to geographical factors.

Research hypotheses

Considering the similarity of political resources and the ease of governmental interaction, local governments will observe subjects with closer political status and geographical proximity in green governance. As early as 1986, the Seventh Five-Year Plan divided China's provinces into three regions—eastern, central, and western—based on the similarity of governance systems and geographical conditions.
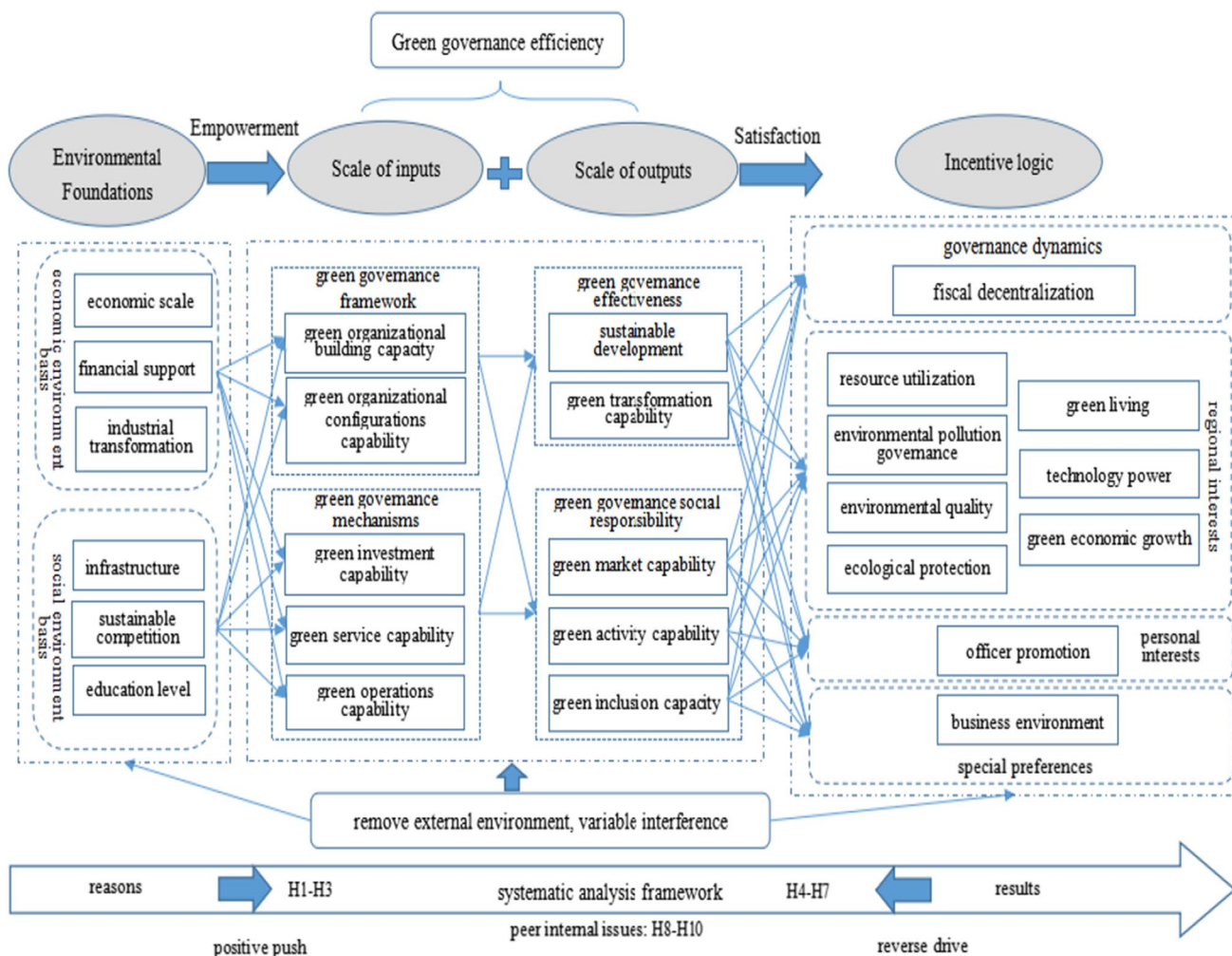
Fig. 1. Systematic analytical framework

Due to the relative consistency of governance systems in the provinces within the region, and with competition on the scale, the central government will use neighboring provinces' relative performance as a benchmark for assessing officials in a particular place (Xu 2011). The resulting peer effects of green governance may be more likely to occur within the same region: the incentive logic of green governance is more similar across provinces within the region, and the resulting behavioral influences force local governments to make similar decisions. On this basis, the paper argues that:

H₁: Peer effects exist between provinces in the same region in green governance

Although local governments are in the same framework of green governance incentive logic, differences in the underlying environment, such as the economic and social environment, can also lead to a tendency to circumvent or

cater to social interactions. For example, when the regional infrastructural environment is superior, local governments will "target" comparable targets to create a competitive relationship, forming peer effects in a series of interactions such as following, imitating, and surpassing. Conversely, when regional infrastructures are lacking, local governments will avoid high-level governments in favor of those similar to themselves, thus extending their advantages in the face of competition on the scale. In essence, the environmental basis of green governance further refines the peer effects. On this basis, the paper argues that:

H₂: Peer effects exist between provinces with close levels of development in the same region in green governance

Beyond intra-regional exploration, there are also neighboring geopolitical relationships between provinces at the margins of each region and spatial interactions between provinces across regions. However, green governance

interactions between local governments are generally mainly rooted in geographic relations, with neighboring local governments more likely to generate observation activities. Furthermore, the presence of markets and economic activity makes it easier for local governments to absorb the results of green governance and amplify its effectiveness, and this economic relationship will progressively strengthen the fit within the green governance community. Thus, the stronger the geographical and economic proximity effects, the greater the interactions and spillovers, and the greater the tendency for local governments to peer in green governance. On this basis, the paper argues that:

H$_3$: Peer effects among provinces with geographic and economic proximity in green governance

Green governance as a critical tool for local governments to seek breakthroughs in governance and cater for future development is inherently more attractive for decision-making. However, this focus on decision-making gradually decays as the external environment and the challenges of governing change. Therefore, the incentive logic underpinning local governments' adherence to green governance comes primarily from endogenous dynamics, i.e., their subjective motivation for governance. As rational human beings, local governments are always driven by multiple interests and exhibit a high level of interest bias, divided into regional and personal interest orientations by differences in interest attributes. Different levels of interest intensity do not provide the same level of incentive for green governance by local governments. In addition, in conjunction with the previous analysis, local governments have a particular preference for a business environment to maintain their social influence and governing image, which stimulates and reinforces local governments' incentives for green governance. The unifying effect of different motivations has led to a peer state of green governance in each local government. On this basis, the paper argues that:

H4: There are incentives for local governments to green governance from governance dynamics and strengthen the green governance peer effects
H5: Regional interests have incentives for local governments to green governance and reinforce the green governance peer effects
H6: There is an incentive for local government green governance from individual interests and reinforces the green governance peer effects
H7: There is an incentive for particular preferences to green governance in local governments and reinforces the green governance peer effects

Economic and social infrastructures drive green governance and its peer effects. However, as a government management activity, green governance cannot be separated from the aid and influence of knowledge, and knowledge management will affect peer effects. Behavioral economics emphasizes that the presence of explicit knowledge such as experience and competence reduces the disposition effect and the decision bias caused by blind confidence, thereby suppressing the peer effects (Sudipta et al. 2018). As a result, regions with relatively more experience and superior capacity in green governance will avoid the social damage caused by blind emulation, while inexperienced regions will rush to the top, leading to a simple convergence of green governance decisions. In addition, the focus of the peer effects is on peers, which are rooted in learning imitation under the interaction of various local governments (Deng and Zhao 2018). This learning imitation makes the dynamics of tacit knowledge such as local governments' willingness to change green governance, with regions with high willingness to govern participating in green governance groups as leaders. In contrast, low willingness groups may follow imitation as an appropriation strategy for green governance and integrate as followers in green governance situations. On this basis, the paper proposes mechanisms for the peer effects of green governance that:

H8: Mechanisms of peer effects are influenced by the role of local government knowledge management

After clarifying the environmental basis, incentive logic, and regulation mechanism of green governance, the characteristics, and dynamics of the green governance peer effects are gradually obtained, but the central subject of this peer becomes another critical issue. In reality, in the face of the uncertainty and complexity of green governance, regions with more experience and greater willingness in green governance tend to become the targets of imitation in the cluster. In contrast, regions with a higher quality of economic development are more likely to take the lead in green governance due to their superior environmental foundation and more substantial expectations of the central government. These regions have, in effect, become the leaders of green governance, driving integrated regional governance with the image of the core subjects of the cluster. Conversely, the less experienced, less willing, and economically weaker regions are left to gather around them as latecomers, thus completing the green governance peer group. Therefore, this paper argues that:

H9: Provinces with a strong will for green governance, outstanding green governance capacity, or mature experience can become the core subjects of the peer

H10: Provinces with higher quality economic development can become the core subjects of the peer

Data and methodology

Model construction

Based on provincial panel data, this paper verifies the peer effect of green governance in local governments from the perspective of environmental foundations. First, it determines the scope and influence of the peer, using the decade before and after the formal introduction of green governance as the research context. On this basis, the behavioral motivation of local governments for green governance is analyzed from the perspective of incentive logic, and then the factors influencing the peer effects of green governance are obtained. Finally, a complementary study from the perspective of knowledge management and the peer core explores the complete characterization of the peer effect of green governance. According to Deng and Zhao (2018), the nature of the peer effects is an endogenous social interaction, so the econometric judgment of the peer effects needs to avoid the problem of endogeneity of data. On the other hand, spatial econometrics can effectively identify spatial interactions, correlated situations and circumvent the interference of data endogeneity. This paper draws on existing literature to construct the following model (Lung and Jihai 2009; Lung et al. 2010):

$$Y_{it} = \alpha + \rho W Y_{it} + \beta X_{it} + \mu_i + \eta_t + \varepsilon_{it} \quad (1)$$

Among them, Y_{it} is the dependent variable, which is a specific portrayal of the external performance of green governance. Combined with the previous analysis, this paper expresses it in terms of the efficiency values of green governance, and the spatial dynamic correlation of green governance efficiency portrays the specific situation of the peer. X_{it} is the covariate that controls the environmental base of the region, i.e., the economic and social environmental variables that drive the formation of green governance. W is the normalized spatial weight matrix, reflecting the spatial relationships between regions. WY_{it} constitutes the potential dependent variable, the spatial lag term, characterizing the average propensity for green governance in other regions with which region i is spatially related. To reduce measurement bias, this paper controls for regional fixed effects μ_i and time fixed effects η_t. α is a fixed coefficient to be estimated, β is the degree of influence of each environmental base variable on green governance, and ρ is a measure of the interaction of each local government

on green governance, which in reality is an indicator for judging peer effects. When ρ is positive and significant, it indicates the peer effects of green governance activities of local governments.

This study also refers to the equitable treatment proposed by Deng and Zhao (2018), firstly, in constructing the spatial matrix, all of which have realistic exogenous relationship interpretation without self-selection bias. Second, a maximum likelihood estimation method was used in the model estimation to avoid the error autocorrelation of the least-squares dummy variables in the model estimation. Finally, lagged variables are considered to circumvent regional fixed effects, and environmental variables are not considered.

Spatial weighting matrix development

Combining the hypotheses to be tested in this paper and the potential spatial relationships among local governments in green governance, various spatial weight matrices have been created: (i) Political adjacency weighting matrix. According to the division conditions of East, Central, and West, each area belongs to the same region. The value of the corresponding element of the spatial weight matrix is 1; otherwise, it is 0. Under the current structure of political relations, local governments in the same region have more information interaction, relatively unified governance systems, and performance assessment systems, and closer relationships within regions, such as Beijing-Tianjin-Hebei and the Yangtze River Delta in the eastern region, which lays the foundation for the peer of green governance. (ii) Administrative adjacency weighting matrix. Based on political continuity, the corresponding element of the spatial weight matrix is 1 if the two regions are contiguous in terms of administrative boundaries and 0 otherwise. In spatial relationships, the closer the co-regional and administrative relationships, the higher the likelihood of green governance interactions. (iii) Geographical relationship weighting matrix. In spatial econometric analysis, distance is a visual indicator of the relationship between regions. In this paper, these spatial weight matrix elements are set as a decreasing function of the distance between the two regions, $d_{ij}^{-0.5}$. This distance more clearly reflects the implied relationship between regional distance and spatial interaction, with the regions interacting more closely with each other as the distance decreases. (iv) Economic adjacency weighting matrix. Under this matrix, local governments make independent judgments about the choice of peer objects, targeting areas similar to them for interaction, learning, and emulating their behavioral decisions while considering their level. Economic distance is measured as

the inverse of the difference in per capita income levels between the two regions, i.e., $1/|PAGDP_i - PAGDP_j|$. (v) Political economy adjacency weighting matrix. Based on the economic adjacency weight matrix, the regional affiliation between regions is considered, and the elements of the economic adjacency matrix are retained if they belong to the same region, or 0 if they do not belong to the same region.

By setting five spatial weight matrices, peer effects under political, administrative, economic, and geographical relationships can be effectively identified, and the extent of green governance peer effects can be indirectly judged.

This paper counts the GDP of each province from 2008 to 2018 and combines green governance willingness, green governance capacity, and empirical indicators, divides the regional data under each indicator into two groups by 0.5 quantiles, and develops the measurement through the following model:

$$Y_a = \alpha + \rho WY_a + \beta X_{it} + \varepsilon_i, a = L, H \tag{2}$$

where Y_a is the average of green governance efficiency in regions with better (worse) economic, green governance willingness, green governance capacity, and experience; WY_a is the peer effects of green governance in the corresponding region; X_{it} is the environmental base variable, which is used as a control variable in the study.

Data sources

This paper takes 31 provinces, autonomous regions, and municipalities directly under the Central Government (except Taiwan Province, Hong Kong, and Macao Special Administrative Region) in China as the research target, and the sample observation period is selected from 2008 to 2018, considering data availability and the reality of green governance. The main reason for choosing local data for this analysis is that provincial governments have greater administrative power and are key players in green governance policies at the grassroots level and shaping the climate for green development. Zhang (2018) also stresses that green governance needs to be underpinned by a profound theoretical, historical, and practical logic, a unification of all parts of society such as people's livelihood and civil rights, which is challenging to achieve prefectural level. In addition, it is difficult for municipal governments to have a strong social influence and attract other governments to follow their example. The paper combines the previous analysis and the analytical framework obtained in Fig. 1 to derive the variables in Table 1.

Results and discussion

Judgement of the environmental basis for the formation of the peer effects of green governance

The stochastic frontier model with a spatial autocorrelation structure is constructed, and model 1 is estimated based on a quasi-great likelihood estimation method. Model 2–model 6 show the estimation results of the spatial lag model under various types of spatial weight matrices. The results show that the spatial lag coefficient ρ is always significant and positive, indicating an extremely significant peer effect of local governments in green governance. Of these, model 2 (0.527) and model 3 (0.571) validate H1, and the comparison of ρ reveals that administrative proximity further strengthens the peer effects within the region and that the closeness of administrative activities intensifies the links between local governments in green governance and serves as a bond for the formation of the peer effects. Model 6 (0.394) confirms H2: within regions, provinces with closer economic activities and development levels also have a peer effect, but this peer effect is weaker than that of peers in a political and administrative neighborhood framework, which suggests that green governance homogeneous groups in the same region with comparable levels of development are affected by competition within the scale, which leads to a slight narrowing of peer activism in spatial interactions as each player fears its losses due to market interactions and spatial spillovers. Model 4 (0.438)–model 5 (0.412) verify H3 that geographic proximity and economic market interaction also significantly positively affect the peer effects of green governance, which can be interpreted as geographic and economic proximity laying down channels for peer activities. However, the economic channels are weaker than the geographic channels, suggesting that higher economic interaction costs are likely to undermine local government peer incentives. The calculation results are shown in Table 2.

In Table 2, model 1 is a regression model that applies least squares and does not consider spatial correlation, reflecting the endogenous relationship between the environmental base of local governments and green governance. At this point, the coefficient of the financial support variable is not significant, indicating that in the context of central-territorial decentralization, the strength of local financial power does not affect the formation of green governance if competition for scale and pressure for performance among local governments are not taken into account. In other words, green governance did not become an arena for regional competition for fiscal revenues, and

Table 1 Variable definitions and sources

Dimension	Variable	Variable meaning	Definition or calculation method	Source of data
Environment foundations	*Scale*	Economic scale	GDP per capita	China Statistical Yearbook
	Financial	Financial support	Fiscal budget/household population	China Statistical Yearbook
	Industry	Industrial transformation	Share of tertiary sector	China Statistical Yearbook
	Infrastructure	Infrastructure	Area of built-up area	EPS data platform
	Sustainable	Sustainable competition	Integration index of Industry and Information Technology	Ministry of Industry and Information Technology
	Education	Education level	Average number of students in higher education institutions	Evaluation Report on the Development Level of the Integration of "Informatization and Industrialization"
Motivation logic	*Decentral*	Fiscal decentralization	Per capita fiscal expenditure / per capita central fiscal budget expenditure	China Education Statistics Yearbook
	Resource	Resource utilization	Resource output rate	China Statistical Yearbook
	Envpollution	Environmental pollution governance	Environmental Pollution Control Index	China Environmental Statistics Yearbook
	Envquality	Environmental quality	Environmental Quality Index	China Environmental Statistics Yearbook
	Ecology	Ecological protection	Area of parks, urban green areas and nature reserves	China Environmental Statistics Yearbook
	Growth	Economic growth	Growth rate of GDP per capita	China Environmental Statistics Yearbook
	Life	Green living	Total domestic consumption	Data reorganization
	Technology	Technology power	Output value of high technology industries	EPS data platform
	Promotion	Officer promotion	Changes in the positions of governors and provincial party secretaries (0-1 engraving)	China High-tech Industry Statistical Yearbook
	Business	Business environment	Total social fixed asset investment	Local government websites
Knowledge management	*Desire*	Willingness to govern green(tacit knowledge)	Number of green education events, communications, launches and evaluation sessions	China Statistical Yearbook
	Ability	Green governance capacity and experience (explicit knowledge)	Green governance efficiency in the previous year	EPS data platform
	Study	Knowledge learning effect	Number of papers generated by scientific and technical exchanges	Data reorganization
	Overflow	Knowledge spillover effect	Knowledge labor productivity	EPS data platform
	Coordination	Knowledge synergy effect	Size of social spending on domestic technology purchases	China Economic Census Yearbook, China Statistics Bureau
	Reciprocity	Knowledge reciprocity effect	Income from social patent ownership transfer and licensing	China Science and Technology Statistical Yearbook
	Inside	Internal knowledge translation	Internal expenditure on R&D funding	China Science and Technology Statistical Yearbook

the dependence of green governance on the local fiscal base was low (0.033). This finding is in line with the findings of Wu (2019), who argues that fiscal decentralization has a limited moderating effect on green total factor productivity in the absence of direct spatial effects, spatial spillovers, and aggregate effects. In contrast, fiscal activities use environmental regulation as an exogenous tool to achieve the moderating effect on green development under spatial interaction. In addition, industrial transformation, sustainable competition, and educational level are

Table 2 Baseline judgements for peer effects

Variable	Model 1 OLS	Model 2 Political neighborhood	Model 3 Administrative adjacency	Model 4 Geographical proximity	Model 5 Economic proximity	Model 6 Political-economic proximity
ρ		0.527***	0.571***	0.438***	0.412***	0.394***
		(7.048)	(7.675)	(7.164)	(6.198)	(6.138)
Scale	− 0.021***	− 0.013**	− 0.006***	− 0.001**	− 0.005	− 0.001
	(− 2.993)	(− 2.489)	(− 2.918)	(− 2.130)	(− 1.271)	(− 1.301)
Financial	0.033	0.012*	0.022**	0.002*	0.007*	0.007*
	(0.681)	(1.758)	(1.942)	(0.173)	(1.852)	(1.756)
Industry	0.067	0.011**	0.017***	0.087**	0.054***	0.061***
	(1.121)	(2.386)	(3.071)	(2.067)	(5.629)	(6.443)
Infrastructure	− 0.028**	− 0.011	− 0.046***	− 0.031*	− 0.014	− 0.008
	(− 1.996)	(− 0.962)	(− 2.694)	(− 1.932)	(− 0.651)	(− 0.371)
Sustainable	0.064	− 0.016	− 0.006	− 0.015	− 0.026***	− 0.029***
	(1.366)	(− 1.261)	(− 1.019)	(− 0.814)	(− 3.568)	(− 3.855)
Education	− 0.014	− 0.028**	− 0.008	− 0.028	− 0.003	− 0.008
	(− 0.931)	(− 1.979)	(− 0.573)	(0.626)	(− 0.182)	(− 0.452)
R^2	0.092	0.973	0.969	0.976	0.954	0.952
LR		490.694	465.244	511.943	420.377	414.672

***, **, and * indicate significant at the 1%, 5%, and 10% statistical levels, respectively. Values in brackets are *t*-values

not significantly related to the formation of green governance, which means that the efficient performance of green governance is not endogenous to the industrial base, the trend of integration, and the educational environment local governments.

This result is consistent with existing theoretical studies. Lu et al. (2019) argues that ecological civilization education presents a normative effect on university students' behavior, but the direct effect of the educational environment on green economic growth is still limited.

The size of the economy (− 0.021) and infrastructure (− 0.028) have a weak negative impact on green governance, a judgment that is also consistent with reality (Lu 2017). Developed regions with better economies and infrastructure tend to have more inadequate initial green environments, such as Shanghai and Beijing, where inherent governance deficiencies make them costly in green governance, which leads to an extrinsic negative relationship between economic size and infrastructure on green governance efficiency. Instead, regions with relatively poor economies and lagging infrastructure have achieved seemingly excellent green governance results thanks to their inherent governance advantages. The spatial lag coefficients of models 2 and 3 and models 4 and 5 show that regional frameworks dominated by political systems are more prone to green governance peer effects and that the scope of activity of the peer effects is predominantly intra-regional, with external geo-regional and economic relations only extending this scope of activity.

Counterfactual judgments on the peer effects of green governance

As seen in the previous analysis, spatial neighborhood interactions lead to a convergence in the performance of local governments in green governance and reinforce the formation of green governance through the environmental base, ultimately characterized as peer effects. To further verify the reasonableness and factuality of this logical judgment, this paper sets up a counterfactual judgment to strengthen the study's validity. First, this study argues that the peer effects of green governance arise from the interaction of spatial neighborhoods, then once this spatial interaction is removed, the peer effects disappear. Thus, the paper constructs a pseudo-political adjacency matrix and a pseudo-administrative adjacency matrix, arguing that this interaction exists in regions where there was initially no political and administrative relationship, while regions where this relationship exists instead do not have an adjacency state, i.e., replacing elements 0 and 1 of the political adjacency weight matrix and the administrative adjacency weight matrix. The final estimates are shown in Table 3.

This section uses a spatial lag and spatial error regression model, values in brackets are standard errors

Of these, the results of the validation of the hypotheses are shown in Table 4.

From Table 4, the coefficients of the spatial lag variables are negative and insignificant (− 0.236, − 0.182) under the

Table 3 Counterfactual extrapolation of green governance by local governments

	Model 13 Pseudo-political adjacency matrix		Model 14 Pseudo-administrative adjacency matrix	
ρ	− 0.236		− 0.182	
	(0.036)		(0.032)	
λ		0.555		− 0.988
		(0.021)		(0.022)
R^2	0.442	0.631	0.442	0.659
LR	86.963	164.488	85.754	177.681

effect of the pseudo-adjacency matrix, indicating that there are no peer effects of green governance. The counterfactual inference that local government green governance activities do not produce coherent convergent decisions regardless of political or administrative pseudo-contiguity across regions reinforces the formation, existence, green governance, and peer effects, further validating the basic conclusions H1–H3.

Sub-regional judgment of the peer effects of green governance considering policy orientation

To further explore the policy-region relationship and impact mechanisms in the green governance peer effect, this section first adds the time dummy variable Gov2015 (2008–2014 takes the value of 0, 2015–2018 takes the value of 1) to control for the impact of the policies. Using 2015 as the implementation boundary for a series of green governance policies

and controlling for the interaction of the spatially lagged term of the dependent variable with the temporal dummy variable in the model, the impact of policy activities on the total sample is fed back. Finally, the political neighborhood weight matrix was combined to divide the 31 provinces and cities into three sub-samples, namely, eastern, central, and western, to examine the differences in peer effects in specific sub-regions before and after the implementation of green governance policies. The model regression results are shown in Table 5.

As seen in Table 5, model 15 shows the results of the whole sample estimation, where the interaction term between the time dummy variable of the policy and the spatial lag term is positively significant, indicating that the introduction of the green policy system has further strengthened the peer effects of local governments in green governance. Green governance's efficient and unified performance depends on spatial interaction and environmental foundation and on the central and even local diversified ecological compensation mechanisms to promote the transfer of green governance efforts. On the one hand, it optimizes the regional financial support; on the other hand, it realizes the problem-oriented, goal-oriented, and result-oriented green governance through the policy layout. Furthermore, the consistent multi-dimensional orientation contributes to the formation of the peer effects. Model 16–model 18 shows the results of the sub-regional tests, in which the peer effects of green governance in the eastern and western regions have always existed, and the peer effects are more prominent after 2015 with the enhanced implementation of green policies (0.537→0.583, 0.605→0.618). In contrast, the spatial lag

Table 4 Hypothesis testing results

Assumptions	Hypothetical content	Judgement-based model	Results
H1	Peer effects exist between provinces in the same region in green governance	Model 2–3/9–10/13–14	Acceptance
H2	Peer effects exist between provinces with close levels of development in the same region in green governance	Model 6/13–14	Acceptance
H3	Peer effects among provinces with geographic and economic proximity in green governance	Model 4–5/13–14	Acceptance
H4	There are incentives for local governments to green governance from governance dynamics and strengthen the green governance peer effects	Model 19/29	Acceptance
H5	Regional interests have incentives for local governments to green governance and reinforce the green governance peer effects	Model 26/29	Acceptance
H6	There is an incentive for local government green governance from individual interests and reinforces the green governance peer effects	Model 27/29	Acceptance
H7	There is an incentive for particular preferences to green governance in local governments and reinforces the green governance peer effects	Model 28/29	Acceptance
H8	Mechanisms of peer effects are influenced by the role of local government knowledge management	Model 30/36	Acceptance
H9	Provinces with a strong will for green governance, outstanding green governance capacity, or mature experience can become the core subjects of the peer	Model 37/44	Acceptance
H10	Provinces with higher quality economic development can become the core subjects of the peer	Model 35/48	Acceptance

Table 5 Sub-regional tests of the peer effects of green governance considering policy orientation

	Model 15 Total sample	Model 16 Eastern region		Model 17 Central region		Model 18 Western region	
		2008–2014	2015–2018	2008–2014	2015–2018	2008–2014	2015–2018
ρ	0.206***	0.537***	0.583***	0.193	0.460***	0.605***	0.618***
	(0.032)	(0.011)	(0.014)	(0.012)	(0.023)	(0.003)	(0.022)
$Gov2015 \times Wy$	0.172***						
	(0.021)						

Values in brackets in this section are standard errors

coefficient for the central region was not significant between 2008 and 2014. However, with the impact of green policies, the green governance peer effects were significantly presented, suggesting that the regression results of the green governance peer effects are consistently robust under the effect of policy orientation. Those green policies vigorously promote the formation of the peer effects. However, the subregional results are also indicative of the differences in green governance activities across the regions.

In the eastern region, green governance activities were carried out earlier, including Zhejiang, which began exploring ecological civilization in 2002 and proposed the "trinity" of ecological culture, ecological economy, and ecological environment for green development. From 2002 to 2011, Jiangsu proposed a comprehensive phase of ecological civilization construction, and built an ecological civilization by practicing the scientific concept of development, vigorously promoting the treatment of wastewater, waste, and waste gas, and achieving full green coverage of environmental protection to human living conditions by first "treating" and then "preventing." The remaining eastern provinces have also carried out a series of green activities around their shortcomings and have launched green attacks in critical areas such as the collaborative governance of Beijing, Tianjin, and Hebei, the ecological protection of the Yellow River Basin, the high-quality development of the Pearl River Basin's water treatment and promotion, and the development of the Yangtze River Economic Belt. These early green activities became the prototype for green governance in the east, and a highly unified concept of green development led to initial green governance peer effects in the east between 2008 and 2014. This trend has been further reinforced by the subsequent formal introduction of green governance.

Effects of incentive logic of green governance

Through the benchmark regression model of environmental fundamentals and green governance efficiency in Part IV, this paper verifies the green governance peer effects and determines the enhancement effect of financial support and industrial transformation on green governance efficiency. Further, the paper finds that this enhancement effect comes from intra-regional competitive pressures and performance appraisal systems, while political, administrative, geographical, and economic interactions in space serve as the underlying platform for forming the peer effects. However, it is worth noting that the purity of the green governance enabled by this competitive pressure and performance appraisal system, and the resulting peer effects from the motivations behind the pressure and appraisal, need to be further analyzed. Moreover, the impact of spatial interactions is relatively limited compared to the driving effect of local government green governance motives on the peer effects and is hardly a mechanism for eliciting and controlling the green governance peer effects as local government relations stabilize. On this basis, this paper re-explores the peer effects based on the incentive logic of green governance.

Combined with the previous analysis of the incentive logic of green governance by local governments, this paper argues that the potential motivations for green governance by local governments are governance dynamics, local interests, personal interests, and particular preferences. Thus, this paper sets up the relevant variables and introduces the interaction term between each variable and the spatial lag. When the interaction term coefficient is positive and significant, it indicates that the motive strengthens local governments' green governance peer effects. The model estimation results are shown in Table 6.

As seen in Table 6, the regression coefficients for the spatially lagged variables are consistently significantly positive in each of the analyzed models, further demonstrating the robustness of the green governance peer effects. By showing the interaction term coefficients between each motivational variable and spatial lag, this paper demonstrates that governance motivation, regional interests, personal interests, and particular preferences positively drive the green governance cohort effect. Local governments learn from each other, imitate each other, and even potentially compete with each other in green governance decisions in order to achieve governance motivation under fiscal decentralization (0.039), promote regional green development (0.001–0.074), satisfy personal promotion and performance needs (0.036), and expand the social influence of local governments (0.027). Ultimately, the motives converge to form a community of

Table 6 Testing the effect of incentive logic on the peer effects of green governance

	Model 19	Model 20–model 26 green development							Model 27	Model 28	Model 29
	Fiscal decentralization	Resource utilization	Environmental pollution	Environmental quality	Ecological protection	Economic growth	Green living	Technology power	Officer promotion	Business environment	Total control
ρ	0.270***	0.030***	0.222***	0.235***	0.241***	0.210***	0.218***	0.263***	0.288***	0.259***	0.436***
	(0.014)	(0.019)	(0.048)	(0.034)	(0.013)	(0.017)	(0.016)	(0.012)	(0.013)	(0.017)	(0.059)
$Decentral*W_y$	0.039***										0.045***
	(0.013)										(0.012)
$Resource*W_y$		0.074***									0.074***
		(0.009)									(0.012)
$Envpollution*W_y$			0.024***								0.005***
			(0.001)								(0.001)
$Envquality*W_y$				0.011*							− 0.001*
				(0.000)							(0.001)
$Ecology*W_y$					0.003***						− 0.002*
					(0.002)						(0.001)
$Growth*W_y$						0.001*					− 0.002*
						(0.001)					(0.001)
$Life*W_y$							0.005***				0.001**
							(0.000)				(0.002)
$Technology*W_y$								0.032***			0.003*
								(0.000)			(0.002)
$Promotion*W_y$									0.036***		0.034*
									(0.013)		(0.010)
$Business*W_y$										0.027***	0.032***
										(0.000)	(0.000)
N	341	341	341	341	341	341	341	341	341	341	341
R^2	0.657	0.779	0.837	0.842	0.885	0.840	0.740	0.688	0.638	0.656	0.910

Standard errors in brackets; ***, ** and * indicate passing significance tests at the 1%, 5%, and 10% levels of significance, respectively

green governance activities. Both Deng and Zhao (2018) and Jia et al. (2017) argue that promotion incentives have an expansive effect on the size of local government debt and indirectly reduce the welfare of residents, which is essentially an irrational behavior. However, for the sake of financial power and performance, local governments can only react rationally to such irrational behavior by unifying development and pursuit, fearing that "falling in line" and "deviating from the group" will result in their performance.

While the main contributors to the green governance peer effects remain official promotion and fiscal decentralization, as shown by the results in Table 6, the regional interest in green development dominates also rises to the level of importance. Of these, the efficient use of resources (0.074) is a crucial driver for aggregating the green governance activities of local governments. In addition, the strengthening of the technological drive (0.032), the promotion of green living by the residents of the region (0.025), and the improvement of the environmental pollution situation in the region (0.024) also had a positive impact on the expansion of green governance. At the same time, expanding the social influence of local governments in the green sector, projecting a positive image of governance, and attracting more generous external funding (0.027) has contributed in part to a collective green governance coherence. At this level, local governments' peer effects of green governance encompass more individual rationality, and its core starting point is to respond to the five development concepts in the new era. In green governance, local governments are fully aware of the balance between people and nature, attaching importance to the green interests of people's livelihoods and the need for the green transformation of the region, and making every effort to create favorable conditions for green development in society. Combining multidimensional interests will make green governance more critical in its core sense and the green governance peer effects more real. Overall, models 19–29 effectively validate H4-H7, suggesting that multidimensional motivations influence green governance with more complex control or steering conditions.

Knowledge management and knowledge effects

The previous analysis suggests that green governance as a government management activity has a dependence on knowledge management, i.e., knowledge management activities may potentially influence the direction of green governance and thus control the green governance peer effects. The related doctrine of deviant behavior and social control found (Collins and Frey 1992) that the formation of the peer effect stems at one level from the interaction of knowledge, i.e., inadequate, asymmetrical, and unclear flows of knowledge lead local governments to follow suit in their decision-making behavior. Then, with the aim of risk avoidance and avoiding exposure to knowledge deficiencies by aligning their behavior with the groups. Knowledge management theory generally summarizes two knowledge base effects: knowledge learning and spillover effects (Frank et al. 2020). The former are organizations with relatively narrow horizons gaining tacit knowledge such as willingness to learn through organizations with higher knowledge capabilities, gaining value to knowledge, and solidifying the willingness of the learned party to participate through benefit sharing. The latter are organizations with a high level of experiential capacity that spill over explicit knowledge through experience sharing so that both they and the recipient receive the benefits of knowledge translation. This section develops a test for these five types of mechanism formation, and the model is as follows:

$$WY_{it} = \alpha + \theta K_{it} + \beta X_{it} + \varepsilon_i \tag{3}$$

where K_{it} is the explanatory variable for knowledge management, including the level of explicit and tacit knowledge of local governments (willingness, capacity, and experience in green governance) and the five types of knowledge management mechanisms of action. X_{it} is the environmental base variable for green governance, ε is the disturbance term, θ is the degree of influence of knowledge management on the peer effects of green governance, and α is a fixed coefficient to be estimated. The specific variables are detailed in Table 1, where the number of green education and other activities reflects the willingness of local governments to govern green, and green governance efficiency as a capacity extrapolation variable portrays the green governance capacity of local governments.

As can be seen from Table 7, the estimated results show that the willingness to govern green (4.203) is more influential in the formation of the peer effects than the ability (4.185), indicating that there is also a certain amount of sentimentality in the integration of local governments into green governance groups. It is also confirmed that the nature of the process of local government emulation, and the following is will-led emotional behavior, where pseudo-rational decisions driven by personal interests and governance dynamics trigger emotional behavior of local government emulation, ultimately leading to irrational group decisions. Therefore, the key to reversing the inappropriate formation mechanism of the green governance peer effects lies in adjusting the local government's willingness to green governance, making it more from the interests of people's livelihood and quality development and other regional interests, and giving more rational connotations to the willingness to green governance.

Of the four types of external mechanisms of knowledge management, knowledge spillovers have the most significant impact on the green governance peer effects (model 33: 5.074), followed by the knowledge learning effect (model

Table 7 Test of the effect of knowledge management on the peer effects of green governance

Variable	Model 30	Model 31	Model 32	Model 33	Model 34	Model 35	Model 36
	Willingness to govern green	Green governance capacity and experience	Knowledge learning effect	Knowledge spillover effect	Knowledge synergy effect	Knowledge reciprocity effect	Internal knowledge translation
Desire	4.203***						
	(12.727)						
Ability		4.185***					
		(16.587)					
Study			4.761***				
			(17.336)				
Overflow				5.074***			
				(19.169)			
Coordination					4.308***		
					(11.389)		
Reciprocity						3.889***	
						(9.756)	
Inside							4.939***
							(15.093)
R^2	0.951	0.985	0.966	0.983	0.944	0.941	0.968

Table 8 Internal characteristics of peer effects under stratification of willingness to govern green

	Model 37 L-L	Model 38 L-H	Model 39 H-H	Model 40 H-L
P	0.114***	0.603***	0.136***	0.653***
	(0.00087)	(0.0065)	(0.0015)	(0.0073)
Control variables	Y	Y	Y	Y
R^2	0.957	0.937	0.945	0.958

32: 4.761), which is in line with the analytical judgment above that: H8 is further validated by the empirical analysis in this section, which shows that knowledge management plays a role in forming peer effects on green governance. Based on the regional groupings, the H-H model (high-level local governments emulating each other), the L-L model (low-level local governments emulating each other), the L-H model (lower-level local governments emulating high-level local governments), and the H-L model (higher-level local governments emulating low-level local governments) can be obtained.

As seen in Table 8, there are L-L, L-H, H-H, and H-L distribution characteristics within the peer effects under the green governance willingness perspective, but the differences between the characteristics are more pronounced. The homogeneous effect of model 41 and model 43 is more negligible, indicating that homogeneous local governments are more hostile and less willing governments themselves

tend to be less active in green governance, and the peer effect is more irrational decisions wrapped up in various motives. Although more subjective in their governance, the higher-willed governments have a similar willingness to follow each other and integrate with a leadership role, when the peer effects are a collective decision making under parallel decisions and parallel activities of each local government. The results of model 42 and model 44 show that the peer effects of green governance in local governments are internally emulated by a core of high willing governments, with low willing governments clustered around them (model 40: 0.653). Due to sufficient willingness to govern green, some of the high willingness governments take the initiative to lead the low willingness governments for a better green governance climate (model 38: 0.603), thus creating an L-H peer characteristic.

As seen in Table 9, there are peer effects in all types of aggregation for L-L, L-H, H-H, and H-L under the green governance capacity and experience perspective. Low-capacity governments create the most substantial peer effects following the example of high-capacity governments, which is characterized by the trust of "followers" in "leaders." This is in line with Liu et al. (2021) study of the peer effects: the peer effects trigger positive effects to drive expected progress at the same level of government. However, it is noteworthy that the peer effects of the same level of government are relatively weak (model 41: 0.088, model 43: 0.095), and in order to facilitate the efficient promotion of green governance, there is an urgent need to strengthen aggregation measures for these two types of green governance groups.

Table 9 Green governance capacity and internal characteristics of peer effects under empirical stratification

	Model 41 L-L	Model 42 L-H	Model 43 H-H	Model 44 H-L
ρ	0.088***	0.611***	0.095***	0.671***
	(0.00099)	(0.002)	(0.0013)	(0.0045)
Control variables	Y	Y	Y	Y
R^2	0.891	0.903	0.935	0.846

Table 10 Internal characteristics of peer effects under economic level stratification

	Model 45 L-L	Model 46 L-H	Model 47 H-H	Model 48 H-L
P	0.025***	0.016***	0.279***	0.586***
	(0.001)	(0.0104)	(0.0012)	(0.0084)
Control variables	Y	Y	Y	Y
R^2	0.974	0.904	0.979	0.894

With the model estimation results obtained from Tables 8 and 9, this paper validates H9.

The analysis in Table 10 shows that there are also peer effects of green governance among local governments at various economic distribution levels. At this point, all types of local governments continue to show the highest peer effects in the distribution of H-L (model 48: 0.586), indicating the persistence of imitative, followership local government decision-making habits and the clustering of irrational behaviors prone to expansive losses in green governance. The slightly increased group nature of green governance in local governments with close economic levels (model 45: 0.025, model 47: 0.279) is due to the interaction mechanism of willingness and capacity observed differently from economic levels. The first two are essentially interoperable

under knowledge management. However, in any case, there is always the problem of knowledge asymmetry among local governments, and out of the strategic thinking of concealing themselves and maintaining competitiveness, some governments even close off knowledge interactions and only carry out internal knowledge transformation activities or do not disclose some of their core knowledge, which leads to limitations and secrecy in knowledge interactions. However, economic levels are visible early on in a range of platforms such as public documents, external events, higher-level performance reviews, and direct observation leading to increased trust in peer activities by local governments, and therefore closer government activity between levels without excessive practical concerns. Through Table 10, this paper further verifies H10 that provinces with higher quality economic development are more likely to be the target and core of peer imitation.

Robustness analysis

This section tests the robustness of the spatial stochastic frontier model by changing the dependent variable, constructing a spatial error regression model (SEM), adding a spatial weight matrix, and re-determining the geographical extent of the peer effect. The specific results are shown in Table 11.

As seen in model 7–model 8, the analytical model in this paper passes the robustness test, showing that the peer effects of green governance are prevalent and independent of the dependent variable, the spatial weight matrix, and that spatial errors are almost non-existent. Further, this paper uses the speed of high-speed rail as the dividing criterion. It constructs a spatial weight matrix-forming 350 km within the same region, 700 km within the same region, 350 km outside the region, and 700 km outside the region to characterize the 1- and 2-h city circles within and outside the region, respectively, in order to depict the spatial interaction between local governments in more detail. As seen in model 9–model 12, the peer effects of green governance in local

Table 11 Green governance peer effects robustness tests and range re-judgments

	Model 7 Magnitude of efficiency change	Model 8 SEM model	Model 9 Within 350 km of the same region	Model 10 Within 700 km of the same region	Model 11 Within 350 km outside the region	Model 12 Within 700 km outside the region
ρ	0.403***		0.429***	0.414***	0.341***	0.301***
	(3.955)		(8.919)	(8.439)	(7.385)	(7.275)
λ		0.133***				
		(40.717)				
R^2	0.156	0.162	0.966	0.971	0.966	0.971
LR	− 1229.066	− 2065.732	453.013	473.956	456.475	478.422

governments do not disappear with increasing geographical scope, demonstrating the universality of the peer effects of green governance. However, as the geographical radius increases, the influence of the cohort effect within and outside the region weakens slightly. It drops sharply after crossing the regional boundary (0.414→0.341, 0.341→0.301), i.e., the peer effects are more substantial among "political neighbors" who are in the same region but farther away than those who are geographically close but not in the same region, which is in line with Deng and Zhao (2018) research. However, its research argues that the differences in administrative boundaries lead to differences in the mechanisms of territorial spatial interaction, making areas within administrative regions subject to scalar competition and presenting a homogeneous cluster.

Conclusion and policy implications

The current study measured the environmental basis and incentive logic of green governance of local governments by using a spatial econometric approach based on provincial panel data from 2008 to 2018. Based on the environmental foundation and incentive logic of green governance, this paper constructs a systematic analysis framework of the peer effects of green governance, determines the formation, scope, and sub-regional situation of the peer effects of green governance, and tests the extent of the role of incentive logic and knowledge management on the peer effects of green governance. As a result, the core subjects of the green governance peer effects are finally obtained. Furthermore, the mechanism of collective irrational interaction caused by pseudo-rational decision-making and emotional behavior in the green governance peer is deciphered theoretically. The result shows that:

(i) Through fiscal restructuring and revitalization of assets, the efficiency of green governance will be enhanced through the practical extension of fiscal support. However, the peer effects of green governance in local governments reflect the shortcomings of local financial management. Local governments are highly dependent on fiscal output in green governance, and in the process of green governance, they want to use it to expand their financial power and "compete" with the central government for authority. The contradiction between finance as the environmental basis of green governance and the incentive logic of green governance has led to confusion in the institutional system of local governments. This confused thinking about governance has led to irrational behavior of blindly following the trend: some disadvantaged regions only see prosperous regions

expanding their fiscal revenues through green governance, ignoring in vain their original mature and solid fiscal base, and distorting the path of green governance in disregard of the essential foundation and real development needs, which will only eventually lead to a systemic crisis of ineffective governance and fiscal shrinkage. Secondly, encourage local finances to invest in green governance and guide them to deeply understand prosperous regions' financial operation methods to support green governance with a small-scale and high-vitality asset operation state. Finally, adopt a zoning policy and precisely match the green governance funding gap, to prevent local governments from triggering significant debt risks in their financial turnover.

(ii) They are reconstructing the performance appraisal system of local governments, strengthening the guiding role of regional interests, adjusting the driving mechanism of individual interests, strengthening the examination of the dynamic link between government inputs and outputs around the new tasks of high-quality development and the degree of social creation of green governance, and forming a new yardstick for local government assessment from the perspective of sustainability and strategic height. Therefore, resource use, environmental pollution control, environmental quality, ecological protection, and green living should be integrated into the government evaluation system, gradually shifting officials' traditional views on economic growth and tax expansion. In this way, local governments should be motivated to develop rationally and strengthen the starting and ending points of green governance so that their actions will be more truly and uniformly directed towards people's livelihood and social transformation. The central government must also pay attention to local governments' financial discretion and promotion assessment as a pseudo-rational motivation to drive the integration and synergistic development of green governance.

(iii) Strengthen the knowledge management of local governments, break the governance barriers of discontinuity, uncertainty, and unpredictability of green governance based on knowledge interaction, and create high-quality peer effects with transparent initiatives, willingness to share, capacity sharing, and experiential learning, rather than simple imitation and competitive caution under knowledge asymmetry. As things stand, the peer effects of green governance in local governments are highly polarized, with many local governments simply believing that they can achieve better green governance performance by following regions with high willingness, capacity, and

experience. This homogeneous but not harmonious, harmonious but not homogeneous peer effects cannot escape the challenge of inefficient governance.

(iv) Accelerate the construction of a regional political, administrative, geographical, and economic, spatial interaction system conducive to coordinated development, promote the formation and improvement of a policy system for the free flow of green factors, and lead the positive and high-quality development of the peer effects through a division of labor pattern with complementary advantages in green governance. The fulcrum for forming the green governance peer effects comes from the spatial interaction between local governments. Improving the quality and efficiency of spatial interaction from the source is conducive to increasing the maximum stock, increment, and green governance peer effects variables. Local governments should seize the strategic opportunity of green governance, solve the problem of green factor blockage through political interaction, optimize the spatial layout of industries based on administrative neighborhood, use geographical and economic relations to create a regional economic and social green cycle system, crack the problem of resource and growth potential limitations, and truly achieve a deep integration of green governance peer and homogeneous.

Data availability The data that support the findings of this study are openly available on request.

Declarations

Conflict of interest The authors declare no competing interests.

Ethical approval and consent to participate We declare that we have no human participants, human data, or human tissues.

Consent for publication We do not have any person's data in any form.

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