



RETRACTED: How Multi-Dimensional Local Government Competition Impacts Green Economic Growth? A Case Study of 272 Chinese Cities

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Green economic growth is an unavoidable choice for China's development model, while the government-led Chinese economic development system determines that local government competition may have an essential impact on green economic growth. For this purpose, this study employs data on Chinese 272 prefecture-level cities and the system generalized method of moments (SYS-GMM) model to investigate the impact of multi-dimensional local government competition (ecological competition, service competition, economic competition, and comprehensive competition) on green economic growth. The empirical results reveal that local government competition significantly influences green economic growth, in which economic competition significantly inhibits green economic growth, and ecological competition, service competition, and comprehensive competition positively influences green economic growth. The influence mechanism indicates that economic competition, ecological competition, service competition, and comprehensive competition significantly affect green economic growth through economic agglomeration and industrial structure upgrading, respectively. Moreover, the impact of multi-dimensional local government competition on green economic growth shows significant temporal and regional heterogeneity. Therefore, policymakers should further develop a multi-dimensional local government competition target system for local government officials and moderately enhance both ecological competition and service competition that is oriented to green economic growth.

Keywords: local government competition, green economic growth, mediating effects, heterogeneity, China

1 INTRODUCTION

China's economy has experienced significant growth for many years since the reform and opening up of the economy (Irfan et al., 2021), which demonstrates the "Chinese miracle" of economic development (Li et al., 2018; Wu et al., 2021b; Ren et al., 2021). In particular, local government has a significant function in attracting factors such as capital, labor, and land (Boyne, 1996; Hao et al., 2021; Wu et al., 2020). China's unique decentralized structure of both central and local governments has driven internal competition among local governments, rendering it the most direct factor in promoting high economic growth

(Abbasi et al., 2022; Fang et al., 2022; Hao et al., 2021). Fiscal decentralization and related competitive institutions have contributed to the accelerated development of the economy (Wu et al., 2021a; Rauf et al., 2021; Tang et al., 2022), while competition in attracting capital (Jinru et al., 2021; Irfan and Ahmad 2022; Qiu et al., 2022), represented by foreign direct investment (FDI), has increased China's economic growth (Clegg et al., 2004; Yang et al., 2021a).

However, under administrative and resource flow constraints, local government competition may accelerate local protectionism (Chandio et al., 2021; Shi et al., 2022), which may bring about increased market transaction costs and inhibits economic growth (Zhang et al., 2020; Ahmad et al., 2021). Moreover, the development model that leans on investment to drive GDP has been responsible for numerous problems in China's economy, such as rapid consumption of resources, serious environmental pollution and ecological damage, and low economic efficiency (Ran et al., 2020; Zhang et al., 2021). As reported in the 2020 Bulletin on the State of China's Ecological Environment, up to 40.1% of 337 cities have ambient air quality exceedances, of which the annual average concentration of PM_{2.5} is even three times higher than the 10 µg/m³ standard set by the World Health Organization's Air Quality Guidelines Values.¹ Therefore, under the situation mentioned above, how to comprehensively strengthen green economic growth has emerged as one of the urgent strategic issues for China's economic transformation (Song et al., 2019; Ren et al., 2022a; Shen et al., 2022). Since 2012, the Chinese government has elevated green development to a national strategy, while the concept of green development, represented by "green mountains and clear water are equal to mountains of gold and silver," has become the consensus of society (Ren et al., 2022b). Only green economic growth can effectively fulfill economic transformation, alleviate resource and environmental constraints, and bridge the gap between the "green mountains and clear water" and the "mountains of gold and silver" (Wang J. et al., 2021; Ren et al., 2022c).

In the context of green development, can local government competition drive China's green economy to continue its high growth? On the one hand, economic competition among local governments, competition in productive fiscal spending, competition in FDI attraction, fiscal competition, and competition in tax burden may not be conducive to green economic growth (Hao et al., 2020; Irfan and Ahmad 2021; Tanveer et al., 2021). Fiscal and economic competition strategies have local emission reduction effects, while investment attraction and regulation competition strategies will aggravate local pollution with the "pollution paradise" effect and "regulation paradox" phenomenon. On the other hand, as the environmental responsibility system is implemented and the environmental performance evaluation system is established, the new promotion champion theory, which focuses on environmental protection, pushes local governments' financial expenditures toward environmental protection and simultaneously strengthens regional environmental governance to contribute to the overall

improvement of environmental quality. However, a diversified performance appraisal system can effectively correct the distortion of resource allocation caused by competition among local governments and reduce the loss of city production efficiency (Zhang et al., 2021). Meanwhile, competition among local governments in moderation facilitates green economic growth, and conversely, excessive local government competition is detrimental to green economic growth. Moreover, in terms of institutional competition, environmental regulation will also improve the green economic growth level (Wu et al., 2020b; Hao et al., 2022; Qiu et al., 2022). Local government competition is comprehensive, multi-dimensional, and dynamic. So, how does multi-dimensional local government competition affect green economic growth? Are there significant heterogeneous effects of multi-dimensional local government competition on green economic growth at different time points and regions? Can multi-dimensional local government competition contribute to green economic growth by influencing economic agglomeration and industrial structure upgrading? The answers to the above questions are significant for promoting green economic growth and achieving reasonable competition among local governments in China. Therefore, this paper investigates the influence mechanism of multi-dimension of local government competition (ecological competition, service competition, economic competition, and comprehensive competition) on green economic growth, to provide an empirical basis and factual reference for optimizing local government competition and promoting green economic growth.

Compared with the existing studies, the potential contributions of this paper are primarily reflected in the following several aspects. Firstly, this paper constructs a multi-dimensional local government competition system from four dimensions: economic competition, ecological competition, service competition, and comprehensive competition, and employs the SYS-GMM method to evaluate the influence of local government competition on green economic growth from a multi-dimensional perspective. Secondly, this paper verifies the influence mechanism of local government competition on green economic growth considering economic agglomeration and industrial structure upgrading as mediating variables. Finally, the heterogeneous characteristics of local government competition on green economic growth are further investigated in terms of temporal and regional heterogeneity, which facilitates the enrichment of relevant studies on local government competition and green economic growth.

The remainder of the paper is organized as follows. **Section 2** gives the literature review. **Section 3** gives the model setting, variables selection, and data description; **Section 4** provides the empirical results and discussion in detail; **Section 5** shows the research conclusions and policy implications.

2 LITERATURE REVIEW

Local government competition denotes cross-regional competition among local officials regarding investment environment, legal system, and government efficiency to catch production factors

¹See more detail: <https://www.mee.gov.cn/hjzl/sthjzk/zghjzkgb/202105/P02010526572756184785.pdf>

such as capital, technology, and talent (Eberts and Gronberg, 1988; Li et al., 2021; Jiang et al., 2022). Government competition has been studied for ages, starting with Adam Smith's argument that capitalists determine capital flows in response to taxation (Edwards and Keen, 1996; Lyytikäinen, 2012; Claveres, 2022). Following Smith, the American economist Tiebout studied "local government competition," a theory of "voting with one's feet" that suggests that residents will migrate to regions that provide better satisfaction of their requirements for public goods (Tiebout, 1956). Breton (1998) provides a more comprehensive overview of "local government competition," arguing that government competition is inevitable and exists not only between different levels of government but also between government and non-government agencies. Allers and Elhorst (2005) argue that local governments compete in terms of resources, policies, performance, and institutions, but they essentially compete in terms of resources and capabilities. Local governments are individuals with relatively independent interests and needs, while various mobile resources for regional development are scarce, thus they need to compete with each other (Wang K.-L. et al., 2021; Trojanek et al., 2021; Li, 2022).

Local government competition is a multi-dimensional competition that includes economic competition, ecological competition, and service competition (Oates and Schwab, 1988). Competition in the local government economy is essentially about catching up with developed economies and overtaking homogeneous economies (Tang et al., 2021; Tang and Qin, 2022). Economic competition is a prominent competitive situation in terms of performance, both in terms of pressure for economic growth targets and economic growth rates and in terms of motivation for investment and tax competition (Mintz and Smart, 2004; Jiang et al., 2022). Local governments' economic growth targets are derived from the central government's economic growth target setting, while local governments will cascade and enhance their economic growth targets (Xu and Gao, 2015; Su et al., 2021). The country's urgent need for economic growth drives local governments to generate GDP growth preferences, and choosing the GDP growth rate as a measure of the economic competition dimension is a frequent practice of researchers (Mohammad et al., 2021). Hong et al. (2020) suggest that increased investment by local governments can not only directly boost local economic growth but also play the role of "attracting phoenixes to the nest." In addition, local governments are active in attracting foreign capital, while FDI is characterized by significant economic efficiency and liquidity, reflecting the "voting power" feature for local governments (Zhang et al., 2021). Capital attraction competition is a more used variable in local government competition studies, which portrays the strength and ability of local governments in attracting capital through FDI (Fan and Zhou, 2019). Fiscal competition, as the most directly controlled competitive tool for local governments, captures the economic spending propensity of local governments through the ratio of fiscal expenditure to fiscal revenue (Jiang et al., 2022; Liu et al., 2022).

Government investment in environmental management and pollutant treatment rates are the primary symptoms of ecological competition. To promote ecological improvement and build a

livable environment, local governments invest more in environmental management and improve environmental regulations (Yang et al., 2018; Ren et al., 2022). The local governments have shown different forms of competition in fiscal environmental protection spending due to the "free-rider" mentality and concern for enhancing environmental quality (Keyu, 2021). Yang et al. (2018) choose three representative indicators to characterize environmental regulation, namely COD reduction task, wastewater discharge compliance rate, and private wastewater reduction cost, to examine the Pollution Haven Hypothesis (PHH) effect of environmental regulation in Jiangsu province. Some scholars have also used wage level, human capital, and population density as basic indicators of informal environmental regulation (Wang and Tan, 2017; Hao et al., 2021). Moreover, according to Hicks' theory of induced innovation, stricter regulation will lead to changes in input factor prices and increased environmental costs, forcing firms to adopt green technology innovations to cope with the problem (Cai et al., 2020).

The ability of the government to provide basic services to businesses and residents is the key factor in service competition. Freret (2005) analyzes the spatial interaction of social services and health care expenditures, economic construction expenditures, highway expenditures, and education expenditures and argues that there are differentiated competitive strategies for different public expenditures. Heng and Hong (2012) point out that the decentralized model of local government decision-makers in China, who are primarily accountable to their superiors, leads local governments to pursue the highest possible economic growth rate. Wu et al. (2017) find that increasing the proportion of government expenditure can increase total factor productivity after dividing fiscal expenditure into government administrative service expenditure, investment and development expenditure, and protection and governance expenditure. Petrusha et al. (2019) propose a framework for human resource attraction and retention and intellectual capital creation for sustainable low-carbon economic transition based on micro-and macro-level changes.

The influence of local government competition on green economic growth is multi-dimensional, which not only responds to the impact of local government competition on environmental quality such as haze and carbon emissions but also on energy efficiency and green economic efficiency. Some scholars believe that local government competition has deteriorated environmental quality (Deng et al., 2019; Li et al., 2021; Shen et al., 2022). Bai et al. (2019) reveal that tax competition is one of the strategies of local governments to cope with fiscal pressure, inter-regional tax competition not only brings about a local environmental negative impact but also deteriorates the environmental quality of spatially related regions. Moreover, local governments exert control over the effective tax rate via several factors including tax enforcement and regulation, both of which are major contributors to the distorted implementation of environmental regulatory policies and the effectiveness of environmental regulation (Deng et al., 2021). Ma et al. (2020) find that formal environmental regulation can influence water

pollutant discharges through formal environmental regulation in local government competition, however, there is no clear role mechanism for informal environmental regulation. With the increase in formal environmental regulations, local government competition played a greater role in curbing water pollutant discharges (Ma et al., 2020; Pan et al., 2020; Nie et al., 2021). As an essential tool for environmental management, government environmental spending can not only induce social capital and corporate environmental behavior but can also impinge on economic growth and environmental quality (Ruffing, 2010). Galdeano et al. (2008) and Zhang and Wang (2022) verify that local governments' emission reduction targets lead to more emission reduction efforts, implying that local governments increase competition in environmental protection and reduce local governments' competition in economic growth, which ultimately improves environmental performance effectively (Yang et al., 2020). However, under the concept of functional finance, additional fiscal spending on public goods is likely to spur economic growth, which consequently creates more pressure on the environment (Lin and Zhu, 2019). The government's environmental livability policy expands urban green space and facilitates green economic growth (Bush, 2020; Irfan et al., 2022). In addition, the government's subsidy policy for enterprises can promote enterprises to improve production technology and reduce energy consumption, thus contributing to a higher level of green economic growth (Yang et al., 2021b).

However, some scholars have also measured green economic growth from multiple dimensions and analyzed the role of local governments on green economic growth based on different perspectives. Li and Xu (2020), for example, identify local government competition as one of the primary causes of the regional "green paradox." Wang (2020) employs a super-efficient DEA model to measure green economy efficiency and reveals that the use of environmental regulation competition from local governments has a "U" shaped relationship with green economy efficiency. Chai et al. (2021) find that the overall level of competition in investment promotion significantly inhibits the increase of green total factor productivity, and the interaction between institutional quality and competition in investment promotion shifts green total factor productivity from inhibition to promotion. Tang and Qin (2022) reveal that local government competition not only distorts factor prices across regions but these factor distortions are also transmitted to green total factor productivity. Zhang et al. (2020) unveil that growth competition, fiscal competition, and investment competition among local governments significantly dampen green development efficiency.

To sum up, most scholars focus on single competition such as economic competition, ecological competition, and service competition, and less on multi-dimensional and dynamic local government competition. In addition, the study on the impact of local government competition on environmental quality and green economic growth is also mainly based on economic competition and environmental regulation. Most scholars support local government competition to inhibit environmental quality and green economic growth. Meanwhile, less attention has been paid to the mechanisms by

which local government competition affects green economic growth. As such, Based on the panel data of 272 prefecture-level cities in China from 2004 to 2019, this paper studies the impact of multi-dimensional local government competition (economic competition, ecological competition, service competition, and comprehensive competition) on green economic growth using the dynamic panel system generalized method of moments estimation model (SYS-GMM), explores its impact mechanism in the context of economic agglomeration and industrial structure upgrading, to make some contributions to the relevant fields of local government competition and green economic growth.

3 METHODOLOGY

3.1 Economic Strategies

Most scholars have confirmed the existence of time-lagged characteristics of green economic growth (Zhao et al., 2021a; Cao et al., 2021). Therefore, this paper utilizes a generalized method of moments (GMM) to perform optimal estimation of the correlation coefficient parameters. GMM are generally subdivided into differential GMM (DIFF-GMM) and the system GMM (SYS-GMM). Panel data in DIFF-GMM estimation advances over time, inevitably triggering more instrumental variables. In contrast, the SYS-GMM is developed based on the DIFF-GMM approach, which effectively overcomes the endogeneity problem that arises within the model. Following Arellano and bond (1991) and Yang et al. (2021b), this paper incorporates a one-period lag of the green economic growth into the benchmark regression model, while using SYS-GMM to evaluate the impact of multidimensional local government competition (service competition, economic competition, ecological competition, and comprehensive competition) on green economic growth from the perspective of economic agglomeration and industrial structure upgrading. The set form of Eq. 1 is given as follows.

$$GEG_{it} = \alpha \cdot GEG_{it-1} + \beta_0 + \beta_1 \cdot COM_{it} + \beta_2 \cdot X_{it} + \varepsilon_{it} \quad (1)$$

where i and t respectively denote the year t of prefecture-level city i . β represents the coefficient vector. ε is a random disturbance term that matches the orthogonal characteristics. The explained variable is green economic growth (GEG). The core explanatory variable is local government competition (COM), which is an index system, including economic competition, ecological competition, service competition, and comprehensive competition. The control variables are denoted by X which mainly include marketization (MAR), urbanization (URB), financial development (FIN), informatization (INF), human capital (HUM), internet development (INT), economic development (PGD), natural population growth rate (NAT).

Economic agglomeration, industrial structure upgrading, and may have had a significant impact on multi-dimensional local government competition for green economic growth. So what role do economic agglomeration, industrial structure and technological innovation as key factors influencing green economic growth perform in multi-dimensional local

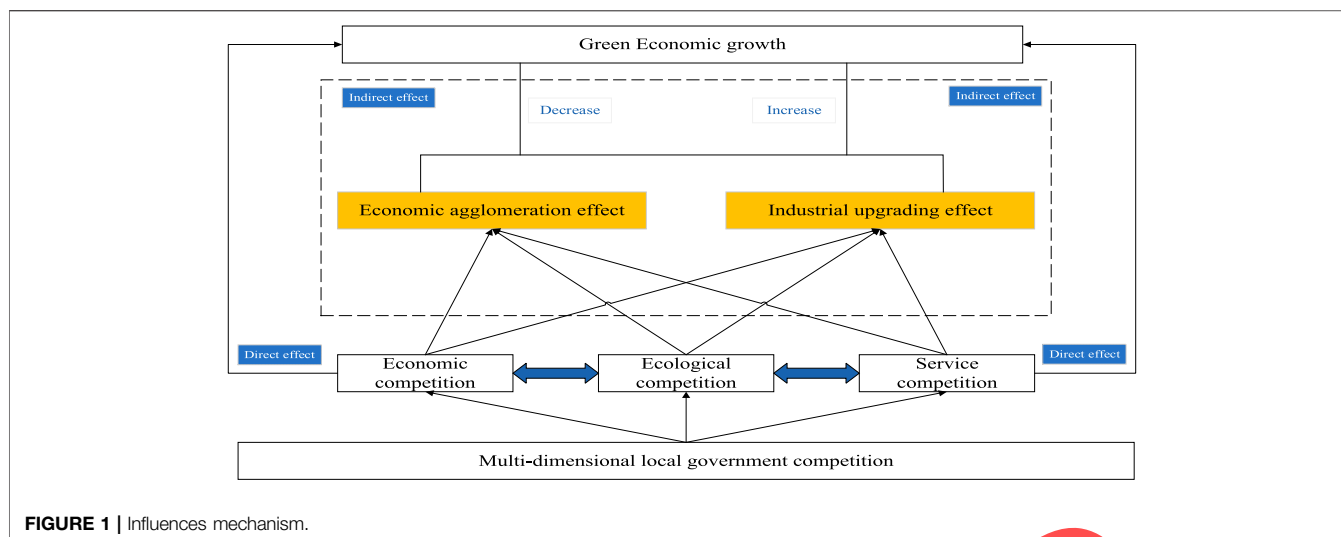


FIGURE 1 | Influences mechanism.

government competition to influence green economic growth? This paper uses **Figure 1** to briefly describe the impact of multi-dimensional local government competition on green economic growth in the context of economic agglomeration, technological innovation, and industrial upgrading.

Therefore, referring to Yang et al. (2021c) and Baron and Kenny (1986), this paper employs the stepwise regression method proposed to test the mediating effect of economic agglomeration and industrial structure. To intuitively describe the verification procedure of mediating effect, the mediation effect model is simplified into Eqs 2–4.

$$GEG_{it} = \alpha \cdot GEG_{it-1} + c \cdot COM_{it} + \beta \cdot X_{it} + \varepsilon_1 \quad (2)$$

$$MED_{it} = \alpha \cdot MED_{it} + a \cdot COM_{it} + \beta \cdot X_{it} + \varepsilon_2 \quad (3)$$

$$GEG_{it} = \alpha \cdot GEG_{it-1} + c' \cdot COM_{it} + b \cdot COM_{it} + \beta \cdot X_{it} + \varepsilon_3 \quad (4)$$

where *Mediator* represents the mediating variable, *c* represents the total effect, $c = ab + c'$, *a*·*b* means mediating effect, that is indirect effect, and *c'* means direct effect. *X* denotes the same variables as in Eq. 1. For the measure of mediating effects, we examine them using a stepwise regression method. The first step is to investigate the total effect of local government competition on green economic growth in Eq. 2 and measure whether the coefficient *c* is significant. The second and third steps are to examine the effect of local government competition on the mediating variables in Eq. 3 and the effect of the mediating variables on green economic growth in Eq. 4, respectively while estimating the significance of the coefficients *a* and *b*.

3.2 Variables Selection

3.2.1 Explained Variable

Green economic growth (*GEG*). Based on the calculation method of Yang et al. (2021d) and Liu et al. (2021), we apply the research framework of non-radial SBM including unexpected output to characterize *GEG*. GDP at the prefecture-level, which is discounted using 2004 as the base period, is employed as the desired output. Industrial wastewater emissions from prefecture-

level cities, industrial soot emissions from prefecture-level cities, and industrial sulfur dioxide emissions from prefecture-level cities were employed as the undesired outputs. There are three indicators of input variables, namely, unit employment from prefecture-level cities, capital stock, and energy consumption. In the case of capital stock, we characterize the depreciation rate of fixed assets at 9.6% and assume that the capital stock in the base period is expressed as 10 times the investment in fixed assets in the base period (Young, 2003). Energy consumption is replaced by per capita electricity consumption from prefecture-level cities. Green economic growth is calculated by MAX-DEA software and super efficiency SBM model of undesired output, which is expressed by SBM-GML. Additionally, we apply the DDF-GML model to perform robustness checks on green economic growth (Su et al., 2021). **Table 1** reports the green economic growth indicator construction system.

3.2.2 Core Explanatory Variable

Local government competition (*COM*). Local government competition is a multi-dimensional comprehensive competition. Under this idea, this paper constructs a local government competition index system, covering economic competition (*JJJZ*), ecological competition (*STZJ*), service competition (*FWZJ*), and comprehensive competition (*ZHJZ*). **Table 2** characterizes the construction of indicators specific to local government competition and the interpretation of the indicators.

In this paper, local government competition is a multi-dimensional government competition, including three sub-index competition and comprehensive competition: economic competition, ecological competition, and service competition. This paper adopts the full permutation polygon synthesis illustration method to calculate the multi-dimensional local government competition (Wang et al., 2015; Kosajan et al., 2018). The fully arranged polygon graphic method can be used for multi-index evaluation. Taking the upper limit value of *n* evaluation indexes as the radius to form a central regular *N*-sided shape, the connecting line of index values forms an

TABLE 1 | Green economic growth indicator construction system.

Variables	Definition	Specific Indicators	References
Output	Desired outputs Undesired outputs	Discounted real GDP using 2004 as the base period Industrial wastewater emissions Industrial soot emissions Industrial sulfur dioxide emissions	Lin and Zhu (2019) Wang et al. (2021a) Yang et al. (2021) Wang et al. (2021a)
Input	Labor Capital Energy	Employment in units from prefecture-level cities Calculated using the perpetual inventory method Electricity consumption per capita from prefecture-level cities	Su et al. (2021) Lin and Zhu (2019) Liu et al. (2021)

TABLE 2 | Local government competition index system.

Level-I	Level-II	Level-III	References
Economic competition (JJJZ)	Growth competition Capital attraction competition Tax competition Investment competition	GDP growth rate Foreign direct investment divided by GDP $\frac{tax_i/GDP_i}{tax_j/GDP_j}$ Fixed asset investment in prefecture-level cities divided by national fixed asset investment	Liu et al. (2021) Fan and Zhou. (2019) Hong et al. (2020) Zhang et al. (2020)
Ecological competition (STZJ)	Overall greening competition Per capita greening competition Environmental regulation competition Pollutant treatment competition	The green coverage rate of the built-up areas Per capita green space level in prefecture-level cities The proportion of environmental employees in employed persons Wastewater treatment rate in prefecture-level cities	Gao and Hua (2015) Lu and Xiang (2020) Gao et al. (2020) Wu et al. (2020)
Service competition (FWZJ)	Basic conditions competition Medical service competition Commuter competition Income competition	Road area per capita Number of beds in medical and health institutions Public transport vehicles per 10,000 people The average wage of employees	Meng et al. (2021) Qiu et al. (2022) Feng and Liu (2016)

irregular central N-sided shape, and the vertex is a full arrangement of N indexes connected head to tail.

First, a hyperbolic standardization was performed for each index:

$$F(x_i) = \frac{(U_i - L_i)(x_i - T_i)}{(U_i + L_i - 2T_i)x + U_iT_i + L_iT_i - 2U_iL_i} \quad (5)$$

Among them, the number of indicators is denoted using i . The standardized value of the i th indicator is characterized by $F(x_i)$. The lower limit value of the upper limit level of the i th indicator is characterized by U_i and L_i , respectively. The critical value of the i th indicator is characterized by using T_i , and the value of the i th indicator is characterized by using x_i .

$$S = \sum_{i \neq j}^{i,j} \frac{(S_i + 1)(S_j + 1)}{2N(N - 1)} \quad (6)$$

$$F(x_i) = \frac{(U_i - L_i)(x_i - T_i)}{(U_i + L_i - 2T_i)x + U_iT_i + L_iT_i - 2U_iL_i} \quad (7)$$

Then, a regular polygon with n sides in the center is composed of the upper limit values of N indicators, while the overall arrangement and combination of irregular n -shaped areas are composed of the standardized values of each indicator. The calculation method of polygon comprehensive index is the

ratio of the area of arrangement and combination to the corresponding area of the central n -side regular polygon. The calculation formula is as follows.

$$S = \sum_{i \neq j}^{i,j} \frac{(S_i + 1)(S_j + 1)}{2N(N - 1)}$$

The value range of the comprehensive index is $[0, 1]$. The larger the composite index, the higher the level of local government competition.

3.2.3 Mediating Variables

This paper selects three indicators of economic agglomeration (EAG) and industrial upgrading (IND) as mediating variables to examine the role mechanism of local government competition in green economic growth. Among them, the total output value of secondary and tertiary industries divided by the area of the regional jurisdiction is used to characterize EAG . According to Pan et al. (2019), the value of tertiary sector output divided by the ratio of secondary sector is employed to estimate the industrial structure upgrading (IND).

3.2.4 Control Variables

Considering the impact of other unobservable factors on green economic growth, this paper mainly employs market (MAR),

TABLE 3 | Variables description.

Variables	Obs	Mean	Std. Dev	Min	Max
GEG	4352	0.985	0.2451	0.135	6.570
JJZ	4352	-1.852	0.527	-5.125	-0.587
STJZ	4352	-1.590	0.550	-4.659	-0.554
FWJZ	4352	-1.566	0.527	-3.519	-0.386
ZHJZ	4352	-1.003	0.121	-1.307	-0.620
EAG	4352	1.807	1.318	-3.140	5.508
IND	4352	4.399	0.463	2.390	9.010
HUM	4352	4.525	1.109	-0.450	7.180
INF	4352	1.942	1.167	-0.810	23.750
INT	4352	6.720	1.141	-0.500	9.900
NAT	4352	5.668	5.447	-16.640	113
MAR	4352	3.794	0.348	1.600	4.690
FIN	4352	0.816	0.807	-1.010	21.300
PGD	4352	10.337	0.789	4.600	13.130

urbanization (*URB*), financial development level (*FIN*), information level (*INF*), internet development (*INT*), economic development (*PGD*), natural population growth rate (*NAT*), and human capital level (*HUM*) to control green economic growth. Among them, following Lin and Du (2015), the ratio of private and solopreneur employees to the resident population is used as the quantitative indicator for the marketization of each prefecture-level city. Referring to Pan et al. (2019), the non-agricultural population divided by the total population is employed to calculate urbanization. Referring to Wang J. et al. (2021), the ratio of deposit and loan balance to GDP is used to express the financial development level. Referring to Shen and Du (2018), the informatization level is expressed by regional electricity business volume. Drawing on Wang J. et al. (2021), human capital levels (*HUM*) are denoted by the number of college students in school, and GDP per capita is chosen to measure economic development (*PGD*). Following Yang et al. (2021b), the number of Internet users is utilized to measure internet development (*INT*). The natural population growth rate (*NAT*) is chosen to examine the extent to which population growth affects green economic growth.

3.3 Data Sources

This paper investigates the panel data of 272 prefecture-level cities from 2004 to 2019. The source data for all variables in this paper are captured from the China City Statistical Yearbook, EPS database, and the National Research Network. Missing values for a few variables were supplemented by interpolation (Yuan et al., 2020). **Table 3** reports the descriptive statistics of the variables.

4 RESULTS AND DISCUSSION

4.1 Benchmark Regression Results

Table 4 reports the direct impact of multi-dimensional local government competition on green economic growth estimated employing the SYS-GMM method [columns (1)–(4) exhibit the estimation results without control variables, while columns

(5)–(8) exhibit the estimation results with the inclusion of control variables]. The insignificant value of AR (2) suggests that there is no second-order autocorrelation. Hansen tests confirms that the benchmark regression model does not suffer from an excess of this instrumental variable. To conclude, the result of estimating the impact of local government multi-dimensional competition on green economic growth employing the SYS-GMM method is valid. **Table 4** reveals that the coefficient of *JJZ* is negative ($p < 0.05$), implying that economic competition significantly dampens green economic growth. Besides, the coefficients of *STJZ*, *FUJZ*, and *ZHJZ* ($p < 0.01$) are positive ($p < 0.05$), implying that the multi-dimensional local government competition, ecological competition, service competition, and comprehensive competition significantly contributes to green economic growth. This result is in line with the conclusions reached by Zhang et al. (2021), Hong et al. (2020), and Wu et al. (2020). We may explain the above results for the following reasons.

The focus of the economic competition is to pursue GDP performance. Aiming to enhance economic competitiveness, local governments favor productive expenditures in fiscal spending and make great efforts to attract FDI and increase investment in fixed assets, resulting in the investment of funds for economic competition mainly in productive fields (Zhang et al., 2021). At the same time, to further improve economic catch-up, it is the consistent practice of local governments to reduce taxes and transfer profits (Wu et al., 2021). Through policies such as tax reduction and tax rebates, enterprises are attracted to invest and improve economic performance (Rauscher, 2005). Although economic competition has promoted rapid economic growth, the accompanying negative effects such as environmental pollution and ecological damage have increasingly become a threat to sustainable development (Zhang et al., 2020). The economic competitiveness of local governments has strengthened local protectionism, appeared the behavior of sacrificing long-term development potential in exchange for the growth of short-term economic assessment level, exacerbated the externality of environmental pollution, brought difficulties to regional collaborative governance, and triggered “bottom-by-bottom competition” in the environment and “adverse selection” in the market, to strengthen the path dependence of the regional economy on extensive growth and curb green economic growth (Tang and Qin, 2022).

The ecological competition includes overall greening competition, per capita greening competition, environmental practitioners competition, solid waste treatment competition, and sewage treatment competition. These five indicators measure the green and ecological level of regional development, reflect the green investment ability and environmental regulation level of local governments. Along with the launch of the “Evaluation and Assessment Measures for the Construction of Ecological Civilization” and other relevant policies, the Chinese government has included green development as a crucial assessment indicator for local governments. Under the context of ecological competition, environmental regulation of top-by-top competition and

TABLE 4 | Benchmark regression results.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
L.GEG	−0.118*** (0.001)	−0.120*** (0.001)	−0.118*** (0.001)	−0.118*** (0.001)	−0.085*** (0.003)	−0.098*** (0.002)	−0.100*** (0.002)	−0.097*** (0.002)
JJZJ	−0.002*** (0.001)				−0.004** (0.002)			
STJZ		0.018*** (0.000)				0.035*** (0.003)		
FWJZ			0.014*** (0.001)				0.046*** (0.003)	
ZHJZ				0.071*** (0.004)				0.227*** (0.019)
Control variables	NO	NO	NO	NO	YES	YES	YES	YES
Constant	1.099*** (0.001)	1.133*** (0.001)	1.125*** (0.001)	1.174*** (0.004)	0.887*** (0.031)	1.108*** (0.031)	1.209*** (0.027)	1.429*** (0.071)
AR (2)	−0.51 [0.608]	−0.55 [0.580]	−0.54 [0.589]	−0.54 [0.597]	0.03 [0.976]	−0.26 [0.795]	−0.31 [0.755]	−0.25 [0.801]
Hansen test	267.87 [0.999]	271.19 [0.999]	269.41 [0.999]	269.20 [0.999]	265.11 [0.993]	263.80 [1.000]	266.98 [0.999]	263.17 [1.000]
N	272	272	272	272	272	272	272	272

Note: Standard errors in parentheses and p-value in brackets; ***p < 0.01, **p < 0.05, *p < 0.1.

governmental environmental governance behaviors which will improve resource use efficiency and reduce pollution emissions will positively reflect on green economic growth (Zhuo and Minjie, 2018; Neves et al., 2020). In addition, the porter effect of environmental regulation (Acemoglu et al., 2012; Peng, 2020) shows that enterprises will improve the level of technological innovation, use the increased income to increase pollution control, and bring the “technological progress effect” of enterprises (Li et al., 2021). Increased government environmental expenditure and environmental personnel as important instruments of environmental governance in China will not only guide the direction of social investment and the environmental behavior of enterprises but also play an essential catalytic role in green economic growth through informal environmental regulations such as public oversight (Langpap and Shimshack, 2010; Ruffing, 2010; Cole et al., 2013).

Service competition includes five dimensions: basic condition competition, medical service competition, commuting competition, income competition, and employment competition. “People’s yearning for a better life” is one of the goals of Chinese local governments in the new era (Lin, 2021). In terms of service competition, through the comprehensive promotion of early childhood education, education, labor, medical care, elderly care, housing, and support for the weak, local governments can gain an advantage in this field (Llena-Nozal et al., 2019). Under the guidance of macro policies, regional governments vigorously develop high-tech industries, and local governments gradually transition their development strategy from attracting investment to building nests and attracting Phoenix and implementing the war of robbing people. The competition for talents reflects the important content of service competition (Luna-Arocas and Lara, 2020). The transformation of local governments from production-based to service-based governments will not only strengthen the effective supply of public services but also facilitate human capital and

technological innovation, thus promoting green economic growth.

Local government competition is multidimensional, dynamic, and comprehensive. Comprehensive competition promotes green economic growth. During the early phase of economic development, the “competition for growth” model of governance was able to maximize social effects, while as external conditions changed, “competition for ecology” emerged. Such a paradigm shift can give institutional assurance to fulfill the transformation of the economic development model. “The fact that” competition for growth” has contributed to China’s rapid economic development has also introduced a gradual deterioration of environmental pollution, which resulted in a shift in competition among local governments to “competition for environmental protection” along with changes in assessment rules (Wang et al., 2021). Under the background of fully implementing the innovation-driven strategy, indicators such as technological innovation performance have been incorporated into the assessment system, while the “competition for innovation” has gradually emerged. To further improve innovation ability, “competition for talents” has become a new phenomenon of local government competition (Zhao et al., 2021b). During the current stage, local governments have switched from high-speed competition to high-quality development competition, and local government competition is becoming more and more diversified and integrated. Under the comprehensive effect of economic competition, ecological competition, and service competition, the comprehensive competition to promote green development and high-quality development will also effectively promote green economic growth.

4.2 Role Mechanism Results and Discussion

Table 4 implies that multi-dimensional local government competition significantly affects green economic growth. To further explore the intrinsic mechanism of multidimensional

TABLE 5 | Role mechanism of economic agglomeration results.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	GEG	EAG	GEG	GEG	EAG	GEG	GEG	EAG	GEG	GEG	EAG	GEG
L. GEG/EAG	-0.085*** (0.002)	0.959*** (0.001)	-0.081*** (0.004)	-0.077*** (0.003)	0.966*** (0.001)	-0.081*** (0.002)	-0.085*** (0.002)	0.963*** (0.001)	-0.086*** (0.002)	-0.091*** (0.002)	0.967*** (0.001)	-0.091*** (0.002)
EAG			-0.007*** (0.001)			-0.008*** (0.001)			-0.004*** (0.001)			-0.008*** (0.001)
JJJZ	-0.013*** (0.002)	0.055*** (0.002)	-0.005** (0.002)									
STJZ				0.023*** (0.002)	-0.045*** (0.003)	0.020*** (0.003)						
FWJZ							0.066*** (0.003)	-0.085*** (0.004)	0.063*** (0.005)			
ZHJZ										0.210*** (0.018)	-0.064*** (0.015)	0.195*** (0.021)
Control variables	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Constant	1.237*** (0.010)	0.508*** (0.012)	1.191*** (0.018)	1.418*** (0.021)	0.097*** (0.029)	1.335*** (0.022)	1.692*** (0.034)	-0.189*** (0.024)	1.653*** (0.032)	1.711*** (0.043)	0.270*** (0.036)	1.635*** (0.050)
AR (2)	0.08 [0.933]	-0.11 [0.912]	0.11 [0.908]	0.24 [0.814]	-0.10 [0.918]	0.10 [0.920]	-0.01 [0.991]	-0.10 [0.924]	-0.05 [0.958]	-0.11 [0.914]	-0.10 [0.919]	-0.13 [0.900]
Hansen test	266.50 [1.000]	267.84 [1.000]	265.02 [1.000]	263.65 [1.000]	266.86 [1.000]	265.27 [1.000]	267.85 [1.000]	266.33 [1.000]	267.57 [1.000]	268.19 [1.000]	269.45 [1.000]	266.67 [1.000]
N	272	272	272	272	272	272	272	272	272	272	272	272

Note: Standard errors in parentheses and p-value in brackets; ***p < 0.01, **p < 0.05, *p < 0.1.

local government competition on green economic growth, this paper examines its mechanism using SYS-GMM model.

Table 5 reports the estimation results of multi-dimensional local government competition on green economy growth under the economic agglomeration perspective. Among them, columns (1)–(3) of **Table 5** indicate that economic competition can inhibit green economic growth by facilitating economic agglomeration. Columns (4)–(12) of **Table 5** suggest that ecological competition, service competition, and comprehensive competition can promote green economic growth by dampening economic agglomeration. Local governments in pursuit of economic growth have manifested great enthusiasm in investment, taxation, and attracting foreign investment (Zhang et al., 2021). The economic competitiveness of local governments motivated by the economic growth goals is beneficial to economic agglomeration. The direct consequence of economic agglomeration carries with it the expansion of production capacity and the increase of production and consumption, which in turn has a dampening effect on environmental quality (Hong et al., 2020). Ecological competition is more reflected in environmental regulation, and economic agglomeration exists in the scale effect of pollution emissions resulting in increased pollutant emissions is the primary reason for the lower level of green economic growth (Deng et al., 2019). Under the influence of ecological competition, the increase of the environmental level of regulation will heighten the production cost for enterprises, increase the environmental tax burden, and inhibit economic agglomeration. Service competition is more reflected in public infrastructure construction and talent attraction. Service competition provides public infrastructure and talent support for industrial agglomeration, promotes the development of new industries and tertiary industries, and inhibits economic agglomeration (Hong et al., 2020). However,

local government competition is prone to local protection, which favors subsidizing mobility factors while increasing essential public services to attract investment, thus economic agglomeration of local protection causes a decrease in resource allocation efficiency (Brakman et al., 2002; Irfan et al., 2021a). Moreover, excessive clustering in the same industry generates congestion effects of agglomeration, contributing to market rigidity and distorted factor allocation. Simultaneously, economic agglomeration usually coexists with pollution agglomeration and the two promote each other, resulting in a realistic situation where economic agglomeration inhibits green economic growth.

Table 6 reports the estimation results of multi-dimensional local government competition on green economy growth under the industrial structural upgrading perspective. Columns (1)–(3) results of **Table 6** reflect that the coefficients of *JJJZ* and *IND* are one-negative and one-positive ($p < 0.01$), suggesting that economic competition can significantly inhibit green economic growth through inhibiting industrial structural upgrading. Columns (4)–(12) results of **Table 6** show that the coefficients of *STJZ*, *FWJZ*, and *ZJJZ* are negative and the coefficient of *IND* is positive ($p < 0.01$), pointing to the fact that ecological competition, service competition, and comprehensive competition can significantly contribute to green economic growth through facilitating industrial structure upgrading. One potential interpretation is that industrial upgrading requires inputs of key factors of production, while government competition is crucial to influence industrial structural upgrading (Wu, 2015). Although economic competition stimulates industrial structure rationalization, it inhibits industrial structure advancement, which can be complemented by fiscal spending policies that intervene in market mechanisms and industrial structure upgrading (Li and Mao, 2019). In terms

TABLE 6 | Role mechanism of industrial structural upgrading results.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	GEG	IND	GEG	GEG	IND	GEG	GEG	IND	GEG	GEG	IND	GEG
L. GEG/IND	-0.085*** (0.002)	0.675*** (0.142)	-0.083*** (0.002)	-0.077*** (0.003)	0.671*** (0.139)	-0.082*** (0.003)	-0.085*** (0.002)	0.673*** (0.142)	-0.087*** (0.002)	-0.091*** (0.002)	0.619*** (0.145)	-0.090*** (0.001)
IND			0.047*** (0.002)			0.040*** (0.002)			0.039*** (0.002)			0.037*** (0.002)
JJZJ	-0.013*** (0.002)	-0.029*** (0.011)	-0.023*** (0.002)									
STJZ				0.023*** (0.002)	0.035*** (0.009)	0.020*** (0.002)						
FWJZ							0.066*** (0.003)	0.054*** (0.019)	0.067*** (0.005)			
ZHJZ										0.210*** (0.018)	0.243** (0.107)	0.126*** (0.027)
Control variables	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Constant	1.237*** (0.010)	-0.566*** (0.118)	0.983*** (0.016)	1.418*** (0.021)	-0.169 (0.110)	1.217*** (0.026)	1.692*** (0.034)	-0.086 (0.139)	1.515*** (0.037)	1.711*** (0.043)	0.490 (0.313)	1.363*** (0.061)
AR (2)	0.08 [0.933]	0.64 [0.524]	0.10 [0.992]	0.24 [0.814]	0.73 [0.467]	0.12 [0.906]	-0.01 [0.991]	0.68 [0.496]	-0.05 [0.956]	-0.11 [0.914]	0.69 [0.487]	-0.05 [0.916]
Hansen test	266.50 [1.000]	269.10 [1.000]	264.81 [1.000]	263.65 [1.000]	267.46 [0.999]	264.26 [1.000]	267.85 [1.000]	267.18 [0.988]	268.96 [1.000]	268.19 [1.000]	267.94 [1.000]	269.40 [1.000]
N	272	272	272	272	272	272	272	272	272	272	272	272

Note: Standard errors in parentheses and p-value in brackets; ***p < 0.01, **p < 0.05, *p < 0.1.

of service competition, for example, competition in science, education, culture, and health expenditures is beneficial to industrial structure upgrading, while competition in economic construction expenditures hampers industrial structure upgrading. Meanwhile, ecological competition and service competition are mainly reflected in the competition of local governments for ecological environment-related construction and infrastructure construction in public service areas, which provides an excellent business environment for industrial development and thus facilitates industrial upgrading. Under the combined effect of economic competition, ecological competition, and service competition, the comprehensive competition reveals the positive effect of industrial structure upgrading. In addition, according to the law of industrial evolution, the secondary industry gradually evolves into the tertiary industry, the structure within each industry is also constantly optimized and upgraded, and various production factors gradually shift to high value-added industries (Irfan et al., 2021b). During the process, resource-based industries and high-energy-consuming industries will strengthen intensive production efficiency, facilitate energy conservation and emission reduction, as well as push forward environmental management and ecological protection, and thereby stimulate green economic growth.

4.3 Heterogeneity Results and Discussion

4.3.1 Time Heterogeneity Results and Discussion

The year 2012 is an extremely crucial juncture in China's economic development, with the 18th Congress of the Communist Party of China, the change of the President and the introduction of ecological civilization, all of which have had a significant influence on the direction and goals of multi-dimensional local government competition. Therefore, this

paper separates the research sample from 2004–2019 into two groups (one for 2004–2011 and the other for 2012–2019) to heterogeneously analyze the impact of multi-dimensional local government competition on green economic growth, using 2012 as the time point (Table 7).

Table 7 shows the significant temporal heterogeneity of the effect of multidimensional local government competition on green economic growth, i.e., the effect of multidimensional local government competition on green economic growth diminishes after 2012 compared to before 2012. Judging from the economic competition, China's economic growth rate is progressively shifting from high-speed growth to medium-high growth, and the economic competition pressure on local governments is gradually decreasing, thus reducing the inhibitory effect on green economic growth (Su et al., 2021). Moreover, the Chinese government further advances market-oriented reforms after 2012, which highlight "a greater and broader role of the market in resource allocation," thus the status of the market in resource allocation is enhanced and the economic competition from local governments is relatively reduced, resulting in a relatively lower impact of economic competition on negative green economic growth (Tang and Qin, 2022). Judging from the perspective of ecological competition and service competition, environmental regulation strengthens after 2012, investment in environmental pollution control rises year by year, which contradicts the increase in environmental infrastructure and contributes to the increase in the number of environmental practitioners (Liu et al., 2022). Moreover, local governments' ecological competition intensified in line with the yearly reinforcement of their environmental governance capacity and guided by the eco-performance assessment. Nevertheless, the degree of influence of local governments' ecological competition on green economic

TABLE 7 | Time heterogeneity results.

Variables	Year 2004–2011				Year 2012–2019			
L.GEG	–0.113*** (0.003)	–0.109*** (0.004)	–0.125*** (0.003)	–0.116*** (0.003)	–0.226*** (0.003)	–0.068*** (0.003)	–0.067*** (0.003)	–0.067*** (0.003)
JJZJ	–0.012*** (0.002)				–0.005** (0.003)			
STJZ		0.005* (0.003)				0.048*** (0.006)		
FWJZ			0.116*** (0.005)				0.016*** (0.006)	
ZHJZ				0.280*** (0.025)				0.172*** (0.021)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	1.078*** (0.041)	1.068*** (0.041)	1.851*** (0.052)	1.735*** (0.058)	0.902*** (0.039)	1.033*** (0.063)	0.871*** (0.057)	1.158*** (0.057)
AR(2)	–0.38 [0.702]	–0.31 [0.756]	–0.60 [0.548]	–0.45 [0.656]	–1.48 [0.139]	0.51 [0.614]	0.56 [0.576]	0.57 [0.569]
Hansen test	262.29 [0.993]	261.27 [0.975]	257.71 [0.983]	259.77 [0.979]	266.62 [0.997]	264.20 [0.994]	265.75 [0.992]	266.61 [0.991]
N	272	272	272	272	272	272	272	272

Note: Standard errors in parentheses and p-value in brackets; ***p < 0.01, **p < 0.05, *p < 0.1.

growth decreases after 2012 in the context of increasing environmental pollution emissions and slowing GDP growth. Judging from the service competition, local governments step up the construction of public service infrastructure to elevate their human capital level and continuously improve its livability and basic education capacity. However, a demographic dividend gradually vanished after 2012, the competition for talent among local governments intensified, the operating costs of enterprises gradually escalated, while the service competition among local governments exhibited a decreasing degree of impact on green economic growth. Eventually, the comprehensive competition of local governments also characterizes a decrease in the degree of influence on green economic growth.

4.3.2 Regional Heterogeneity Results and Discussion

Chinese mainland lies high in the western part of the land and low in the eastern part, with a stepped distribution of high mountains and plateaus in the western part and hills and plains on the eastern coast, and a stepped slope descending from west to east, thus resulting in an unbalanced development of each region and significant regional differences (Zeng et al., 2020). Therefore, referring to Wang (2020), this paper divides the research samples into three parts: the eastern, the central, and the western for regional heterogeneity analysis (Tables 8, 9). Table 8 reports the regional heterogeneity results of economic competition and ecological competition, suggesting that the impact of economic competition on green economic growth demonstrates the strongest feature of central (insignificant), followed by western and the weakest eastern, and the degree of impact of ecological competition on green economic growth exhibits the strongest in the eastern, followed by the western, and the weakest in the central (insignificant). Table 9 reports the regional heterogeneity results of service competition and comprehensive competition, which demonstrates that the influence of both service competition and comprehensive

competition on the green economic growth presents the strongest degree in the eastern region, followed by the western region, and the weakest in the central region (insignificant).

The remarkably different regional natural conditions and economic bases in China, provide a potential explanatory foundation for the regional heterogeneity effect of multidimensional local government competition. Judging from the characteristics of physical geographic distribution and natural conditions, the natural conditions of China gradually deteriorate from eastern to western, precipitation decreases, and its weak ecological and environmental endowment determines that the economic and social development of the western region lags behind that of the eastern and central regions (Zhang et al., 2021; Tang and Qin, 2022). In addition, judging from the economic foundations, the eastern region owns better basic conditions for economic development. Taking the Aihui-Tengchong Line as the boundary, the eastern and central regions are mainly located east of the Aihui-Tengchong Line, which is densely populated and provides sufficient labor for economic development while the western region is mainly located west of the Aihui-Tengchong Line and has a relatively small population. Meanwhile, the capital stock in the eastern region is higher than that in the central and western regions, and the investment reveals a decreasing trend from eastern to western, which supplies a differential capital foundation for economic development. As such, the economic development degree is strongest in the eastern region, followed by the central region, and weakest in the western region, and conversely, the impact of local government competition on green economic growth shows the characteristics strongest in the central region, followed by the western region, and weakest in the eastern region (Jiang et al., 2022). Judging from the ecological competition, the fragile ecological environment has higher requirements for environmental regulation, while the

TABLE 8 | Regional heterogeneity results under economic and ecological competition.

Variables	(1) Eastern	(2) Eastern	(3) Central	(4) Central	(5) Western	(6) Western
L.GEG	−0.049* (0.026)	−0.078*** (0.011)	−0.149*** (0.012)	−0.149*** (0.010)	−0.054 (0.034)	−0.070* (0.040)
JJZJ	−0.037*** (0.007)		0.014* (0.008)		−0.028* (0.016)	
STJZ		0.066*** (0.010)		−0.005 (0.012)		0.036* (0.021)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Constant	0.788*** (0.092)	1.306*** (0.091)	0.193** (0.081)	0.012 (0.068)	1.179*** (0.119)	1.587*** (0.203)
AR(1)	−2.26 [0.024]	−2.33 [0.020]	−5.48 [0.000]	−5.41 [0.000]	−5.49 [0.000]	−5.00 [0.000]
Hansen test	89.21 [1.000]	89.22 [1.000]	92.04 [1.000]	94.16 [1.000]	70.57 [1.000]	68.14 [1.000]
N	98	98	98	98	76	76

Note: Standard errors in parentheses and p-value in brackets; ***p < 0.01, **p < 0.05, *p < 0.1.

TABLE 9 | Regional heterogeneity results under service competition and comprehensive competition.

Variables	(1) East	(2) East	(3) MID	(4) MID	(5) West	(6) West
L.GEG	−0.062*** (0.018)	−0.089*** (0.009)	−0.153*** (0.012)	−0.146*** (0.012)	−0.092*** (0.030)	−0.071*** (0.021)
FWJZ	0.088*** (0.013)		0.021 (0.016)		0.073*** (0.024)	
ZHJZ		0.363*** (0.040)		0.073 (0.055)		0.215** (0.094)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Constant	1.299*** (0.139)	1.677*** (0.092)	0.271* (0.159)	0.305** (0.152)	1.782*** (0.164)	1.760*** (0.244)
AR(2)	−1.18 [0.237]	−1.61 [0.108]	−0.63 [0.528]	0.73 [0.463]	−1.56 [0.120]	−1.35 [0.177]
Hansen test	88.15 [1.000]	96.22 [1.000]	94.96 [1.000]	92.51 [1.000]	60.59 [1.000]	70.72 [1.000]
N	98	98	98	98	76	76

Note: Standard errors in parentheses and p-value in brackets; ***p < 0.01, **p < 0.05, *p < 0.1.

western region has relatively lagging economic development and relatively less environmental management investment (Wu et al., 2020). Under this background, local governments, as suppliers of public goods, are bound to strengthen their influence on the ecological environment, ultimately producing the result that the degree of influence of ecological competition on green economic growth is higher in the eastern region than in the western region, and higher in the western region than in the central region.

Judging from the service competition, talents as the source of innovation have been the key resources for economic and social development. The eastern region had more advanced facilities in both basic education and higher education than the central and western regions, while the western region lacked talents and educational resources. To further elevate the human capital level, local governments undertake considerable efforts, which eventually yield the result that service competition has the strongest influence on green economic growth in the eastern region, followed by the western region and the weakest in the central region (Hong

et al., 2020). Ultimately, the comprehensive competition for green economic growth is characterized as the strongest in the eastern region, followed by the western region, and the weakest in the central region under the comprehensive effect of economic competition, ecological competition, and service competition.

4.4 Robustness Checks

To confirm whether the above findings are reliable, methods such as replacing the explanatory variables and excluding special years are applied to perform robustness checks on the effect of local government competition on green economic growth.

4.4.1 Replace the Explained Variable Results and Discussion

Following Su et al. (2021), this paper re-measures green economic growth using the DDF-GML model and then re-validates the effect of local government competition on green economic growth (Table 10). Columns (1)–(4) of Table 10 suggest that

TABLE 10 | Robustness tests for replacing the explanatory variables.

Variables	(1)	(2)	(3)	(4)
L.GEG	−0.056*** (0.006)	−0.073*** (0.008)	−0.068*** (0.006)	−0.077*** (0.006)
JJJZ	−0.003*** (0.001)			
STJZ		0.016*** (0.001)		
FWJZ			0.027*** (0.003)	
ZHJZ				0.079*** (0.009)
Control variables	Yes	Yes	Yes	Yes
Constant	1.071*** (0.012)	1.171*** (0.021)	1.269*** (0.020)	1.264*** (0.023)
AR (2)	0.36 [0.717]	0.00 [0.997]	0.10 [0.921]	−0.10 [0.100]
Hansen test	265.25 [0.993]	265.46 [1.000]	264.47 [1.000]	267.37 [0.999]
N	272	272	272	272

Note: Standard errors in parentheses and p-value in brackets; ***p < 0.01, **p < 0.05, *p < 0.1.

TABLE 11 | Remove special year's result.

Variables	(1)	(2)	(3)	(4)
L.GEG	−0.089*** (0.003)	−0.089*** (0.003)	−0.093*** (0.002)	−0.088*** (0.004)
JJJZ	−0.016*** (0.004)			
STJZ		0.030*** (0.003)		
FWJZ			0.049*** (0.004)	
ZHJZ				0.216*** (0.016)
Control variables	Yes	Yes	Yes	Yes
Constant	0.857*** (0.030)	1.139*** (0.047)	1.234*** (0.048)	1.379*** (0.057)
AR (2)	0.15 [0.785]	0.14 [0.757]	0.03 [0.683]	0.08 [0.757]
Hansen test	266.7 [1.000]	267.47 [0.999]	268 [0.999]	261.66 [0.999]
Ob	3,791	3,791	3,791	3,791
N	272	272	272	272

Note: Standard errors in parentheses and p-value in brackets; ***p < 0.01, **p < 0.05, *p < 0.1.

economic competition still significantly ($p < 0.01$) inhibits green economic growth, while the ecological competition, service competition, and comprehensive competition significantly ($p < 0.01$) contribute to green economic growth.

4.4.2 Remove Special Years Results and Discussion

Because of the global recession induced by the US subprime mortgage crisis in 2008, FDI and international trade in many parts of China were severely affected, the competition forms of local governments in China in terms of preserving employment, economic growth and safeguarding people's livelihood as well as environmental management were also severely impacted (Chor

and Manova, 2012). Following Li et al. (2021), robustness checks on the effect of local government competition on green economic growth are carried out by excluding the special year 2008. The test results are shown in **Table 11**. After excluding special years, economic competition still presents a significantly dampening effect on green economic growth, while it is significantly stimulated by ecological competition, service competition and integrated competition.

5 CONCLUSION AND POLICY IMPLICATIONS

This paper employs the EBM-GML model to calculate the green economic growth and then investigates the impact of multidimensional local government competition (ecological competition, service competition, economic competition, and comprehensive competition) on green economic growth in terms of economic agglomeration and industrial structure upgrading, and technological innovation using SYS-GMM and mediating effect models on the basis of 272 prefecture-level cities in China from 2004 to 2019. The main research conclusions are: First, the green economic growth of China's prefecture-level cities shows an upward trend. Second, multi-dimensional local government competition has a significant impact on green economic growth, in which economic competition significantly inhibits green economic growth, while ecological competition, service competition, and comprehensive competition significantly contribute to green economic growth. Third, the role mechanism shows that economic competition, ecological competition, service competition, and comprehensive competition significantly affect green economic growth from the perspective of economic agglomeration and industrial upgrading. Finally, temporal and regional heterogeneity reports that the ability of multi-dimensional local government competition to influence green economic growth diminishes after 2012. The impact of economic competition on green economic growth shows a significant characteristic of heterogeneity (central > western > eastern), while the impact of ecological competition, service competition, and comprehensive competition on green economic growth show the characteristics of the eastern > western > central. Based on the above findings, some necessary policy implications should be provided.

- (1) The effect of multidimensional local government competition on green economic growth shows that effective and multidimensional local government competition is beneficial to green economic growth. Therefore, policymakers should continue to moderate local government competition, reasonably construct a multidimensional local government competition goal system and improve the ecological goal and service goal level of local governments.
- (2) Policymakers should optimize the competition system of local governments, weaken economic competition and enhance ecological and service competition under the goal of green economic growth. For example, policymakers

should strengthen the quality of services, create a livable environment, and increase the rational allocation of talents and other resources. Moreover, policymakers should develop economic growth targets according to local conditions and facilitate the harmonization of economic growth and environmental governance.

- (3) To eliminate conflicts between local interests and regional common interests, policymakers must establish cross-administrative organizational coordination bodies and strengthen local government cooperation to further enhance inter-regional environmental governance. Furthermore, policymakers should develop regional competition programs specifically based on local realities. From regional characteristics, industrial competitiveness should be improved, industrial upgrading should be increased, environmental regulation should be improved, and service competitiveness should be enhanced.

Although this paper provides an analysis of the impact of multidimensional local government competition (ecological competition, service competition, economic competition, and comprehensive competition) on green economic growth in terms of economic agglomeration, industrial upgrading, and technological innovation, some crucial factors that need to be considered urgently in the future are still ignored. For example, some studies confirm the existence of spatial spillover characteristics of green economic growth, so future researchers can use spatial econometric models to perform an extended analysis of the impact of local government competition on green economic growth (Lei et al., 2021). Moreover, local

government competition is also likely to influence green economic growth through, foreign direct investment, and resource misallocation. Therefore, scholars can evaluate the perspective of local government competition affecting green economic growth from several perspectives.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding authors.

AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

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