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The impact of upgrading administrative rank on regional innovation from an agglomeration perspective: a quasi-natural experiment based on the establishment of Chongqing as a province-level municipality

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Introduction: Administrative rank, as an intuitive manifestation of a region's political capital, significantly influences regional agglomeration capacity and innovative development.
Methods: This study utilizes Chongqing's promotion to a province-level municipality as a quasi-natural experiment, employing panel data from 219 counties in Sichuan and Chongqing (1992–2010) and applying the difference-in-differences (DID) method to evaluate the impact of administrative rank upgrades on regional innovation.
Results: The findings show: (1) Administrative rank upgrade significantly enhances regional innovation with long-term positive effects; (2) Spatial spillover effects follow an inverted U-shape, peaking at 60 km and remaining significant within 30–120 km; (3) Population agglomeration and economic agglomeration are key mechanisms, with economic agglomeration having greater impact.
Discussion: This study provides theoretical insights for optimizing administrative resource allocation, advancing institutional reform, and refining national innovation-driven development strategies.

KEYWORDS

administrative rank, regional innovation, difference-in-differences, economic agglomeration, population aggregation

1 Introduction

Enhancing independent innovation capabilities is essential for achieving high-quality economic development. In the context of intensifying global technological competition, innovation-driven development has emerged as the cornerstone of China's national development strategy. Accelerating the establishment of a new economic development model necessitates not only technological breakthroughs but also a holistic enhancement of independent innovation capabilities. In recent years, a series of policy documents aimed at local development have been successively released. These include the Notice of the State Council on Several Measures to Support the Deepening of Reform and Innovation in Pilot

Free Trade Zones (State Council of the People's Republic of China, 2018), the Outline of the Yangtze River Delta Regional Integrated Development Plan (Central Committee of the Communist Party of China and State Council of the People's Republic of China, 2019a), the Outline of the development plan for the Guangdong-Hong Kong-Macao Greater Bay Area (Central Committee of the Communist Party of China and State Council of the People's Republic of China, 2019b), and the Guiding opinions on promoting high-quality development in central China in the new era (Central Committee of the Communist Party of China and State Council of the People's Republic of China, 2021). Additionally, the National innovation-driven development strategy outline (Central Committee of the Communist Party of China and State Council of the People's Republic of China, 2016) explicitly proposed the establishment of regional innovation strategic highlands, while the Notice on issuing the "14th five-year" special plan for scientific and technological innovation in urbanization and urban development (Ministry of Science and Technology of the People's Republic of China and Ministry of Housing and Urban-Rural Development of the People's Republic of China, 2022) emphasized the importance of regional collaborative innovation, supporting the creation of innovation clusters with international competitiveness. These policies underscore that regional innovation is not only a vital engine for local economic transformation and upgrading but also a crucial component in the implementation of the national innovation-driven development strategy.

As a crucial component of the national governance system, the timely reform and adjustment of local administrative divisions hold significant importance for enhancing both national and local governance capabilities, as well as ensuring the orderly operation of the economy and society. The General Secretary Xi has emphasized that "administrative divisions themselves are also an important resource." The upgrading of administrative ranks, which is one of the key methods for adjusting administrative divisions, provides regions with distinct advantages in strategic positioning and administrative management (Wang et al., 2019). Regions with higher administrative ranks benefit from priority access to various resources and possess a greater share of public resources, including education, healthcare, sanitation, transportation, and infrastructure. This, in turn, attracts population concentration and fosters economic development. From the "abolition of prefectures and establishment of cities" in the 1980s, to the large-scale "abolition of counties and establishment of cities" in the 1990s, and subsequently to the "abolition of counties and establishment of districts" in the early 21st century, the ongoing adjustments to administrative ranks underscore the significance of this limited political resource in regional economic development. While existing studies have demonstrated that administrative rank significantly influences the service industry, corporate location strategies, urban resource allocation efficiency, resource misallocation, and corporate productivity (Wang, 2014; Xie et al., 2017; Jiang et al., 2018; Sun and Xu, 2023), its effects on regional innovative development and the underlying mechanisms involved remain an under-researched area.

The agglomeration capacity is directly linked to the economic vitality of a region. The concentration of resources primarily depends on top-down administrative redistribution. Regions with higher administrative rankings have a comparative advantage in central decision-making negotiations, significantly influencing talent mobility, technological research and development, and investments in science and technology—all of which are closely associated with regional innovative development. This paper adopts the perspective of agglomeration and specifically defines along two dimensions: population agglomeration (the spatial concentration of labor and talent) and economic-activity agglomeration (the spatial concentration of industrial and capital factors). These two concepts are clearly distinguished: population agglomeration emphasizes the scale effects of human resources and knowledge spillovers, whereas economic agglomeration highlights the economies of scale in production factors and synergies along industrial chains. Building on this framework, the paper examines how administrative elevation affects regional innovation. Using a county-level panel dataset of 219 counties in Sichuan and Chongqing from 1992 to 2010, we employ a difference-in-differences strategy and find that administrative elevation significantly promotes regional innovation. The findings indicate that the effect of administrative rank upgrades on regional innovation exhibits a one-year lag and a long-term positive trend. Furthermore, the spatial heterogeneity of this impact is characterized by an inverse distribution, with spatial spillover effects occurring within a range of 30 to 120 kilometers, peaking at 60 kilometers. The paper also empirically verifies the distinct impact pathways of population agglomeration and economic agglomeration.

This paper contributes to the literature in several significant ways. First, unlike previous studies that examine how administrative borders affect regional innovation (Camagni et al., 2014; Luo et al., 2023), this study adopts a macro-level perspective to construct a logical framework linking "macro policy — behavioral response — factor agglomeration — innovation outcome." Although it utilizes county-level macro data, the core focus of this research is to reveal the internal mechanism behind the causal effect of "administrative level elevation promoting regional innovation. Policies influence the incentive structure for regional development, guide the reallocation of resources, drive the agglomeration of factors such as economic activity and population, and ultimately enhance innovation capacity. This analysis not only expands the theoretical pathways through which administrative levels impact regional innovation but also provides empirical evidence supporting the mechanisms underlying related policy objectives. Secondly, unlike existing studies that utilize administrative-level upgrades such as county-to-district conversions or prefecture-to-city promotions (Chen et al., 2020; Yu et al., 2024), this paper employs the establishment of Chongqing Municipality as a quasi-natural experiment to minimize the endogeneity issues commonly associated with administrative level adjustments. Specifically, typical adjustments like county-to-district or prefecture-to-city conversions usually result from "selective promotion" after the relevant regions meet certain thresholds in socio-economic development indicators. For example, under the 1986 standards for city establishment, counties with populations exceeding 500,000 were required to meet criteria such as a non-agricultural population of at least 120,000 and an annual gross national product exceeding 400 million yuan. The 2019 revised standards further introduced 16 quantitative indicators and 5 qualitative indicators (Fan and Zhou, 2021). This "self-selection" mechanism, based on development levels, causes administrative upgrades to be highly correlated with inherent regional characteristics, making it difficult to clearly identify their causal effects. In contrast, the establishment of Chongqing Municipality primarily resulted from macro-strategic decisions at the national level and historical needs for administrative adjustments,

rather than from its socio-economic development reaching a specific promotion threshold. Historical context indicates that the direct motivations for establishing Chongqing Municipality included managing the Three Gorges Project, addressing large-scale migrant resettlement, and strategically optimizing connectivity between central and western China, among other macro-governance factors (Jia et al., 2021). Crucially, this decision was exogenous relative to Chongqing's regional economic development trajectory at the time. In other words, even if a potential economic development threshold existed, Chongqing's elevation to municipality status was not triggered by meeting such standards. This effectively eliminated the "self-selection" effect, making it a suitable quasi-natural experiment for identifying the net effect of administrative level elevation. Based on this relatively exogenous policy shock, this study can more reliably capture the causal relationship between administrative level and regional innovation development. Third, departing from existing perspectives on heterogeneity (Wang and Wang, 2023; Zhang et al., 2024), this paper empirically examines both the temporal heterogeneity and the spatial spillover effects of administrative divisions on regional innovation.

The remainder of this paper is organized as follows: Section 2 provides a literature review; Section 3 analyzes the theoretical mechanisms and proposes research hypotheses; Section 4 introduces historical background; Section 5 presents the model specification, variable construction, and research methods; Section 6 includes the main empirical results, robustness tests, heterogeneity tests, and mechanism tests; and Section 7 concludes the paper.

2 Literature review

2.1 The innovative effect of administrative divisions

Administrative divisions, as a key component of the national governance system, have a significant impact on innovation effects, which can be analyzed from both direct and indirect dimensions, mainly reflected in resource allocation and regional coordination. Firstly, the unique spatial governance logic and mechanisms inherent in administrative division adjustments can provide superior and abundant factor resources for innovative development. These resources include administrative resources, spatial resources, policy resources, labor resources, economic resources, industrial resources, and technological resources, etc. (Li et al., 2021; Xu et al., 2023; Lu et al., 2023; Ma and Cheng, 2023). Administrative divisions directly promote the flow and exchange of innovative knowledge and information resources by increasing urban population density, enhancing innovation investment, expanding market size, optimizing economic structure, and strengthening technological foundations, thereby improving urban innovation efficiency. Secondly, administrative divisions can break market segmentation and promote the integration of regional markets. As a result, innovative enterprises can enter foreign markets more efficiently, which helps to enhance the complementary effects between regions, reduce zero-sum game phenomena in adjacent areas, and thereby promote the coordinated development and linkage effects of regional innovation (Wei, 2022), enhancing the indirect and spillover effects of urban innovation. However, some scholars have pointed out that administrative divisions may lead to "innovation inertia" due to excessive market intervention through government subsidies or other means, or may neglect the investment in non-productive projects such as science and education in favor of productive projects like infrastructure due to the pursuit of short-term growth in "political tournaments," leading to fiscal expenditure bias and insufficient innovation motivation (Gu and Shen, 2012). Therefore, there is no consensus on the impact of administrative divisions on innovation, which remains a topic worth exploring in depth. In particular, current research on administrative division innovation has mainly focused on methods such as "abolishing counties to set up districts," boundary reorganization, establishment of national-level new districts, and government relocation, with relatively less research on the promotion of administrative rank. Thus, this paper can further supplement and improve research in related fields.

2.2 The agglomeration effect of administrative divisions

Administrative divisions play a significant role in enhancing the functions of regional factor agglomeration and in forming regional agglomeration effects. Existing research has conducted in-depth analyses of the agglomeration effects of administrative divisions from multiple perspectives, including population, industrial, financial, and economic agglomeration. Regarding population agglomeration, administrative divisions facilitate directed migration and the geographical concentration of populations, resulting in agglomeration effects that promote urbanization and urban development processes. Tang and Wang (2015) reported that the population agglomeration effect is more pronounced in regions with higher market potential, particularly in the eastern areas. Whereas Nie et al. (2019) findings indicate that the urbanization effect on populations within administrative divisions is primarily attributable to the rapid development of the tertiary sector. Ebinger et al. (2019) find that between 1973 and 2013, the number of municipalities in several European countries-especially Greece and Belgium-declined by as much as 75% or more due to administrative boundary reforms, resulting in a significant increase in the average municipal population size. In terms of industrial agglomeration, under the influence of administrative divisions, the infrastructure, public services, and business environment of cities have improved, promoting the entry of enterprises and the expansion of industries. This, in turn, has led to industrial agglomeration (Xu and Fang, 2015) and enhanced economies of scale. In terms of financial agglomeration, Zhang and Wang (2020) empirically indicates that adjustments to administrative divisions can enhance the financial density of cities, ultimately fostering financial agglomeration. As the level of economic development increases, the proportion of the tertiary sector expands, and the degree of government intervention and human capital levels rise, the financial agglomeration effect becomes increasingly pronounced. In terms of economic agglomeration, existing research has confirmed the significant economic agglomeration effects of administrative divisions (Chen et al., 2022). These divisions primarily promote economic integration and market integration by dismantling inter-regional administrative barriers and optimizing urban spaces, thereby increasing economic density and facilitating agglomeration effects. Ahrend et al. (2017), examining the relationship between

urban productivity, city size, and governance structures across five OECD countries (Germany, Mexico, Spain, the United Kingdom, and the United States), argue that maintaining a relatively flexible configuration of urban administrative boundaries at both the national and regional levels facilitates the agglomeration of productivity and the expansion of city size. However, excessive agglomeration may lead to an increase in "dispersive forces," which, when combined with "centripetal forces," could potentially result in negative agglomeration effects. Wei (2014) argues that the bias towards administrative centers results in functional overlap in high-administrative-rank cities, such as capitals and provincial capitals, creating a strong attraction for populations and industries. The excessive influx of people and industries exacerbates urban competition, leads to unbalanced regional development, and contributes to various diseconomies of scale. In summary, the academic community has not yet reached a consensus on the agglomeration effects of administrative divisions, and further in-depth exploration is still necessary.

2.3 The innovation effect of agglomeration

Agglomeration plays a crucial role in promoting economic growth and technological innovation through mechanisms such as sharing, matching, and learning. The innovative effects of agglomeration can be traced back to Marshall's concept of specialized agglomeration and Jacobs' notion of diversified agglomeration (Arrow, 1962; Romer, 1986). Numerous studies have expanded on these discussions. For instance, research conducted by Lu et al. (2023) indicates that high-tech specialized agglomeration has an inhibitory effect on green technological innovation, while diversified agglomeration exerts the opposite effect. Scholars have not only debated the forms of specialized and diversified agglomeration but have also refined the characteristics of agglomeration's innovative effects, categorizing them into linear and non-linear relationships. Linear relationships refer to the promotion of innovative development through agglomeration. Specifically, the innovative effects of industrial agglomeration can be divided into four types: first, the reverse effect induced by competitive pressure (Lee and Sohn, 2019); second, the spillover effect resulting from the diffusion of knowledge and technology (Yu, 2024); third, the synergistic and symbiotic effects generated by the innovation environment (Liu and Qian, 2024); and fourth, the acceleration effect stemming from the collision of knowledge. However, some scholars argue that the relationship between industrial agglomeration and innovation may exhibit non-linear characteristics, as excessive competition and technological lock-in can suppress innovation, leading to "U-shaped" or "inverted U-shaped" relationships (Du et al., 2017; Lee and Fong, 2019). Furthermore, clusters demonstrate a threshold effect on innovative development (Hu and Chen, 2019; Bai and Wan, 2024), complicating the innovative effects of clusters complex and resulting in research conclusions that are not entirely consistent. Research on agglomeration is conducted not only at the meso level but also encompasses micro and macro perspectives. From the micro-level perspective, talent serves as the primary driving force behind innovative development. Existing studies indicate that for every 10% increase in the agglomeration of the high-skilled population in cities, urban innovation output rises by 3% (Lyu et al., 2018). Therefore, scholars have conducted extensive research on talent agglomeration. For instance, Xia and Li (2023) concluded that the concentration of scientific and technological talent has a significant positive effect, as well as a spatial spillover effect, on green innovation performance. Fan (2023) differentiated the agglomeration of international talent into two categories: returned international talent and expatriate talent, yielding heterogeneous results. He suggests that the former positively influences innovation efficiency, while the impact of the latter has yet to be observed. From a macro perspective, economic agglomeration is a significant manifestation of the spatial distribution of economic activities. Research conducted by Zhou and Li (2023) indicates that economic agglomeration can foster green innovation by creating environments that favor innovation, establishing competitive mechanisms, driving technological advancements, and facilitating the concentration and mobility of innovative technological resources. In summary, it is essential to continue exploring the innovative effects of agglomeration from micro, meso, and macro perspectives, particularly by enhancing in-depth discussions at both the micro and macro levels. From a research standpoint, the innovation value chain and green technological innovation perspectives are frequently addressed; however, studies that approach the topic from the perspective of administrative divisions are relatively scarce, presenting an opportunity for the research presented in this paper.

In summary, existing literature has conducted multidimensional analyses of the relationships among administrative divisions, innovation, and agglomeration, highlighting the significance of these three elements. However, several shortcomings persist: few studies have integrated administrative divisions, agglomeration, and innovation into a cohesive analytical framework; there is a lack of research that simultaneously examines both population and economic agglomeration perspectives; and there is a relative scarcity of innovation research related to the elevation of administrative divisions, particularly quantitative studies. Agglomeration is the most critical factor influencing innovation, and the elevation of administrative rank creates an optimal environment for agglomeration. Therefore, it is essential to analyze administrative divisions, agglomeration, and innovation within a unified framework. Consequently, this paper builds upon the foundational research of previous scholars to explore the innovative effects of administrative rank elevation from the perspectives of population and economic agglomeration, offering an alternative approach for evaluating administrative division policies.

3 Theoretical mechanism and research hypotheses

Agglomeration theory posits that spatial concentration fosters innovation through knowledge spillovers, economies of scale, and specialized division of labor (Marshall, 1890; Duranton and Puga, 2004). Innovation is not the result of a single input but rather an ecosystem shaped by institutional settings, resource endowments, and spatial structure. Within China's urban hierarchy, administrative rank serves as a crucial institutional lever: by reallocating authority, resources, and policies, it fundamentally influences factor mobility and the spatial configuration of agglomeration. While separate strands of research have examined how either population or economic agglomeration affects innovation or productivity (Ahrend et al., 2017; Wang and Wang, 2021; Cai et al., 2023), they have not integrated administrative rank, dual agglomeration, and regional innovation

within a unified analytical framework. This paper addresses this gap by proposing that administrative upgrading promotes regional innovation through two mediating channels—population agglomeration and economic agglomeration—thereby extending the institutional dimension of agglomeration economics and refining its mechanistic narrative.

3.1 Population agglomeration mechanism

The concentration of population in cities with higher administrative ranks is an objective outcome of resource-skewed allocation and institutional incentives. Administrative upgrading intensifies this agglomeration through three channels. First, the center-biased allocation of resources grants high-ranking cities privileged access to central fiscal transfers, flagship projects, and policy preferences, thereby generating abundant jobs and career opportunities. Second, these cities typically provide superior public services, infrastructure, and living environments, thereby enhancing their amenity value and attractiveness to migrants (Wang and Yeh, 2020). Third, once an initial stock of human capital is established, a cumulative circular process is initiated: highly skilled individuals tend to migrate to areas where the concentration of human capital is already high (Jia and Liu, 2020). Population agglomeration is therefore more than a mere expansion of the labor force; it fosters innovation through the three micro-mechanisms identified by agglomeration economics—sharing, matching, and learning (Duranton and Puga, 2004). First, sharing (Marshall, 1890). A large population sustains a robust market for specialized labor and intermediate business services. Firms share infrastructure, specialized inputs, and a heterogeneous labor pool, thereby increasing the efficiency of factor allocation (Rosenthal and Strange, 2001). Second, matching. High density improves the quality of matches between employers and employees, as well as between firms and their collaborators, reducing search costs and contractual uncertainty. This effect is especially valuable for highly specialized workers—such as research scientists—and for innovative enterprises (Coles and Smith, 1998; Finney and Kohlhase, 2008). Third, learning. Spatial proximity accelerates the diffusion and recombination of tacit knowledge. Face-to-face interaction sparks new ideas and novel combinations, particularly benefiting innovation-intensive industries (Glaeser, 1999). Finally, a diversified consumer base drives firms toward product and process innovation, creating demand-side incentives for inventive activity.

3.2 Economic agglomeration mechanism

Administrative upgrading also significantly accelerates economic agglomeration. High-ranking cities employ policy tools—such as tax holidays, industrial subsidies, and preferential land allocations—to attract investment, creating a "resource sink" or backwash effect (Chen and Partridge, 2013). At the same time, institutional advantages promote the development of high-end services and advanced manufacturing, enhancing industrial sophistication and clustering (Feldman and Florida, 1994), thereby intensifying the spatial concentration of economic activity. This agglomeration stimulates regional innovation through three channels. Firstly, industrial clustering and localization Economies. In the new economic geography framework (Krugman, 1991), agglomeration attracts related industries to the same location, fostering localized knowledge spillover networks and innovation communities. Firms share industry-specific expertise, technical facilities, and innovation resources, creating an "innovation milieu" (Malmberg, 1996). Specialized regions enhance the division of knowledge labor and increase innovation efficiency. Second, enhanced regional resilience. Highly agglomerated economies reallocate resources and adapt more quickly, exhibiting greater stability when impacted by external shocks such as economic volatility or technological disruption (Martin and Sunley, 2020). This resilience provides a stable environment for innovation and reduces systemic risk in the innovation process. Third, enhanced integration and openness. Economic concentration is typically accompanied by increased openness and inter-regional coordination, which reduces market fragmentation and attracts foreign capital, advanced technologies, and managerial expertise (Jaffe et al., 1993). Regional integration facilitates the movement of innovation factors across boundaries, aligns upstream and downstream segments of value chains, and achieves scale effects, thereby enhancing overall innovation performance (Agarwal et al., 2012).

Therefore, this paper proposes the following:

> *H1:* The enhancement of administrative rank may facilitate the advancement of regional innovation development.
>
> *H2*: The enhancement of administrative rank can facilitate the advancement of regional innovation development through the mechanism of population agglomeration.
>
> *H3:* The enhancement of administrative rank can facilitate the advancement of regional innovation development through the mechanism of economic agglomeration.

4 Historical background

In the mid-1990s, as China's reform and opening entered a deeper phase, the central Party and the State Council decided to establish Chongqing as a municipality directly under the central government (hereafter referred to as "municipality") to address Sichuan Province's chronic challenges—excessive population, vast territory, and overlapping administrative tiers that hindered management and development efficiency—and to support the national strategy of balanced regional growth. This upgrade aimed to create, through institutional innovation in an upper-Yangtze metropolis, a stronger growth pole for the lower Yangtze River Economic Belt, to pioneer a "big-city-leads-big-countryside" development model, and to provide robust organizational and resettlement support for the Three Gorges Project. A municipality is a province-level administrative unit reporting directly to the central government and carries exceptional political and economic significance. Echoing the 1960s "Third Front" strategic relocation of industry inland for national defense purposes, Chongqing's elevation again reflected top-level planning designed to reshape the spatial layout of productive forces and governance. It symbolized the shift from a coast-first development era to one of coordinated coast-interior growth.

To implement this strategic decision, Chongqing undertook a comprehensive restructuring of its administrative divisions between 1992 and 2010. This process can be divided into three stages. Stage 1: Prefecture-City Consolidation and Preparatory Period (1992–1996). Adjustments focused on clarifying the administrative relationship between Sichuan Province and Chongqing City. In 1992, Chongqing governed nine urban districts and three counties. By 1994, the counties of Ba and Jiangbei were converted into districts, the boundaries of the original core districts were redrawn, and the number of urban districts increased to eleven. Meanwhile, Sichuan transferred the county-level cities of Yongchuan, Hechuan, and Jiangjin, as well as the counties of Changshou and Bishan, to Chongqing's jurisdiction, laying the groundwork for the forthcoming reorganization. Stage 2: Founding of the Municipality and Initial Framework (1997–1999). In 1997, the Fifth Session of the Eighth National People's Congress approved the creation of Chongqing Municipality, marking a fundamental break with the past. The new municipality merged the former Chongqing City, Wanxian City, Fuling City, and Qianjiang Prefecture, resulting in a sprawling administrative structure comprising 43 county-level units: 11 urban districts, 6 county-level cities, 22 counties, and 4 autonomous counties. This change marked the end of the "big-city-leads-big-countryside" pilot model and the beginning of direct central governance. Stage 3: Post-upgrade Optimization and Integration (2000–2010). To expand metropolitan development space, streamline administrative layers, and enhance governance efficiency, Chongqing initiated a new round of reforms, including the "abolish city/county to district" and "abolish district, merge township to town" policies. Key measures included the revocation of Wansheng and Shuangqiao districts in 2000, the conversion of Changshou County into Changshou District in 2001, and, in 2006, the simultaneous transformation of the county-level cities Jiangjin, Hechuan, Yongchuan, and Nanchuan into urban districts. As a result, the number of urban districts increased significantly, the metropolitan core's radius and carrying capacity expanded markedly, and a modern administrative system aligned with that of a central-government municipality was established.

In summary, through these three stages, Chongqin's county-level map evolved from 9 districts and 3 counties in 1992 to 19 districts and 21 counties (including autonomous counties) by 2010. This sequence of exogenous changes provides a quasi-natural experiment that identifies the impact of administrative rank promotion on regional innovation.

5 Research design

5.1 Model specification

Following Redding and Sturm (2008), this paper employs a difference-in-differences (DID) design that compares innovation performance on either side of the Chongqing-Sichuan border. The DID estimator identifies the causal effect by contrasting the before-and-after changes in the outcome variable in the treated group with the corresponding changes in the control group. The regression model is specified as shown in Equation 1:

$$\ln patent_{it} = \beta_0 + \beta_1 did_{it} + \delta control_{it} + \pi_i + \theta_t + \varepsilon_{it} \quad (1)$$

In this study, the variables i and t denote the country and year, respectively, while $lnpatent_{it}$ serves as the dependent variable, reflecting regional innovative development. This variable is specifically quantified by the logarithm of the number of domestic invention patent authorizations at the county level. The coefficient β_0 signifies the effect of administrative level upgrades on regional innovation, which constitutes the primary focus of this research. The explanatory variable did_{it} is a dummy variable indicating Chongqing's elevation to a municipality; specifically, for countries within Chongqing Municipality from 1997 onwards, $did_{it} = 1$; otherwise, it is 0. A significantly positive β_1 would suggest that the upgrade in administrative level has fostered regional innovative development, a hypothesis that has been substantiated. The term π_i represents the country fixed effect, θ_t denotes the time fixed effect, and ε_{it} indicates the random error term.

Chongqing's elevation to municipality status in 1997 provides a clear quasi-natural experiment (Jia et al., 2021). Prior to this upgrade, Chongqing and the adjacent regions of Sichuan were economically and socially similar, allowing the latter to serve as a credible control group. This setup helps isolate the effect of the reform from other confounding factors. Difference-in-differences (DID) mitigates potential endogeneity through two primary mechanisms: First, mitigating omitted variable bias. Regional innovation is influenced by numerous observable and unobservable factors. If unobservable factors are correlated with the likelihood of being upgraded, the estimates will be biased. Difference-in-differences (DID) methodology eliminates all time-invariant county-specific unobservables through county fixed effects and accounts for common temporal shocks via year fixed effects. Provided that the treated and control counties would have followed parallel trends in the absence of the reform (the parallel-trends assumption), any differential change observed after 1997 can be attributed to the administrative upgrade rather than to pre-existing differences. Second, mitigating reverse causality. Reverse causality would occur if counties with higher levels of innovation were more likely to be upgraded. Our design mitigates this concern. Administrative reorganization in China is a top-down decision driven by national strategy, geography, history, and other macro-level considerations, rather than by a county's current economic or innovation performance. Therefore, the upgrade can be considered plausibly exogenous at the county level. The difference-in-differences (DID) approach compares the before-and-after changes in innovation between treated and control counties, thereby identifying the causal effect of the administrative upgrade rather than a mere correlation.

5.2 Data and sources

The explanatory variable is the DID estimator did_{it}. It equals 1 for all counties located in Chongqing from 1997 onward (the year the city became a municipality) and 0 otherwise.

The dependent variable, $Patent_{it,}$ measures regional innovation and is defined as the natural logarithm of the number of domestic invention patents granted in county i during year t. In robustness checks, we replace it with the logarithm of (i) domestic invention patent applications and (ii) domestic utility model applications. All patent data are sourced from the China Research Data Services Platform (CNRDS), which cleans and standardizes the raw records from the China National Intellectual Property Administration. It also provides geocoded applicant addresses, enabling us to construct accurate county-level patent counts.

TABLE 1 Variable definitions and descriptive statistical.

Varname	Definition	Obs	Mean	Sd	Min	Max
lnpatent	The logarithm of the number of authorized invention patents	4,161	0.308	0.823	0	6.519
lnpatent1	The logarithm of the number of accepted invention patent applications	4,161	0.4589	1.013	0	6.877
lnpatent2	The logarithm of the number of accepted utility model patent applications	4,161	0.699	1.253	0	7.019
lnpop	The logarithm of the population	4,161	12.797	1.024	9.616	14.876
lngdp	The logarithm of the GDP	4,161	12.034	1.421	7.571	15.590
wdegree	The average annual temperature	4,161	13.072	6.110	−7.381	20.618
idls	Topographic roughness	4,161	1.875	1.792	0.256	5.974
light	Nighttime light data	4,161	2.967	7.981	0	61.016
ssgdp	The proportion of secondary industry in GDP	4,161	0.377	0.201	0.011	6.402
lnzhidis	The logarithm of the distance from the administrative centroid of each county to the Sichuan–Chongqing provincial boundary	4,161	11.670	1.055	9.028	13.550

$Controls_{it}$ represents the control variables. This study includes a total of five distinct control variables. ① The average annual temperature data (*wdegree*), which is sourced from the ERA5-Land dataset, published by organizations such as the European Union and the European Centre for Medium-Range Weather Forecasts. Temperature serves as a macroscopic indicator of the average kinetic energy of air molecules and facilitates the transfer of internal energy through various mechanism, including conduction, convection, phase changes in water and radiation. The ambient temperature significantly influences human production activities, with both high and low temperatures exerting varying effects on research and development (R&D) activities. ② Topographic roughness (*idls*). which is defined as a comprehensive representation of the altitude and degree of surface alteration within a given region. This study adopts the definition of topographic roughness as delineated in the context of urban and rural environmental evaluations in China, as referenced by Feng et al. (2007). This variable accounts for the lag effect associated with increased enterprise investment, which is influenced by the location principle of "mountain reliance, dispersion, and concealment" during the "Third Front Construction" period (Wang and Ren, 2022). ③ Nighttime light data (*light*), which is derived from a corrected dataset complied by Wu et al. (2021) through the integrating of DMSP-OLS and NPP-VIIRS data. Nighttime light data are frequently employed as proxies for economic activity, and as a control variable, they help mitigate the impact of innovation development attributable to fluctuations in economic activities. ④ The proportion of secondary industry in GDP (*ssgdp*), which serves as in indicator of the level of industrial development within a region. Given the robust industrial foundation characteristic of the Sichuan–Chongqing region, controlling for industrial structure is essential to account for the influence of high industrial development on innovative activities. ⑤ The distance from the administrative centroid of each county to the Sichuan–Chongqing provincial boundary (*zhidis*). The data for this variable were obtained by the author using ArcGIS software. Controlling for this variable is crucial to address the spatial spillover effects associated with the border area.

In addition, this paper uses the logarithm of the population and gross domestic product (GDP) of a county as proxy variables for population agglomeration and economic agglomeration mechanisms. The data come from the annual "Sichuan Statistical Yearbook" and "Chongqing Statistical Yearbook." Considering that the introduction of the Chengdu–Chongqing economic zone regional plan in 2011 interfered with the administrative division policy of this study, and on the basis of the availability of materials published in the county-level statistical yearbook, 219 counties in Sichuan and Chongqing from 1992--2010 were ultimately selected as the research subjects. The Enyang District and Qianfeng District, which have severe missing data, are excluded, and other missing data of counties are supplemented by the linear interpolation method. Variable definitions and descriptive statistical results are shown in Table 1.

6 Results and analysis

6.1 DID regression results

Table 2 presents the baseline regression results derived from the difference-in-differences methodology employed in this study. In column (1), only the fixed effects of time and county are included. The results indicate that the elevation of administrative rank exerts a significant positive effect on the number of domestic invention patent authorizations, with an impact coefficient of 0.5159 and a significance level of 1%. In column (2), both the fixed effects of time and county, along with five control variables, are incorporated. The findings reveal that the elevation of administrative rank continues to exert a positive influence on the number of domestic invention patent authorizations at a 1% significance level, with an impact coefficient of 0.403. This suggests that the elevation of Chongqing's administrative rank has a substantial positive effect on the region's innovation development, thereby providing preliminary support for the validity of Hypothesis 1. The introduction of control variables results in a lower regression coefficient compared to the model without these variables, indicating that factors such as climate conditions, terrain characteristics,

TABLE 2 Basic regression results.

	(1)	(2)
lnpatent	0.5159*** (0.0492)	0.4030*** (0.1021)
wdegree	-	−0.0230** (0.0024)
idls	-	0.0286** (0.0091)
light	-	0.145*** (0.0032)
ssgdp	-	−0.0104* (0.0491)
zhidis	-	0.0309* (0.0476)
Year fe	Y	Y
Id fe	Y	Y
N	4,161	4,161
Adj. R^2	0.5857	0.7296

The numbers in parentheses are standard errors; ***, **, and * indicate that the variable is significant at the 1, 5, and 10% significance levels, respectively.

economic activities, industrial structure, and spatial spillover effects significantly influence innovation development. This study accounts for these factors to more effectively mitigate the impact of confounding variables on the fundamental regression results.

6.2 Spatiotemporal heterogeneity test

6.2.1 Temporal heterogeneity test

The validity of Difference-in-Differences (DID) estimates depends on the parallel-trends assumption: before the exogenous shock, the treatment and control counties must follow the same trajectory. If their pre-treatment trends differ, the DID estimate no longer accurately captures the policy's net effect, resulting in biased regression results. We therefore conduct an event-study analysis. Figure 1 plots the temporal heterogeneity: each point represents the estimated coefficient (with a 95% confidence interval) on the interaction between the Chongqing dummy variable and year indicators, using the year immediately preceding the upgrade as the reference. The graph was generated using Stata's reghdfe command and visualized with coefplot, illustrating how invention-patent grants in the treated counties evolved relative to the control group both before and after 1997. It can be observed that, first, prior to Chongqing's elevation to a centrally administered municipality, there were no significant differences in regional innovation between the treatment and control groups, thereby satisfying the assumption of parallel trends. Second, one year after Chongqing's elevation to municipal status, there remained no significant differences in regional innovation between the treatment and control groups. This indicates that the policy of upgrading Chongqing to a municipality had a one-year lagged effect on regional innovation. This suggests that it takes time for the government to formulate and implement relevant policies following the administrative upgrade, and enterprises also require time to adapt to the new policy environment and adjust their innovation strategies. Third, overall, as time progresses, the relationship between the establishment of Chongqing Municipality and the number of invention patent grants exhibits a pattern of initially decreasing and then increasing, reaching its lowest point in the fourth year following its establishment. This suggests that during the initial phase of the administrative transition—whether concerning the administrative system, policy framework, or economic structure—time is required for adjustment and adaptation. Enterprises and research institutions must also align with the new policies, which may result in a temporary stagnation of innovation activities. Subsequently, as the innovation environment gradually improves, innovation activities are restored and accumulate over time. The results indicate that not only does the Difference-in-Differences (DID) model of administrative rank upgrades on regional innovation satisfy the temporal stability assumption, but it also confirms the significant temporal heterogeneity of its innovation effects.

6.2.2 Spatial heterogeneity test

Following Cao (2020), we include the distance from the upgraded counties in Equation 1 to test for spatial heterogeneity. Figure 2 illustrates the resulting spatial heterogeneity effects, demonstrating how the impact of the administrative upgrade policy on regional innovation varies with geographic distance. Specifically, we first obtain the latitude and longitude coordinates of each county seat in Sichuan and Chongqing using the Baidu coordinate-picker tool. Using ArcGIS, we then calculate the point-to-line distance (zhongdis) from each county seat to the Sichuan-Chongqing border. We divide this distance into 30-km intervals (0–30, 30–60, 60–90, 90–120, and 120–150 km) and interact each interval dummy variable with the DID treatment indicator, did_{it}. These interaction terms are incorporated into Equation 1 and estimated using Stata. The resulting coefficients are plotted to evaluate how the policy effect varies across distance bands, with statistical significance indicating the presence or absence of spatial heterogeneity. As shown in Figure 2, the coefficient on the interaction term exhibits an inverted-U pattern: it becomes significant at 30 km, peaks at 60 km, declines steadily between 60 and 120 km, and is essentially zero beyond 120 km. This finding confirms that the innovation impact of administrative upgrading initially increases and then decreases with distance from the provincial border, consistent with agglomeration economy theory and evidence of pronounced spatial heterogeneity.

6.3 Robustness test

This study conducts robustness tests using five distinct methodologies, with the results primarily presented in Table 3.

Method 1. Alternative Innovation Indicators. To rule out measurement error in the dependent variable, we replace the baseline proxy with two alternative indicators. Column (1) uses the logarithm of domestic invention-patent applications, while column (2) uses the logarithm of domestic utility-model applications. Both coefficients remain positive and significant at the 1% level, confirming that the upgrade effect is not an artifact of a specific patent indicator.

Method 2. Optimal Bandwidth DID. Poor overlap between treated and control counties can bias difference-in-differences (DID) estimates. Therefore, we re-estimate the model using a 50-kilometer bandwidth on each side of the Sichuan-Chongqing border, which is the optimal distance selected by the mean squared error (MSE) minimization procedure of Calonico et al. (2014). This bandwidth balances variance (too narrow results in few observations) and bias

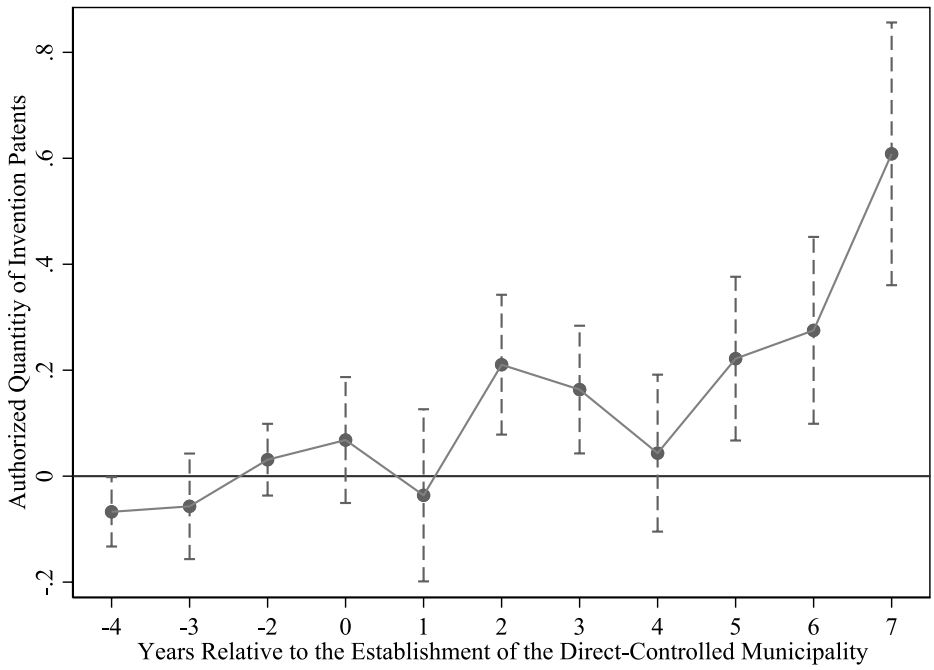

FIGURE 1
Temporal heterogeneity of the effects of administrative level improvement policies.

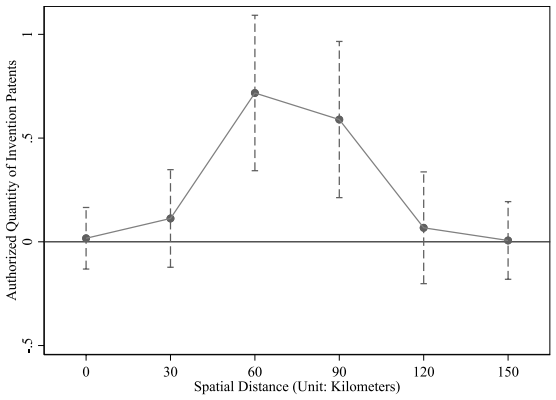

FIGURE 2
Spatial heterogeneity of the policy effect of administrative hierarchy promotion.

(too wide includes dissimilar units). Restricting the sample to counties within 50 kilometers maximizes comparability in geography, initial income, and culture, approximating a local randomized experiment. Column (3) shows that the coefficient remains highly significant, indicating that the baseline finding is not driven by distant, incomparable counties.

Method 3. Dropping Western Sichuan. The four prefectures in Western Sichuan (Panzhihua, Aba, Ganzi, and Liangshan) are located on the Tibetan Plateau and form part of the Tibetan-Yi cultural corridor, distinguishing them significantly from the Sichuan-Chongqing heartland. Excluding these counties eliminates potential geographic and cultural heterogeneity that could confound the analysis. Column (4) reports a consistent and significant coefficient, demonstrating that our results are robust to changes in sample composition.

Method 4. PSM-DID: Correcting Sample Selection Bias. Although the upgrade was a top-down decision, minor selection bias may still persist. We combine Propensity Score Matching with Difference-in-Differences (PSM-DID), following Bai et al. (2022). Night-time light intensity (a proxy for economic size) and the share of secondary industry in GDP (a proxy for industrial structure) are used as matching covariates-both highly relevant for the industrialized Sichuan-Chongqing region. Cross-sectional PSM: Nearest-neighbor matching within the common support region is applied once to the full panel; counties outside the common support are excluded. Year-by-year PSM: Separate matching is performed for each year, and the matched panels are then stacked. Columns (5) and (6) present the DID estimates based on the matched samples. The coefficients and significance levels are nearly identical to the baseline results, indicating that self-selection does not drive the findings.

Method 5. Bootstrap. To verify that the standard errors are not sensitive to sampling variation, we conducted 1,000 bootstrap replications. Result shows that the bootstrap standard error of the core DID term is 0.1242, which is very close to the cluster-robust standard error reported in the baseline model (0.1021). The 95% percentile-based confidence interval is [0.173, 0.655], excluding zero and remaining significant at the 1% level. Thus, the inference that "Chongqing's elevation significantly boosts regional innovation" is highly robust to resampling variability, further reinforcing our main conclusion.

6.4 Placebo test

To mitigate the impact of systematic differences on the results, this study employs the methodology outlined by Cao (2020) and conducts

TABLE 3 Robustness test results.

	Method 1		Method 2	Method 3	Method 4	
	(1)	(2)	(3)	(4)	(5)	(6)
	Accepted invention patent applications	Accepted utility model patent applications	Narrow the bandwidth window	Delete the Western Sichuan region	Section PSM	PSM year by year
did	0.4935*** (0.0480)	0.4357*** (0.0546)	0.2730*** (0.079)	0.3990*** (0.0451)	0.4079*** (0.0400)	0.4000*** (0.0397)
wdegree	−0.0251** (0.0297)	−0.0425* (0.0332)	−0.0192* (0.0231)	0.0438* (0.0665)	0.0438* (0.0665)	0.0233* (0.0046)
idls	0.0182** (0.0014)	0.0115* (0.0245)	0.0106* (0.0219)	0.0158* (0.0299)	0.0158* (0.0299)	0.0121* (0.0252)
light	0.1491*** (0.0042)	0.1387*** (0.0047)	0.1371*** (0.0033)	0.1445*** (0.0043)	0.1445*** (0.0043)	0.1458*** (0.0032)
ssgdp	0.0224* (0.0591)	0.0334* (0.0672)	0.0042* (0.0484)	0.0042* (0.0584)	0.0042* (0.0584)	−0.2234* (0.0963)
zhidis	0.0248* (0.0413)	0.0221* (0.0375)	0.0190* (0.0276)	0.0362* (0.0201)	0.0362* (0.0201)	0.0265* (0.0296)
Year fe	Y	Y	Y	Y	Y	Y
Id fe	Y	Y	Y	Y	Y	Y
N	4,161	4,161	817	3,154	4,143	4,034
Adj. R^2	0.7418	0.7812	0.7110	0.7379	0.7302	0.7307

The numbers in parentheses are standard errors; ***, **, and * indicate that the variable is significant at the 1, 5, and 10% significance levels, respectively.

a placebo test by randomizing the treatment and control groups (see Figure 3). The cities originally classified in the treatment group that have been upgraded to municipalities are designated as the new control group, while maintaining the original establishment date of the municipality. If n cities are designated as municipalities in year t, then n cities are randomly selected from those that have not established municipalities from that year backward in time to form the new treatment group. Subsequently, a new sample is utilized to re-estimate the results presented in column (2) of Table 1, thereby completing one iteration of the randomization process for the placebo test. By repeating this procedure 1,000 times, it is possible to derive 1,000 coefficient estimates. The estimation results indicate that the average value of the variable coefficient is negative and significantly smaller than the 0.4030 estimated in column (2) of Table 1, suggesting that the policy of upgrading administrative levels within administrative divisions exhibits a distinct geographical orientation. As illustrated in regression result graph 3, the regression coefficients of the model are distributed approximately around zero, indicating that the random sampling of 1,000 sample combinations does not affect the promotion effect of regional innovation. Consequently, the findings from the baseline regression, which differentiates between the experimental and control groups based on administrative divisions, are deemed robust.

6.5 Mechanism analysis

This paper, building upon the research conducted by Jiang (2022), employs a two-step methodology to assess the effectiveness of the relevant mechanisms. The previous analysis has established the significant influence of administrative rank elevation on regional innovation development, while the theoretical hypothesis section has thoroughly discussed the effects of population agglomeration and economic agglomeration on regional innovation. Consequently, it is essential to examine the impacts of administrative rank elevation on both population agglomeration and economic agglomeration to substantiate the effectiveness of these mechanisms. In this study, the dependent variable in the foundational regression model (1) is substituted with variables representing the intermediary mechanisms of population agglomeration and economic agglomeration, while all other variables remain constant. Subsequently, regression Equations (2) and (3) are formulated to evaluate these two mechanisms individually.

$$\ln pop_{it} = \beta_0 + \beta_1 did_{it} + \delta control_{it} + \pi_i + \theta_t + \varepsilon_{it} \quad (2)$$

$$\ln gdp_{it} = \beta_0 + \beta_1 did_{it} + \delta control_{it} + \pi_i + \theta_t + \varepsilon_{it} \quad (3)$$

As indicated by the mechanism regression results in Table 4, under the dual fixed effects of time and space, and after introducing five control variables—average annual temperature, terrain ruggedness, nighttime light data, the proportion of the secondary industry, and the distance from county centers to the Sichuan-Chongqing boundary—both population agglomeration and economic agglomeration exhibit positive estimates and pass the significance test at the 1% level. This confirms the validity of Hypotheses 2 and 3, demonstrating that the administrative rank upgrade of Chongqing has leveraged the effects of population and economic

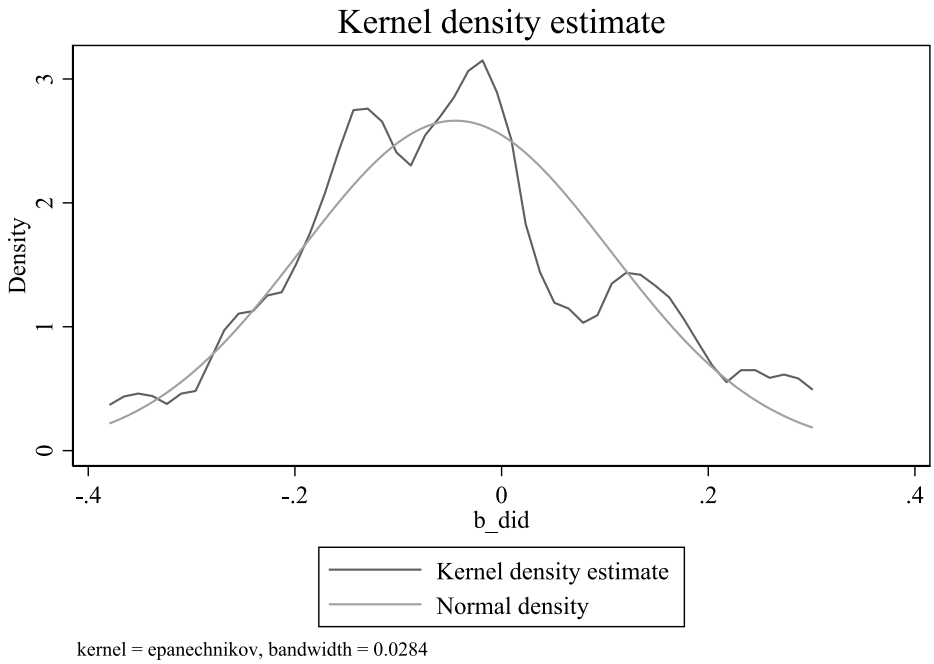

FIGURE 3
Distribution of regression coefficients from 1,000 placebo tests on the randomized treatment and control groups.

agglomeration to drive regional innovative development. The significant population agglomeration effect indicates that following the upgrade in administrative rank, Chongqing, as a centrally administered municipality, has attracted a greater influx of people, particularly high-quality and innovative talent. This influx has facilitated the exchange and sharing of knowledge, technology, and experience, thereby propelling regional innovative development. Additionally, the notable economic agglomeration effect suggests that after the administrative rank upgrade, economic activities in Chongqing have become more concentrated, generating economies of scale and agglomeration benefits. This concentration has provided increased funding, technology, and market opportunities for regional innovation, fostering both competition and cooperation among enterprises, and thus driving regional innovation. Overall, the upgrade in administrative rank has resulted in population and economic agglomeration through various channels, including advantages in resource allocation, policy preferences, infrastructure development, and strategic positioning of cities. To some extent, it has lowered the institutional transaction costs associated with entrepreneurial activities and removed institutional barriers that hinder regional innovation capacity. The mechanism analysis demonstrates that upgrading to a higher administrative level promotes regional innovation primarily through two channels: population agglomeration and economic agglomeration. This finding confirms the central role of Jacobs externalities-knowledge spillovers arising from diversified agglomeration-in driving innovative activity (Glaeser et al., 1992).

TABLE 4 Mechanism test results.

	Population agglomeration	Economic agglomeration
	(1)	(2)
did	0.0252***	0.1818***
	(0.0093)	(0.0210)
wdegree	−0.0025**	−0.0073*
	(0.0067)	(0.0133)
idls	0.0197**	0.0037*
	(0.0023)	(0.0541)
light	0.0179***	0.0089***
	(0.0014)	(0.0029)
ssgdp	0.0064*	−0.1860*
	(0.0115)	(0.0262)
zhidis	0.0225*	0.0402*
	(0.0013)	(0.0290)
Year fe	Y	Y
Id fe	Y	Y
N	4,161	4,161
Adj. R^2	0.9905	0.9744

The numbers in parentheses are standard errors; ***, **, and * indicate that the variable is significant at the 1, 5, and 10% significance levels, respectively.

7 Conclusions and recommendations

Drawing on a 1992–2010 panel dataset of 219 counties in Sichuan Province and Chongqing, this paper estimates the impact of Chongqing's upgrade to a municipality on innovation using a difference-in-differences design. Four main findings emerge. (1) Administrative upgrading significantly accelerates regional innovation. The result aligns with Bai et al. (2022), who evaluated innovation-city policies; however, we provide new evidence based on a change in administrative rank, thereby enriching the literature on institutional drivers of innovation. (2) The effect is delayed and follows

a U-shaped temporal pattern. Innovation responds only after a one-year lag, initially exhibiting a dip followed by a rebound. This finding corroborates Cao (2020) evidence of policy-delayed effects, while also revealing a more complex, nonlinear dynamic as new institutions become established and structures adjust. (3) Spatial spillovers are significant but limited by distance. The impact peaks at approximately 60 km and diminishes to insignificance beyond 120 km, forming an inverted-U pattern. This outcome aligns with the standard proposition that knowledge externalities decay with distance (Glaeser et al., 1992) and provides evidence from China on how administrative resource allocation influences the geography of innovation. (4) Agglomeration serves as the mediating channel. Mechanism tests indicate that the policy functions through both population agglomeration and economic agglomeration, highlighting the significance of Jacobs externalities in the context of China.

Although the conclusions of this study are based on a Chinese case, the core mechanism it reveals "political status elevation — resource reallocation — factor agglomeration — innovation development a certain degree of theoretical universality. Its applicability and specific manifestations, however, vary according to different national governance structures. First, the findings of this study are most relevant to economies with strong traditions of centralization or characteristics of a "developmental state, such as France, South Korea, and Vietnam. France's "Competitiveness Clusters" policy exemplifies the central government's top-down approach of selecting specific regions and providing them with special policy and fiscal resources, thereby artificially "catalyzing" innovation agglomeration (Brossard and Moussa, 2014). This approach closely aligns with the rationale behind Chongqing's post-elevation access to national resource allocation. Although the mechanisms differ (policy designation versus administrative elevation), the core principle remains the same: the state directs the spatial flow of high-end factors by creating an "institutional potential difference." The case of Sejong City in South Korea illustrates the complexity of state-led agglomeration mechanisms and their impacts. While it successfully achieved the "physical agglomeration" of population and sectors (Kang et al., 2024), it has limitations in fostering endogenous "chemical integration" and economic growth (Jung, 2024). This contrast underscores the potential advantages of the "administrative elevation" model observed in the Chongqing case, which may be more systematic and synergistic. As the country with the institutional background most similar to China, Vietnam's centrally administered municipalities—Hanoi and Ho Chi Minh City—enjoy significantly greater advantages in fiscal resources, administrative authority, and development policies compared to other provinces. This observation confirms the strong correlation between higher administrative status, greater resource agglomeration capacity, and enhanced innovation performance in transitional economies. Second, in federal and market-oriented countries such as the United States and Germany, direct "administrative level elevation" is neither practical nor conventional. However, the core insight of this study—"guiding factor agglomeration through privileged resource injection albeit in different forms. These countries tend to adopt "functional" elevation. For example, the United States locates national laboratories, regional headquarters of federal agencies, or major research projects (such as Silicon Valley with defense contracts, and Houston with NASA) in specific cities, granting them significant "functional privileges" without altering their administrative status. This similarly creates an "institutional potential difference" that attracts top talent and venture capital, thereby fostering innovation. In summary, the universality of the mechanism explored in this study lies in its economic core: any measure that significantly alters a region's resource endowment and institutional environment can influence innovation through agglomeration economies. Its specificity lies in the political-administrative tools used to effect this change. In unitary states like China, adjustments to administrative levels serve as particularly powerful instruments, whereas in federal states, "functional" methods such as legislative authorization and project allocation are more commonly employed.

Based on the findings above, we propose the following policy recommendations:

1. Support administrative upgrades with dedicated funding and follow-up policies. The central and local governments should establish a "Regional Innovation Development Fund" immediately upon the upgrade of a jurisdiction, allocating no less than 3% of the annual fiscal expenditure to public R&D focused on basic research and generic technologies. To maximize spatial spillovers, a "Cross-border Innovation Corridor" should be planned within 60–120 km of the new boundary, utilizing tax-sharing and enclave-economy arrangements to extend benefits to neighboring counties.
2. Integrate Economic Agglomeration and Innovation Policies. Transform the upgraded city into an Integration Pilot Zone that unites high-tech companies, universities, and research institutes within innovation consortia. Double the R&D super-deduction for firms located in the zone, standardize regional technology markets, talent certification standards, and technology commercialization regulations, and eliminate administrative barriers to enable the free flow of innovation resources.
3. Launch an "Innovative Talent Agglomeration Program." Ease hukou restrictions in the upgraded city, develop high-end talent apartments, guarantee placements in quality schools, and introduce a "talent-innovation contribution points" system that directly links personal R&D output to housing subsidies and professional advancement. Encourage the establishment of joint postdoctoral workstations and training bases between enterprises and universities to transform the "demographic dividend" into a "talent dividend."
4. Develop a "Population–Economy–Innovation" Monitoring and Evaluation System. The NDRC and the Ministry of Science and Technology should develop a Regional Innovation Coordination Index that regularly evaluates the alignment among population structure, industrial structure, and innovation vitality in each region. Industry and talent policy frameworks should be dynamically adjusted based on these evaluations to prevent resource misallocation and reduce low-level competition. Additionally, an inter-provincial information-sharing platform for innovation resources should be established to enhance allocation efficiency.

In summary, this paper presents new empirical evidence on how administrative rank influences regional innovation and offers practical policy recommendations to support China's efforts to become an innovative nation and promote balanced regional development.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Author contributions

LW: Formal analysis, Visualization, Data curation, Software, Writing – original draft, Writing – review & editing. BZ: Supervision, Conceptualization, Writing – review & editing, Methodology.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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