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Research article

Analysis of the impact of healthy real estate development on urban economic resilience—A study based on mediating and spillover effects

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Abstract: Against the backdrop of rising uncertainties in both the international and domestic economic landscapes, the construction of a resilient urban economic structure has become crucial for addressing complex risks. As a vital component of the urban economy, the real estate industry plays an irreplaceable role in improving urban economic resilience. Based on panel data from 278 Chinese cities at the prefecture level and above from 2012 to 2021, this paper systematically examines the impact mechanism and spatial spillover effects of healthy real estate development on urban economic resilience by constructing a spatial Durbin model (SDM) and a mediation effect analysis framework. The results indicate that healthy real estate development significantly enhances urban economic resilience, with notable regional heterogeneity. The direct pathway strengthens a city's risk resistance by optimizing resource allocation and stabilizing investment expectations, while the indirect pathway improves resilience by promoting urban infrastructure construction and fostering innovation and entrepreneurship activities. Further analysis reveals significant positive spatial spillover effects, implying that healthy real estate development not only boosts local economic resilience but also contributes to that of neighboring cities. Based on these findings, this paper proposes policy recommendations from four aspects: optimizing real estate market regulation, deepening regional coordinated development, improving infrastructure, and enhancing innovation and entrepreneurship

vitality. These suggestions provide theoretical support and practical guidance for achieving synergistic progress between a healthy real estate market and urban economic resilience.

Keywords: healthy real estate development; urban economic resilience; mediating effect; spillover effect; regional heterogeneity

JEL Codes: R31, R11, O18

1. Introduction

In recent years, global economic uncertainty has intensified, and major shocks like the COVID-19 pandemic have highlighted the importance of enhancing economic resilience (Chen et al., 2023; Liu et al., 2024; Wu, 2024). As the world's second-largest economy, China is in a critical stage of high-quality development transformation, with building "resilient cities" as a strategic direction to strengthen cities' ability to cope with emergencies and long-term pressures. Against this backdrop, the real estate industry, deeply embedded in economic, financial, and social systems, has become a key variable affecting urban resilience (Tan, 2016). It meets residents' basic housing needs and has an investment attribute; since 2013, housing assets have accounted for about 70% of Chinese households' total assets, far above the international level. Meanwhile, driven by public land ownership and local governments' "GDP tournament", the "land finance" model has closely bound real estate with local finance, debt, and economic growth (Sun et al., 2023; Sun et al., 2024).

The real estate industry has a high correlation, a long industrial chain, and strong driving effects, contributing significantly to macroeconomic growth for a long time. However, its location fixity has led to severe regional market differentiation and prominent structural contradictions. Coupled with the tendency of excessive financialization, real estate not only provides wealth storage functions but also accumulates systemic risks (Doran and Fingleton, 2018). Since 2020, liquidity crises of some real estate enterprises have exposed the threat of industry imbalance to financial stability and urban economic security. Since the 18th National Congress of the Communist Party of China, the per capita housing area in urban China has exceeded 40 square meters, with an average of more than 1.1 housing units per household. The market has generally shifted from incremental expansion to stock quality improvement and efficiency enhancement, and the supply-demand relationship has undergone fundamental changes. Promoting the real estate industry to return to its residential nature and achieve "healthy development" has become the core requirement of the new stage (Li et al., 2021).

The so-called healthy development not only refers to stable prices but also emphasizes systematic coordination between ensuring people's livelihood, preventing and controlling risks, supporting fiscal sustainability, and promoting social equity. In this context, in-depth exploration of how the healthy development of real estate affects urban economic resilience helps clarify its mechanism in enhancing cities' shock resistance, stabilizing expectations, and stimulating endogenous motivation. Based on China's institutional context and market characteristics, this study analyzes the impact path of the healthy operation of real estate on urban economic resilience, aiming to provide theoretical support

and policy reference for improving the long-term mechanism and promoting the coordinated development of real estate and urban high-quality development.

2. Literature review

Existing studies' understanding of the healthy development of real estate is mainly based on its dual attributes of consumption and investment. One strand focuses on the residential function of housing, emphasizing resource allocation efficiency, supply structure, and residential affordability, with a core focus on residential security and people's well-being (Zhou, 2025). The other strand focuses on its asset attribute, drawing on financial asset pricing ideas to judge market stability by whether housing prices reasonably reflect fundamental information and thereby assess risk accumulation (He, 2020). In recent years, under the guidance of the "housing is for living in, not for speculation" orientation, academic circles have gradually shifted to comprehensively considering the overall performance of real estate in meeting residential needs (Kong and Dong, 2024), preventing financial risks (Qi et al., 2024), supporting fiscal sustainability (Lai et al., 2025), and promoting social equity (Ye et al., 2021). However, most empirical analyses still rely on single indicators, such as housing prices, investment, or credit, making it difficult to fully reflect the multi-dimensional connotation of healthy development in the real estate market (Gao, 2019; Qian et al., 2025; Ye et al., 2021).

Research on urban economic resilience mainly focuses on temporal-spatial differences and driving factors. At the regional level, there is obvious differentiation in urban resilience in China: regions with more diversified industrial structures have stronger shock resistance (Zhang and Chen, 2022; Xu and Zhang, 2019). Southern cities have advantages in innovation and openness resilience, while northern cities rely more on institutional and structural resilience (Wang et al., 2022). Regional development level, industrial layout, and policy environment have also been proven to have important impacts. Mechanically, industrial structure optimization helps diversify risks; technological innovation promotes industrial upgrading to enhance adaptability (He, 2020; Xu and Zhang, 2022; Cheng and Jin,2022); and the efficient operation of factor markets, such as labor, capital, and land, provides support for resource allocation and improves overall flexibility (Dai and Mao, 2015; Zhu and Dong, 2024). Despite the rich relevant achievements, real estate, as a key sector deeply embedded in the local economy and fiscal system, still lacks systematic attention in resilience research (Sun et al., 2023).

Existing research on the relationship between real estate and urban economic resilience is still relatively weak (Giannakis et al., 2024). Most studies on the economic role of real estate focus on the macro level, and most use single indicators, such as housing prices, investment, credit, or consumption, to proxy overall real estate activities, rarely examining its comprehensive impact from a systematic perspective (Cui and Gao, 2020; Tan, 2016). Among them, housing prices are widely used and are considered to have both "crowding-in" and "crowding-out" effects. On the one hand, they drive the expansion of related industries, such as construction and building materials. On the other hand, they push up enterprise operation and labor costs, inhibiting manufacturing investment (He, 2020). Some studies point out from a financial perspective that real estate is likely to attract capital to shift from the real economy to the virtual economy due to its high returns and low volatility (Xu and Zhang, 2022). Although these findings reveal the dual impact of real estate on economic performance, studies connecting it to urban-level shock resistance, adaptability, and recovery capacity remain limited.

Furthermore, few studies adopt the holistic perspective of healthy development to comprehensively examine its synergistic effects on residential security, risk prevention and control, and fiscal sustainability (Huang et al., 2018).

Although existing studies have provided preliminary theoretical support for the relationship between the healthy development of real estate and urban economic resilience, further in-depth exploration is still needed in terms of regional heterogeneity, mechanism of action, and spatial spillover effect. To this end, based on the panel data of 278 prefecture-level and above cities in China from 2012 to 2021, this study empirically examines the impact of the healthy development of real estate on urban economic resilience, aiming to provide more targeted theoretical basis and policy reference for promoting their coordinated development.

The marginal contributions of this study are mainly reflected in the following three aspects: (1) systematically incorporating the healthy development of real estate into the analytical framework of urban economic resilience, exploring its potential impact on the resilience of local and surrounding cities, and expanding the perspective of existing research; (2) combining the dual attributes of consumption and investment of real estate, constructing a comprehensive indicator system for healthy development from four dimensions (i.e., price rationality, supply structure, development speed, and policy coordination), providing a new idea for measuring the overall state of real estate; and (3) identifying potential transmission paths, such as infrastructure construction and innovation and entrepreneurship vitality, and analyzing the heterogeneity of the impact of real estate healthy development on urban economic resilience in combination with characteristics, such as city scale, location, and development stage, which helps clarify the internal correlation mechanism and action logic between the two.

3. Theoretical analysis and research hypotheses

Amid heightened economic uncertainty, healthy real estate development significantly impacts urban economic resilience. A healthy real estate market exhibits self-sustaining and integrative properties, enhancing urban resilience through multiple direct and indirect channels. On one hand, its direct influence manifests in continuously improving urban governance systems and enhancing cities' adaptive adjustment capabilities post-shock. A healthy real estate market helps optimize resource allocation, stabilize investment expectations, and enhance cities' risk resistance capacity through infrastructure development. Specifically, driven by healthy real estate development, cities can better plan and manage themselves, building more flexible urban governance systems. This provides a favorable external environment and foundational conditions for the upgrading of industrial structures, the growth of total factor productivity, and the enhancement of innovation and entrepreneurship activities. By stimulating the vitality of market entities and improving resource allocation efficiency, it ultimately promotes economic resilience. On the other hand, healthy real estate development empowers industrial digital transformation, inevitably accompanied by industrial structure upgrading. This upgrading not only improves resource allocation efficiency but also elevates the city's total factor productivity, strengthening its resistance to risks and resilience. Moreover, the self-sustaining nature of healthy real estate development generates numerous entrepreneurial opportunities, facilitating the recovery of post-pandemic urban economies. Thus, it may also enhance urban economic resilience by

boosting innovation and entrepreneurship activity. For instance, a stable real estate market reduces startup costs and bolsters entrepreneur confidence, thereby fostering a favorable entrepreneurial ecosystem and stimulating public enthusiasm for innovation and entrepreneurship.

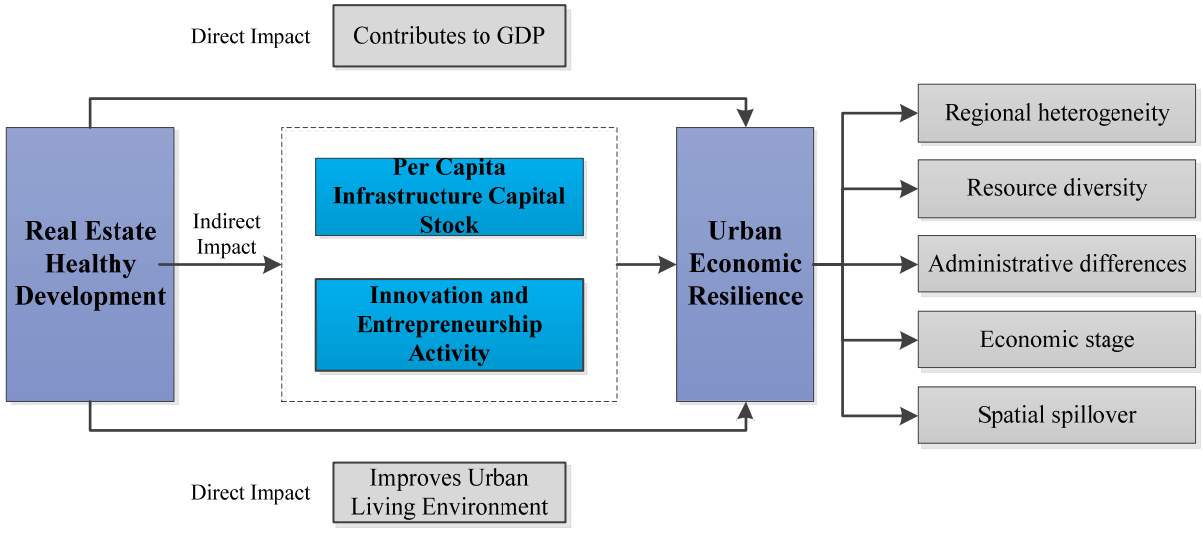

Figure 1. Theoretical framework of how healthy real estate development influences urban economic resilience.

In summary, healthy real estate development refines urban governance systems, strengthens inter-industry connections, and boosts total factor productivity under high-quality economic development. It not only fosters a favorable entrepreneurial environment while stimulating public innovation and entrepreneurship but also mitigates the negative impacts of external shocks by enhancing cities' adaptive adjustment capabilities, thereby safeguarding the stability and sustained growth potential of economic systems. Simultaneously, healthy real estate development reduces entrepreneurial risks, bolsters confidence among entrepreneurs, and gradually elevates the resilience of urban economies. Therefore, this paper constructs the theoretical analytical framework shown in Figure 1 to explore the underlying mechanisms through which healthy real estate development impacts urban economic resilience. This framework not only reveals how healthy real estate development enhances urban economic resilience through multiple channels but also provides valuable references for policymakers to achieve the synergistic advancement of healthy real estate market development and urban economic resilience.

3.1. Direct impact of healthy real estate development on urban economic resilience

As a vital pillar of the national economy, the healthy development of the real estate sector plays a crucial role in stabilizing and growing the urban economy. A healthy real estate market not only injects sustained momentum into urban development but also comprehensively enhances the risk resistance and adaptability of the urban economy through pathways, such as stimulating upstream and downstream industries, improving livability, and maintaining financial system stability (Büchler et al., 2024). On one hand, the real estate sector exhibits significant industrial spillover effects, being highly

interconnected with multiple industries, including construction, building materials, home furnishings, home appliances, and finance (Fan and Zhou, 2019). According to the China Statistical Yearbook (2022)[1], the real estate sector and related industries collectively contributed approximately 30% of China's GDP, making it a vital engine for urban economic growth. On the other hand, the rational development of real estate helps optimize urban spatial planning, improve infrastructure and public services, enhance residential quality and urban attractiveness, and strengthen population carrying capacity and agglomeration effects, thereby solidifying the social foundation of urban economic resilience (Cui and Gao, 2020). Furthermore, the stable operation of the real estate market helps maintain reasonable fluctuations in asset prices, avoids credit risks and financial turmoil triggered by sharp housing price volatility, reduces local governments' reliance on land-related fiscal revenues, prevents systemic financial risks, and ensures the long-term stable operation of urban economies (Sun et al., 2023). In summary, the healthy development of the real estate sector plays a crucial role in promoting industrial synergy, improving living environments, and stabilizing financial order, significantly enhancing cities' adaptability and resilience in the face of internal and external shocks. Based on this theoretical foundation, this leads us to Hypothesis 1.

Hypothesis 1: Healthy real estate development significantly enhances urban economic resilience.

3.2. Indirect impact of healthy real estate development on urban economic resilience

The impact of the real estate market on urban economic resilience stems not only from its direct contributions but also from profound indirect effects by shaping the key support systems for urban development. This study focuses on two core channels (i.e., urban infrastructure capital accumulation and regional innovation and entrepreneurship ecosystem cultivation) and elucidates their inherent mechanisms of action.

Notably, the healthy development of the real estate market promotes infrastructure construction through a fiscal resource conversion mechanism, thereby consolidating the material foundation of urban economic resilience. Sound market operation can provide local governments with stable and sustainable fiscal revenues, mainly derived from land transfer fees and related taxes and fees (Fu et al., 2019). This fiscal resource is not automatically converted into resilience; instead, it is systematically injected into infrastructure sectors, such as transportation, energy, education, and medical care, through government public investment decisions, forming a long-term usable capital stock (Huang et al., 2025). As (Chen and Ye, 2021) pointed out, a high-quality infrastructure network can significantly reduce the logistics and transaction costs of enterprises, improve the matching efficiency of the labor market, and enhance the accessibility of public services (Xu et al., 2017). These improvements collectively enhance the operational efficiency and anti-interference capacity of the urban economic system, enabling it to quickly maintain basic functions and initiate recovery processes when facing external shocks (Cheng et al., 2024). Therefore, the real estate market essentially plays the role of a capital engine for the construction of the urban "hard environment", and its health directly determines the sustainability and scale of infrastructure investment.

[1] National Bureau of Statistics of China. China Statistical Yearbook 2022, Table 3-1 "Gross Domestic Product by Industry". China Statistics Press, 2022. Available online: https://www.stats.gov.cn/sj/ndsj/2022/indexch.htm.

Conversely, the healthy development of the real estate market stimulates innovation and entrepreneurship vitality through a confidence and expectation stabilization mechanism, injecting endogenous momentum into urban economic resilience (Luo et al., 2025). A real estate market with stable prices and orderly supply and demand can effectively reduce future uncertainty for residents and enterprises. For residents, stable housing costs and asset values enhance confidence in consumption and human capital investment. For enterprises (especially start-ups), an active rental market provides flexible and low-cost office space options, while real estate itself can serve as an important collateral to alleviate financing constraints (Fan et al., 2022; Zhang et al., 2022). This "confidence dividend" derived from market stability attracts the agglomeration of high-skilled talents and encourages risk-taking behaviors, ultimately spurring more innovative activities and start-up enterprises. As relevant studies have emphasized, such an innovation and entrepreneurship ecosystem supported by a livable environment and financial accessibility is crucial for improving the diversity of urban industries, accelerating structural upgrading, and enhancing the self-repair and transformation capabilities of the economic system (Yang et al., 2025). Therefore, a healthy real estate market is not only a provider of residential carriers but also a catalyst for the optimization of the urban "soft environment".

In summary, the healthy development of the real estate market indirectly empowers urban economic resilience through two paths: on the one hand, it drives infrastructure capital accumulation through fiscal resources as the medium, improving the physical carrying capacity of the system, and on the other hand, it activates innovation and entrepreneurship behaviors through stable expectations as the link, enhancing the endogenous adaptability of the system. Based on the above theoretical analysis, this study posits the following research hypotheses:

Hypothesis 2: The healthy development of the real estate market indirectly enhances urban economic resilience by increasing the per capita infrastructure capital stock.

Hypothesis 3: The healthy development of the real estate market indirectly strengthens urban economic resilience by improving regional innovation and entrepreneurship vitality.

3.3. Spatial spillover effects of real estate development on urban economic resilience

As an important link in the regional economy, the healthy development of the real estate industry not only exerts a direct impact on local economic resilience but also generates significant spatial spillover effects on neighboring cities through cross-regional factor mobility and coordinated development mechanisms. Studies have demonstrated that a healthy developing real estate market can attract the agglomeration of production factors, such as labor, capital, and technology, to developed regions, while driving the optimal allocation of resources in surrounding cities (Kuang and Li, 2024). Notably, relying on a highly integrated transportation network and industrial division of labor system, the steady development of the real estate market in the Yangtze River Delta region has significantly enhanced the economic resilience of adjacent cities through pathways, such as infrastructure interconnection and innovation factor sharing (Zhu and Dong, 2024). In contrast, the spatial spillover effect in the central and western regions is relatively limited due to weaker regional economic linkages (Zhang et al., 2021). The formation mechanism of this positive spillover effect is mainly reflected in two aspects: first, strengthening regional economic vitality through factor mobility, such as the stability

of the real estate market in large cities attracting the inflow of labor and capital from surrounding areas, promoting regional industrial coordination and innovation diffusion, and second, optimizing resource allocation through regional coordination, driving infrastructure construction, equalization of public services, and industrial chain division of labor, thereby improving the risk resistance capacity and adaptability of the entire region (Huang et al., 2018). Based on the above mechanisms and empirical findings, this study posits the following hypothesis:

Hypothesis 4: Healthy real estate development not only positively impacts the economic resilience of the city itself but also generates positive spatial spillover effects on surrounding regions.

4. Model construction and variable explanation

4.1. Model construction

This paper constructs a basic model illustrating the impact of healthy real estate development on urban economic resilience, as shown in Equation (1):

$$Uer_{i,t} = \alpha_0 + \alpha_1 Rh_{i,t} + \alpha_2 X_{i,t} + \mu_i + \delta_i + \varepsilon_{i,t} \tag{1}$$

In Equation (1), the subscripts i denote different cities, t denote different years, the dependent variable $Uer_{i,t}$ represents the level of urban economic resilience in city i during year t, the core explanatory variable $Rh_{i,t}$ is the real estate healthy development index for city i in year t, $X_{i,t}$ is the control variable, μ_i is the individual fixed effect, δ_i is the time fixed effect, and $\varepsilon_{i,t}$ is the random disturbance term.

To examine the mechanism through which healthy real estate development enhances urban economic resilience, this study considers two potential pathways: first, healthy real estate development improves urban economic resilience by optimizing per capita infrastructure capital stock, and second, it enhances resilience by stimulating innovation and entrepreneurial activity. The regression model incorporating the mediating variable is specified as follows:

$$M_{i,t} = \beta_0 + \beta_1 D_{i,t} + \beta_2 X_{i,t} + \mu_i + \delta_i + \varepsilon_{i,t} \tag{2}$$

$$Uer_{i,t} = \gamma_0 + \gamma_1 M_{i,t} + \gamma_2 D_{i,t} + \mu_i + \delta_i + \varepsilon_{i,t} \tag{3}$$

where $M_{i,t}$ represents the mediating variables, which in this study include $Ccon_{i,t}$ and $Entr_{i,t}$. $Ccon_{i,t}$ denotes the per capita infrastructure capital stock of city i in year t, and $Entr_{i,t}$ indicates the innovation and entrepreneurship activity level of city i in year t. Other variables retain the same definitions as in Equation (1). In model (3), the total effect of healthy real estate development on urban economic resilience is $\gamma_1 + \beta_1 \times \gamma_2$. γ_2 represents the direct effect of healthy real estate development on urban economic resilience after accounting for the mediating effect. If both β_1 and γ_1 are significant, then $\beta_1 \times \gamma_1$ indicates the indirect effect of healthy real estate development on urban economic resilience.

4.2. Variable explanation

4.2.1. Construction of the real estate healthy development index evaluation system

The real estate healthy development index aims to comprehensively reflect the stability and sustainability of real estate market operations. This paper builds upon the research frameworks of scholars, such as Chen Hongyan and Ye Jianping, to construct an evaluation system across three dimensions: price, structure, speed, and policy (Huang and Zhang, 2016; Ye et al., 2021; Qian et al., 2025).

(1) Price dimension

The price dimension focuses on the alignment between market price levels and macroeconomic conditions. It selects the price-to-income ratio (L1) to measure residents' home-purchasing power, employs the commercial housing price growth rate (L2) to reflect market supply-demand trends, and introduces two comparative indicators (i.e., the price growth rate minus disposable income growth rate (L3) and the residential price growth rate - CPI growth rate (L4)) to assess the alignment of housing price growth with household income growth and overall price levels, thereby identifying price deviations or bubble risks.

(2) Structural dimension

The structural dimension examines the coordination between the internal supply-demand structure of the real estate market and external economic structures. It analyzes the match between housing supply and demand using residential floor area/commercial housing floor area (L5) and housing sales value/commercial housing sales value (L6). It assesses the alignment between real estate investment types and market demand by analyzing the ratio of residential investment to commercial property investment (L7). It also evaluates market supply-demand equilibrium using commercial housing sales area/commercial housing supply area (L8), while reflecting suitability for household housing needs through the rationality of unit structure (e.g., proportion of housing units across different size segments).

(3) Speed dimension

The speed dimension captures the development pace and growth efficiency of the real estate market. The scale and growth rate of capital investment are measured using the real estate investment growth rate (L9) and the ratio of real estate investment to total fixed-asset investment (L10). The coordination between investment growth and population growth is examined through the difference between the real estate investment growth rate and the population growth rate (L11). To eliminate the impact of dimensional differences, this study standardizes the raw data and employs the entropy weighting method to calculate weights, as shown in Table 1. This ultimately generates estimated values for the real estate healthy development index of China's 278 prefecture-level cities from 2012 to 2021.

(4) Policy dimension

The policy dimension reflects the intensity of government regulation on the real estate market. Considering data availability, two indicators are adopted: real estate credit constraints (per capita housing loan balance of urban residents/per capita disposable income of urban residents) (L12) and land finance dependence (local land transfer fees/local general public budget revenue) (L13).

Table 1. Evaluation indicator system for real estate healthy development index.

Primary Indicators	Second-Level Indicators	Weight	Ideal Range
Price Dimension S1	L1Price-to-IncomeRatio	0.062	Negative
	L2CommercialHousingPriceGrowthRate	0.064	Positive
	L3HousingPriceGrowthRate-DisposableIncomeGrowthRate	0.065	Positive
	L4HousingPriceGrowthRate-CPIGrowthRate	0.064	Positive
Structural Dimension S2	L5HousingArea/Commercial Housing Area	0.086	Negative
	L6HousingSalesValue/Commercial Housing Sales Value	0.077	Negative
	L7HousingInvestment/Commercial Property Investment	0.163	Negative
	L8CommercialHousingSalesArea/Commercial Housing Supply Area	0.116	Positive
Speed Dimension S3	L9RealEstateInvestmentGrowthRate	0.071	Positive
	L10RealEstateInvestmentAmount/Fixed Asset Investment	0.158	Positive
	L11RealEstateInvestmentGrowthRate-PopulationGrowthRateDifference	0.072	Positive
Policy Dimension S4	L12 per capita housing loan balance of urban residents / per capita disposable income of urban residents	0.064	Positive
	L13 local land transfer fees/local general public budget revenue	0.080	Positive

4.2.2. Construction of the urban economic resilience index evaluation system

A unified measurement method for urban economic resilience has not yet been established in existing studies. Depending on the research focus, scholars mainly adopt single sensitivity indicators, evaluation index system construction, and counterfactual estimation methods for measurement. Drawing on the approaches of (Ding et al., 2020) and (Liu et al., 2021), and considering the availability of city-level data, this study constructs a multi-dimensional index system from four dimensions (i.e., resistance and recovery capacity, adaptation and adjustment capacity, transformation and development capacity, and shock response capacity) and verifies its construct validity through factor analysis.

Resistance and recovery capacity refers to the ability of the economic system to maintain basic functions and a stable state when facing external shocks. In general, the larger the economic scale and the higher the residents' income level, the more the region can maintain operational resilience in the face of shocks. Chen and Quan (2021) pointed out that cities with a larger economic scale usually have more abundant resource endowments and stronger internal and external circulation capabilities, showing higher stability during crises. Therefore, this study selects per capita gross regional product (L1) as the core proxy variable. Notably, the balance of savings of urban and rural residents (L3) may reflect an excessive precautionary savings motive among residents and insufficient consumption willingness, thereby inhibiting domestic demand and economic vitality, so it is identified as a negative indicator in factor analysis.

Adaptation and adjustment capacity refers to the ability of economic entities to maintain operation and adapt to the new environment through incremental adjustments under continuous shocks. This study selects indicators reflecting domestic demand and structural upgrading, such as total retail sales of consumer goods (L4), the proportion of the tertiary industry in GDP (L5), and fixed asset investment

(L6), while introducing the loan-to-deposit ratio of financial institutions at the end of the year (L7). A lower loan-to-deposit ratio indicates more active credit expansion and stronger financial support for the real economy; conversely, it may reflect credit contraction or capital idling, which is not conducive to risk response (Ahmadi et al., 2025). Therefore, this indicator is also treated as a negative indicator in factor analysis.

Transformation and development capacity emphasizes the ability of the economic system to achieve long-term leapfrog development through innovation and structural changes. Tan et al. (2020) argued that regions with diversified industrial structures and innovation-driven development are more resilient to crises (Ringwood et al., 2019; Giannakis et al., 2024). This study uses the number of patent grants (L8), the number of students enrolled in ordinary institutions of higher education per 10,000 people (L9), and fiscal expenditures on science, technology and education (L10–L11) to measure the regional innovation ecosystem and human capital accumulation, and these indicators collectively reflect the endogenous driving force of cities to promote high-quality development.

Shock response capacity quantifies the actual economic performance of cities under major exogenous shocks. We construct an economic output gap indicator, defined as the difference between a city's actual GDP in 2020 and its predicted value based on the linear trend from 2015 to 2019 (actual value − predicted value). A positive gap indicates that the urban economy performed better than expected under the no-shock scenario, reflecting stronger shock resilience. A negative gap suggests the opposite. Factor analysis shows that this indicator has a factor loading of 0.5948 ($p < 0.01$) with an expected positive sign, verifying its validity as a proxy for economic resilience.

Table 2. Comprehensive evaluation index system for urban economic resilience.

Primary Indicators	Second-Level Indicators	Indicator Weight	Indicator Attributes
Resilience and Recovery Capacity	L1 Per capita regional GDP (RMB)	0.7956	Positive
	L2 Urban Residents' Disposable Income (CNY)	0.7977	Positive
	L3 Urban and Rural Residents' Savings Balance (CNY)	0.9295	Negative
Adaptability and Adjustment Capacity	L4 Total Retail Sales of Consumer Goods (10,000 yuan)	0.9530	Positive
	L5 Tertiary Industry Share of GDP (%)	0.5497	Positive
	L6 Fixed Asset Investment Amount (10,000 yuan)	0.7492	Positive
	L7 Year-end institutional loan-to-deposit ratio (%)	0.5083	Negative
Transformation and Development Capability	L8 Number of Patent Authorizations (units)	0.9282	Positive
	L9 Number of Full-time Students in Regular Higher Education Institutions (persons)	0.6872	Positive
	L10 Fiscal Expenditure on Science (10,000 yuan)	0.9064	Positive
Shock response capacity	L11 Fiscal Education Expenditure (10,000 yuan)	0.9307	Positive
	L12 Economic Output Gap Under the COVID-19 Shock (yuan)	0.5948	Positive

In summary, this study ultimately constructs an urban economic resilience evaluation system consisting of 4 primary dimensions and 12 secondary indicators (see Table 2). All original data are derived from authoritative yearbooks, such as the China Statistical Yearbook, China Financial Yearbook, and China Regional Innovation Capacity Evaluation Report. To ensure the validity of the indicator structure, we conduct factor analysis on all 12 original sub-indicators based on cross-sectional data in

2020 and extract a single common factor as the comprehensive index of urban economic resilience. To test whether the variables are suitable for factor analysis, we calculated the Kaiser-Meyer-Olkin (KMO) measure and Bartlett's test of sphericity. The results show that the KMO value is 0.880, which is higher than the recommended threshold of 0.8. Bartlett's test of sphericity is highly significant ($\chi^2 = 4029.64$, $d_f = 66$, $p < 0.001$), indicating that there is sufficient correlation among variables, which is suitable for extracting common factors. The factor loadings and directions of each indicator are shown in Table 2, where negative indicators have been reversely processed in accordance with specifications.

4.2.3. Mediating variables

Urban infrastructure construction serves as a crucial support linking the healthy development of the real estate market and urban economic resilience. The healthy development of real estate is reflected not only in the balance between market supply and demand but also in promoting the continuous improvement of infrastructure, such as transportation, public services, and digital facilities, thereby enhancing resource allocation efficiency, residents' well-being, and the system's risk resistance capacity (Fu et al., 2019; Yan et al., 2024). Meanwhile, high-quality infrastructure provides a physical carrier for industrial upgrading and population agglomeration, strengthening the adaptability and recovery capacity of urban economies (Zhang et al., 2025). Given that infrastructure investment has strong annual volatility and is difficult to reflect long-term supply capacity, this study adopts per capita infrastructure capital stock (*Ccon*) as the proxy variable. This indicator is estimated using the perpetual inventory method based on annual municipal public facility investment data and standardized by the permanent population, which can more accurately depict the actual service level and per capita enjoyment of urban infrastructure, aligning with the connotation of system stability and sustainability emphasized by resilience.

Innovation and entrepreneurship vitality (*Entr*) serves as a vital engine for driving urban economic resilience. On one hand, the concentration of innovation activities enhances the diversity and flexibility of urban economic systems through technology diffusion, business model iteration, and industrial chain extension, thereby improving their adaptability to external shocks. On the other hand, heightened entrepreneurial vitality helps form a virtuous cycle of "innovation-employment-consumption", expanding domestic demand and optimizing economic structure, which further strengthens urban resilience. This study employs the China Regional Innovation and Entrepreneurship Index, compiled by Peking University, to represent the level of innovation and entrepreneurship activity, following the methodological approach established in prior research (Zhang and Yao, 2023).

4.2.3. Control variables

To control for other structural factors that may influence the outcomes, this study builds upon theoretical analysis and the foundational work of previous scholars (Hu and Liu, 2020). The following control variables are selected: population concentration (*PeoC*), year-end registered population (*People*), government size (*Scalegov*), consumer price index (*CPI*), government emphasis (*GovF*), openness to the outside world (*Open*), environmental regulation intensity (*EnvironR*), level of industrialization (*Industry*), unemployment rate (*Unemploy*), and per capita housing area (*Area*). The natural logarithm of the year-end registered population (*People*) was used to control for the impact of

total regional population size. Government scale (*Scalegov*) is measured by the ratio of local general public budget expenditure to GDP, reflecting the degree of government intervention in economic activities. The consumer price index (*CPI*) was calculated using a month-on-month price index with the previous year set as 100, controlling for the potential impact of inflation on economic behavior and policy effectiveness to avoid estimation biases caused by price fluctuations. Government priority (*GovF*) is measured by the share of energy conservation and environmental protection expenditures in total fiscal spending, reflecting local governments' policy focus and investment intensity in ecological governance. Degree of openness (*Open*) is measured by the share of actual foreign direct investment (*FDI*) utilization in GDP, reflecting the level of regional openness in economy. Environmental regulation intensity (*EnvironR*) is expressed as the ratio of industrial pollution control investment to industrial added value, capturing the strength of government regulation on industrial pollution. Level of industrialization (*Industry*) is measured by the share of secondary industry value-added in GDP, reflecting industrial structure characteristics. Unemployment rate (*Unemploy*) uses the registered urban unemployment rate to control for labor market fluctuations. Per capita housing area (*Area*) is expressed as the average per capita residential floor area (square meters) for urban residents, reflecting housing conditions and urbanization quality. All variables underwent variance inflation factor (VIF) testing, with an average VIF of 1.80 and a maximum VIF below 3.74. This indicates insignificant multicollinearity issues, ensuring the model estimation results possess good stability and reliability. The selection and construction of the above variables aim to more comprehensively control external factors affecting urban economic resilience, thereby enhancing the model's explanatory power and the reliability of empirical results.

4.3. Data sources

The research sample comprises panel data from 278 prefecture-level cities in China covering the period 2012–2021. Housing price data originates from the average residential sales prices across all cities in China, sourced from the Xitai Database. Fixed asset investment and urban population growth rates were sourced from the China Urban Statistical Yearbook. Data on population agglomeration, housing floor area, commercial housing floor area, housing sales value, commercial housing sales value, housing investment, commercial housing investment, and real estate development investment were obtained from the Wind database. Partial missing values in the panel data were imputed using linear interpolation, cubic spline interpolation, and regression analysis (Jawad, 2025). Descriptive statistics for key variables are presented in Table 3.

Table 3. Descriptive statistics of research variables.

Variable Category	Variable Name	Symbol	Sample Size	Mean	Minimum	Maximum	Standard Deviation
Dependent variable	Urban Economic Resilience	*Uer*	2780	2.184	0.133	6.981	0.730
Explanatory Variables	Real Estate Healthy Development Index	*Rh*	2780	0.286	0.109	0.691	0.080
Mediating Variable	per capita infrastructure capital stock.	*Ccon*	2780	0.025	0.003	0.297	0.024
	Innovation and Entrepreneurship Activity	*Entr*	2780	10.437	1.430	6.170	16.179
Control Variables	Population Agglomeration	*PeoC*	2780	1.626	1.267	0.019	10.503
	Year-end registered population	*Population*	2780	5.887	0.673	2.983	8.129
	Government Size	*Scalegov*	2780	0.454	0.783	0.153	41.390
	Consumer Price Index	*CPI*	2780	101.970	0.806	99.000	105.660
	Level of Government Priority	*GovF*	2780	0.260	0.138	0.036	1.145
	Open to the outside world	*Open*	2780	9.901	2.142	0.705	14.941
	Environmental Regulation	*EnvironR*	2780	0.797	0.227	0.002	1.229
	Level of Industrialization	*Industry*	2780	0.453	0.411	0.019	21.390
	Unemployment Rate	*Unemployment*	2780	0.054	0.075	0.000	2.972
	Per capita housing area	*Area*	2780	33.828	2.360	27.986	38.347

5. Empirical findings and analysis

5.1. Benchmark regression analysis

The benchmark regression results are shown in Table 4. Real estate health (*Rh*) has a significantly positive effect on urban economic resilience (*Uer*), with robustness across different model specifications. In Model (1), which includes only core variables, a one-unit increase in Rh leads to an average 0.583-unit increase in *Uer* (z=10.39, 1% significant). When fixed effects were introduced (Model 2), the coefficient for Rh increased to 3.595 (z=8.73, 1% significant), indicating that individual or time fixed effects absorbed some potential confounding factors, amplifying the net effect of *Rh*. After further incorporating control variables, such as population concentration and government size (Model 4), the coefficient for Rh was 2.117 (z=6.61, 1% significant). Although slightly lower than in Model 2, it remained statistically significant, indicating that the impact of real estate health on economic resilience exhibits stability across models. Regarding model fit, the R^2 value significantly improved from 0.310 in Model (1) to 0.761 in Model (4) with the progressive introduction of control variables and fixed effects. This indicates that control variables such as population size, government behavior, and environmental regulations effectively capture key drivers of inter-city economic resilience differences. This improvement highlights the complex interplay between real estate health

and other structural variables: a healthy real estate market directly underpins urban economic resilience by optimizing resource allocation (e.g., reducing systemic financial risks), stabilizing investment expectations (attracting long-term capital inflows), and enhancing risk-resistance capabilities (providing economic buffers). The differentiated effects of control variables further reveal the multidimensional logic underpinning economic resilience formation. Negative coefficients for registered population size (*People*) (−0.013) indicate that excessive concentration may lead to resource crowding and pressures on public services, thereby reducing economic resilience. The negative effects of environmental regulation intensity (*EnvironR*) and industrialization level (*Industry*) (−0.194, −0.293) reflect how short-term environmental costs and industrial homogeneity suppress resilience; conversely, the positive effect of openness (*Open*) (0.157) demonstrates how outward-oriented economies enhance shock resistance through technology spillovers and market diversification. In summary, a direct and stable positive relationship exists between real estate health and economic resilience, while the synergistic effects of variables such as population structure, policy intervention, and external openness collectively shape the dynamic landscape of urban economic resilience.

5.2. Addressing endogeneity issues

To mitigate the bidirectional relationship between healthy real estate development and urban economic resilience, as well as potential endogeneity issues, this study employs lagged-term regression and instrumental variable methods for robustness testing. First, considering the possible time lag in the impact of healthy real estate development on urban economic resilience, the lagged-one-period and lagged-two-period terms of the core explanatory variable (*Rh*) are incorporated into the regression model. The results in Columns (1) and (2) of Table 5 show that the regression coefficients for the one-period lag and two-period lag of Rh are 2.299 and 2.500, respectively, both significant at the 1% level (t-values of 6.84 and 7.33). This indicates that the positive promotional effect of prior healthy real estate development on current urban economic resilience remains robust.

Second, to mitigate endogeneity issues, such as omitted variable bias and bidirectional causality, this study constructs instrumental variables (IV) following the approach of (Sun et al., 2025). The average urban slope is selected as an instrumental variable, which is exogenous to current economic fluctuations and significantly negatively correlated with development costs and the health level of the real estate market. To enhance relevance, an interactive instrumental variable is further constructed: lagged one-period real estate investment × (1/average urban slope). Column (3) of Table 5 presents the 2SLS results, showing that after controlling for covariates and fixed effects, the coefficient of healthy real estate development is 10.822, which is significantly positive at the 1% level. The Cragg-Donald Wald F statistic is 96.327, far greater than the Stock-Yogo 10% critical value of 16.38, indicating no weak instrument problem; the p-value of the Kleibergen-Paap LM test is 0.027, which significantly rejects the null hypothesis of under identification; the model is exactly identified, confirming the validity of the instrumental variable. In addition, to enhance the credibility of the instrumental variables, this study adds a new instrumental variable "distance of each prefecture-level city from the coastline × real estate investment of each province". This instrumental variable not only includes an exogenous locational component but also captures the impact of capital flows on the real estate market through provincial-level investment, exhibiting strong correlation with the endogenous variable and

no direct effect on economic resilience. The results in Column (4) of Table 5 show that the coefficient of Rh is 8.294, significant at the 10% level, with the core sign and direction remaining consistent. Identification tests indicate that F = 63.148 > 16.38, demonstrating sufficient strength of the instrumental variable; KP LM test p-value = 0.064, rejecting under identification at the 10% level, thus confirming the validity of the model identification.

Table 4. Benchmark regression results.

Variable	(1)	(2)	(3)	(4)
Rh	0.583*** (10.39)	3.595*** (8.73)	0.295*** (5.85)	2.117*** (6.61)
PeoC			0.232*** (15.42)	0.142*** (5.59)
People			0.211 (0.75)	−0.013 (−0.08)
scalegov			−0.001 (−0.23)	0.013 (0.92)
CPI			−0.007** (−2.17)	0.001 (0.07)
GovF			−0.273*** (−5.87)	−0.425* (−1.75)
Open			0.025*** (8.54)	0.157*** (4.40)
EnvironR			0.053*** (2.73)	−0.194** (−2.14)
Industry			−0.002 (−0.23)	−0.293* (−1.76)
Unemployment			−0.103 (−0.26)	−0.002 (−0.01)
Area			0.029*** (24.37)	0.006 (0.92)
Constantterm	2.017*** (57.54)	1.128*** (9.47)	1.162*** (2.85)	−0.241 (−0.18)
FixedEffects	NO	YES	NO	YES
R^2	0.310	0.599	0.343	0.761
SampleSize	2780	2780	2780	2780

Note: Numbers in parentheses are z-values for Columns (1) and (3), and t-statistics for Columns (2) and (4). ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 5. Results of endogeneity treatment.

Variable	Lagged Explanatory Variables		Instrumental Variables (IV)		
	(1)	(2)	(3)	(4)	(5)
Rh	2.299*** （6.84）	2.500*** （7.33）	10.822*** （2.34）	8.294* (1.08)	9.772*** (3.70)
Control Variables	YES	YES	YES	YES	YES
Fixed Effects	YES	YES	YES	YES	YES
Cragg−Donald Wald F			96.327	63.148	103.964
10% maximal IV size			16.38	16.38	19.93
KP LM test p-value			0.027	0.064	0.008
Hansen J test p-value			0.000	0.000	0.739
Sample size	2780	2780	2780	2780	2780
R^2	0.762	0.759	0.041	0.317	0.169

Note: t-statistics are reported in parentheses, *** denotes statistical significance at the 1% level.

Finally, to further test the exogeneity of the instrumental variables, this study incorporates both types of instrumental variables into the model for joint estimation. The results in Column (5) of Table 5 show that the coefficient of Rh is 9.772, which is significantly positive at the 1% level, consistent with the results of the single instrumental variable, indicating that the core conclusions are robust. The results of the identification tests show the following: F = 103.964 > 19.93, indicating no weak instrument problem; KP LM p = 0.008, rejecting the null hypothesis of under identification; and Hansen J p = 0.739, failing to reject the exogeneity of the instrumental variables. In summary, whether using a single instrumental variable or joint identification with multiple instruments, the positive promoting effect of healthy real estate development on urban economic resilience is significantly robust, indicating that there is no endogeneity bias in the core conclusions of this study and the causal relationship is reliable.

5.3. Robustness tests

To assess the reliability of the baseline model's regression results, this study further conducts robustness tests through multiple approaches, including replacing the dependent variable, changing the core explanatory variable, and re-selecting the sample.

(1) Replacing the dependent variable: After substituting the original dependent variable "urban economic resilience" with natural logarithm-transformed per capita GDP, the model still indicates that a one-unit increase in real estate health leads to an average 1.761-unit rise in per capita GDP (t=7.26, 1% significance). Although the significance level weakened from 1% to 5%, the coefficient direction remained consistent with the original model and exhibited a higher absolute value (0.734 > 0.085), further validating the robustness of real estate health's positive impact on economic growth. This result indicates that the core relationship remains stable even when measured through different economic indicators.

(2) Substituting the core explanatory variable: After replacing the original core explanatory variable "real estate health" with housing prices (taking the natural logarithm), each unit increase in housing prices leads to an average increase of 0.955 units in urban economic resilience (t=7.44, 1% significance). The direction of this coefficient is consistent with that of the original model, and its absolute value is higher than that of the original model (0.955 > 0.085), the direction remains consistent and the significance is not weakened. This discrepancy may reflect a nonlinear relationship between housing prices and real estate health (e.g., excessively high prices may suppress consumption or investment). This test result reinforces the robustness of the original conclusion, but attention should be paid to potential biases introduced by variable substitution.

(3) Excluding municipality samples: After removing municipality samples, each additional unit of real estate health increases urban economic resilience by 2.157 units on average (t=6.57, 1% significant). Despite a decline in R^2 (from 0.717 to 0.649) following the reduction in sample size (from 2780 to 2740), the core relationship remained largely unaffected. The absolute coefficient (2.157) was slightly larger than the original estimate (0.085). This indicates that the unique characteristics of municipalities directly under the central government (e.g., policy preferences, resource concentration) did not distort the relationship between variables. It further validates that the positive effect of real estate health on economic resilience is universal and not confined to policy-favored regions.

Table 6. Robustness test results.

Variable	Replace Original Dependent Variable	Replacing the Original Core Explanatory Variable	Removing Municipal-Level Samples
Explanatory Variable	1.761***	0.955***	2.157***
	(7.26)	(7.44)	(6.57)
Constant term	11.851***	−6.405***	−0.349***
	(9.77)	(−4.88)	(-0.26)
Control Variables	YES	YES	YES
Fixed effects	YES	YES	YES
R^2	0.734	0.838	0.649
Sample Size	2780	2780	2740

Note: t-statistics are reported in parentheses, *** denotes statistical significance at the 1% level.

5.4. Analysis of mediating effects

Table 7 examines the mediating role of per capita infrastructure capital stock (*Ccon*). Column (1) reports a significantly negative association between real estate health and per capita infrastructure capital stock (coefficient = −0.039, t = −6.37), which seems inconsistent with theoretical expectations but actually reflects resource misallocation under "land finance dependence" in some regions, that is, over-reliance on land transfer income amid an overheated real estate market crowds out long-term infrastructure investment, leading to a short-term restrictive effect. Column (2) shows that after controlling for other factors, per capita infrastructure capital stock has a significantly positive impact on urban economic resilience (coefficient = 8.158, t = 15.32), while the direct effect of real estate health on economic resilience remains significantly positive (1.883), indicating that real estate health

exerts both direct and indirect (via infrastructure accumulation) positive effects on resilience. A Sobel test further verifies the significance of this mediating path ($Z = 6.56$, $p < 0.001$), with the mediating effect accounting for 11.0% of the total effect, confirming that per capita infrastructure capital stock plays an important bridging role between real estate health and urban economic resilience through long-term fiscal resource transformation.

Table 7. Results of the mediation effect tests.

Explanatory Variable	Per Capita Infrastructure Capital Stock		Innovation and Entrepreneurship Activity	
	Ccon	*Uer*	*Entr*	*Uer*
Rh	−0.039*** (−6.37)	1.883*** (16.93)	6.507*** (23.14)	1.276*** (12.98)
Ccon		8.158*** (15.32)		
Entr				0.285*** (35.14)
Control Variables	YES	YES	YES	YES
Fixed Effects	YES	YES	YES	YES
Observations	2,780	2,780	2,780	2,780
R^2	0.308	0.780	0.574	0.836
Direct Effect	1.884***		1.276***	
Total Effect	2.117***		2.117***	
Mediation effect	0.233***		0.841***	
Mediation ratio	0.110		0.397	
Bootstrap confidence interval	[0.165，0.305]		[0.682，1.000]	
Sobel Z-statistic	6.56		12.37	

Note: t-statistics are reported in parentheses, *** denotes statistical significance at the 1% level.

Table 7 presents the test results with innovation and entrepreneurship vitality (*Entr*) as the mediating variable in Columns (3) and (4). Specifically, Column (3) shows that the coefficient of real estate health on innovation and entrepreneurship vitality is significantly positive (coefficient = 6.507, t = 23.14), which echoes the confidence and expectation stability mechanism in theoretical analysis:

the stable operation of the real estate market reduces uncertainty for enterprises and residents, and effectively stimulates the city's innovation and entrepreneurship vitality through providing low-cost office space, easing financing constraints, gathering high-skilled talents and other approaches (Bajwa et al., 2025). Column (4) indicates that innovation and entrepreneurship vitality has an extremely significant positive impact on urban economic resilience (coefficient = 0.285, t = 35.14), and the direct effect of real estate health on economic resilience remains significant (1.276***). The results of the Sobel test show that this mediating path is also highly significant (Z = 12.37, p < 0.001), and the mediating effect accounts for 39.7% of the total effect, indicating that innovation and entrepreneurship vitality plays a key mediating role in the process of real estate health affecting economic resilience, that is, it enhances the city's self-repair and transformation capacity by optimizing the industrial structure and improving the endogenous adaptability of the economic system.

To further ensure the robustness of the conclusions, this study uses 1000 Bootstrap samples to test the mediating effect. The results show that the 95% confidence interval for the mediating effect of per capita infrastructure capital stock is [0.165, 0.305], and the 95% confidence interval for the mediating effect of innovation and entrepreneurship vitality is [0.682, 1.000]. Neither interval includes 0, indicating that both mediating paths are significantly valid.

5.5. Heterogeneity analysis

The impact of healthy real estate development on urban economic resilience may be moderated by city-specific characteristics. To examine such heterogeneous effects, this study conducts subsample analyses along four dimensions: geographical location, resource endowment, administrative level, and development stage (see Table 8 for detailed results).

5.5.1. Geographical location

China's economic development level shows significant regional disparities. Based on economic geography divisions, this study investigates the impact across cities in the eastern, central, and western regions. Results indicate significant regional heterogeneity in the effect of real estate health on urban economic resilience, as shown in Table 8. The strongest positive effect is observed in the eastern region (baseline coefficient = 2.980***), suggesting that in a mature market environment, healthy real estate development directly enhances a city's ability to withstand risks. In contrast, the moderating coefficient is negative for the central region (−1.238, p=0.088) and marginally positive for the western region (−1.880, p=0.010), indicating a weakened promotional effect in both regions, implying a further weakened promotional effect.

Table 8. Analysis results of heterogeneity in urban scale.

Variable	(1) Geographical Location	(2) Resource Endowment	(3) Administrative Leve	(4) Economic Development Stage
Rh	2.980***	2.161***	1.184***	1.825***
	(5.51)	(6.22)	(3.32)	(6.77)
Rh× Region 1	−1.238*	0.599***	1.199	0.445
	(−1.76)	(3.02)	(1.37)	(1.00)
Rh× Region 2	−1.880***			
	(−1.98)			
Constant	−0.106	0.255	0.481	−0.228
	(−0.08)	(0.19)	(0.43)	(−0.17)
Control Variables	YES	YES	YES	YES
Fixed Effects	YES	YES	YES	YES
R^2	0.767	0.772	0.820	0.762
Observations	2,780	2,780	2,780	2,780

Note: t-statistics are reported in parentheses, ***, * *, * respectively indicate significant at the 1%, 5%, and 10% levels. Geographical Location is divided into the eastern region (Rh), the central region (Rh×Region1), and the western region (Rh×Region2); Resource Endowment is classified into resource-based cities (Rh) and non-resource-based cities (Rh×Region1); Administrative Level is divided into provincial capital cities (Rh) and non-provincial capital cities (Rh×Region1); Economic Development Stage is divided into the Resistance Period (Rh) and the Recovery Period (Rh×Region1).

The attenuated impact observed in central China may stem from several factors. Despite significant infrastructure advancement and industrial transfer driven by the "rise of Central China" strategy, intra-regional development disparities, such as urban-rural gaps and a single industrial structure, may have undermined the effectiveness of the real estate market's transmission mechanism. Furthermore, the central region's relatively underdeveloped innovation and entrepreneurship ecosystem, characterized by insufficient aggregation of high-skilled talent and weak financial support for startups, likely constrains the indirect channel through which real estate health enhances economic resilience. In the western region, a prominent resource-dependent industrial structure and persistent population outmigration have led to insufficient vitality in the real estate market, making it difficult to effectively translate improvements in real estate health into enhanced economic resilience. The eastern region, benefiting from high market maturity and well-developed policy response mechanisms, exhibits a more direct and significant positive effect of healthy real estate development on economic

resilience. This conclusion reveals the heterogeneous influence of regional institutional environments, industrial structures, and market maturity on the mediating pathway.

5.5.2. Resource endowment

Resource endowments exert a notable influence on urban economic development trajectories. In China, resource-based cities are predominantly clustered in mineral-abundant regions, where long-standing dependence on traditional industrial models, heightened vulnerability to resource price volatility, and inadequate capacity to capitalize on opportunities in the real estate sector are prevalent characteristics. Drawing on the National Sustainable Development Plan for Resource-Based Cities (2013–2020) issued by the State Council, this study categorizes 112 cities as resource-based, with the remaining 166 designated as non-resource-based. The regression results, as shown in Column (2) of Table 8, indicate that there is a significant difference in the impact of real estate health on economic resilience between resource-based and non-resource-based cities: the main effect coefficient for resource-based cities is 2.161***, and the moderating effect coefficient for non-resource-based cities is 0.599***. Both are significantly positive, but there is an obvious differentiation in the logic of the effect. The core reason for this difference lies in: resource-based cities have a single economic structure, and the healthy development of real estate has become an important short-term buffer to hedge against the decline of the resource industry, so the marginal pull effect is stronger; while non-resource-based cities, relying on a diversified industrial structure and an active market mechanism, have a smoother linkage and transmission between the healthy development of real estate and the real economy, and the long-term enabling effect on economic resilience is more prominent.

5.5.3. Administrative level

Generally, provincial capitals and higher-level cities possess more advanced infrastructure, stronger resource allocation capabilities, and higher economic agglomeration levels, providing substantial support for healthy real estate market development. Simultaneously, these cities demonstrate greater adaptability and recovery capacity when facing external shocks, potentially amplifying the positive effect of healthy real estate on urban economic resilience. In contrast, non-provincial capital cities tend to suffer from relative deficiencies in policy support, market vitality, and factor mobility, giving rise to heterogeneous effects across the two city categories. Against this backdrop, this study divides the sample into non-provincial capital cities and provincial capital/higher-tier cities to further examine the effect. From the regression results in Table 8, the main effect coefficient for real estate health in non-provincial capital cities is 1.199 ($p = 0.181$), statistically insignificant, indicating a weak impact. For provincial capital/higher-level cities, the moderating effect coefficient is 1.184***. Although not significant at the traditional 5% level, the direction aligns with theoretical expectations, and the model exhibits good overall fit (R^2=0.820), showing stronger explanatory power.

The observed difference can be attributed to the fact that provincial-capital-and-above cities typically have greater access to policy support and exhibit enhanced capacity for economic agglomeration and institutional responsiveness. As regional economic centers, they benefit from higher-level fiscal investment and preferential policies, enabling real estate development to be more efficiently translated

into infrastructure optimization, industrial synergy upgrading, and public service improvement, thereby enhancing resilience. Concurrently, high concentrations of population and capital boost real estate market liquidity and vitality; improvements in health, by enhancing living environments and stimulating commercial innovation, further strengthen economic resilience. Non-provincial capital cities, constrained by weaker policy implementation capacity, smaller market size, and simpler industrial bases, find it difficult to effectively realize the marginal contribution of real estate health, leading to a blocked transmission path. Although the moderating effect for provincial capitals is only marginally significant statistically, its economic meaning and directional consistency support the conclusion that "the positive impact of real estate health on economic resilience is more significant in larger cities", highlighting the critical role of policy-market synergy in enhancing urban resilience.

5.5.4. Development stage

Based on changes in China's economic growth rate, the period 2012 to 2021 can be divided into two typical stages: the resistance period (2012 to 2015) and the recovery period (2016 to 2021). The resistance period was characterized by a significant growth slowdown, with GDP growth falling below 8% from 2012 onwards, putting the economy under great downward pressure; the government actively responded through macro-control and stimulus policies to enhance the risk resistance capacity of the economic system. In contrast, the recovery period was marked by a gradual stabilization of economic growth rate and entry into a new normal of medium-high speed growth. Especially driven by the supply-side structural reform and the innovation-driven development strategy, the quality of economic growth continued to improve, and economic resilience was further strengthened. Accordingly, this study divides the samples into the resistance period and the recovery period, and the regression results are shown in Column (4) of Table 8: during the resistance period, the main effect coefficient of real estate health is 1.825*** (t = 6.77), which is significantly positive at the 1% level; during the recovery period, the moderating effect coefficient is 0.445 (t = 1.00), which is not statistically significant, indicating that the promoting effect of real estate health on economic resilience is mainly reflected in the resistance period with great downward economic pressure.

This phased difference may stem from the transformation of the real estate function in different economic cycles: during the resistance period, with the slowdown of economic growth and increased external uncertainty, the healthy development of the real estate market became an important tool to hedge against economic downturns, stabilize local finance and employment, and its "buffer" role in economic resilience was amplified, hence the significant main effect. After entering the recovery period, as economic growth stabilized, the policy focus shifted to supply-side structural reform and high-quality development, the investment demand in the real estate market was restrained, the marginal pull effect of real estate on economic resilience weakened, and it returned more to the residential attribute, so the moderating effect was no longer significant. The overall explanatory power of the model ($R^2 = 0.762$) also confirms the strong explanatory power of the healthy development of real estate on the changes in economic resilience during the resistance period, reflecting the dynamic transformation of the functional positioning of real estate in different economic cycles. In general, the impact of real estate health on economic resilience has obvious cyclical dependence; it is more prominent during the economic resistance period, while the transmission is limited during the

downward pressure period. Therefore, policy formulation should be dynamically adjusted according to the current economic cycle, avoiding over-reliance on real estate stimulus during the recovery period, while strengthening its role as a "stabilizer" and "transmission carrier" during the resistance period to achieve the coordinated development of the real estate market and urban economy.

5.6. Test of spatial spillover effects

Both theoretical and empirical evidence indicates a significant spatial clustering pattern among Chinese cities with similar levels of real estate health and economic resilience. The underlying mechanism can be attributed to the spatial spillover effects exerted on economic resilience by factors such as the real estate market's development model, resource allocation efficiency, and policy interventions (Zhang et al., 2023). For instance, real estate investment attracts capital, labor, and technology to cities with high real estate health via a "siphon effect", which enhances local economic resilience while potentially constraining the resource accumulation capacity of neighboring cities (Qi et al., 2024). Meanwhile, the transmission mechanism of real estate policies exhibits spatial diffusion characteristics; regulatory policies implemented in one locality may propagate to surrounding regions through industrial linkages or market expectations (Li et al., 2021; Li et al., 2023). However, under high climate policy uncertainty, such spillovers may amplify systemic banking risk rather than promote stability (Liu et al., 2024; Wu et al., 2024).

Further analysis reveals a dual nature in the spatial spillover effects of real estate health. On the one hand, a well-regulated and healthy real estate market can strengthen local economic resilience by improving infrastructure and public services, while also driving industrial upgrading in neighboring cities through regional synergy. On the other hand, excessive expansion of the real estate sector may lead to over-reliance on land finance and the hollowing of real industries. Moreover, under environmental or policy uncertainty, firms may engage in fraudulent reporting to mask underlying fragility (Chen et al., 2025), while large shareholders may accelerate equity sales to exit overheated markets (Zhang et al., 2024), further destabilizing local economies, thereby widening interregional disparities in economic resilience. For example, rapidly rising housing prices may exacerbate capital misallocation, dampen investment enthusiasm in cities with lower price levels, and ultimately hinder their economic resilience.

In the digital economy era, the spatial spillover effects of real estate health are also influenced by the flow of data elements. Digital management practices, such as smart communities and intelligent property management, may facilitate digital transformation in adjacent areas through technology diffusion. However, if the improvement of real estate health relies excessively on short-term financial leverage or land conveyance, policy adjustments could trigger cross-regional risk transmission (Li et al., 2021).

Therefore, the impact of sound real estate development on urban economic resilience is not confined to the local level. It may also generate significant spatial spillover effects through mechanisms such as factor mobility, policy demonstration, or risk transmission. The direction and magnitude of these effects warrant in-depth analysis based on regional economic structures, policy environments, and developmental stages.

5.6.1. Global Moran's I test

To fully characterize the spatial spillover effect of healthy real estate development on urban economic resilience, this study adopts three spatial weight matrices for comparative analysis: adjacency matrix, geographical inverse distance matrix, and economic-geographical nested matrix. The adjacency matrix, defined by administrative boundary adjacency, sets a weight of 1 for cities sharing a boundary and 0 otherwise, capturing the direct "neighbor effect" and linking policy transmission and factor flow between adjacent cities. The geographical inverse distance matrix uses the reciprocal of inter-city distance as weights, with higher weights for closer cities, reflecting the distance decay law of economic activities and aligning with actual spatial transmission logic. To address the limitation that pure geographical matrices cannot reflect economic linkage differences, a nested matrix integrating economic scale and geographical distance is constructed (Deng et al., 2025). It takes urban economic scale as a weight, assigning greater influence to more developed cities, considering both distance attenuation and inter-city factor flow and industrial coordination, which is more consistent with the actual characteristics of regional economic linkage.

To examine the potential spatial autocorrelation between urban economic resilience and real estate health, a global Moran's I test was conducted for these two variables across the sample cities from 2012 to 2021. As shown in Table 9, regardless of whether the adjacency matrix, inverse geographical distance matrix, or economic-geographical nested matrix was used, the Moran's I indices for both variables were statistically significant at the 1% level and consistently positive. This indicates the presence of significant spatial dependence and a positive correlation among cities in terms of economic resilience and real estate health. These findings suggest that a city's economic resilience or real estate health is influenced not only by local factors but also by interactions with corresponding indicators in neighboring or economically connected regions.

In constructing the spatial weight matrices, three types were adopted: an adjacency matrix (assigned a value of 1 for adjacent cities and 0 otherwise), an inverse geographical distance matrix (weighted by the reciprocal of geographical distance), and an economic-geographical nested matrix (incorporating the ratio of average city GDP as an economic weight in addition to inverse geographical distance). The results demonstrate that under all three matrix specifications, both urban economic resilience and real estate health exhibit significant spatial clustering, with the positive correlation remaining robust across each weighting scheme. This further validates the interactive mechanism of economic resilience and real estate health across regions (Luan and Hamp, 2025), underscoring the need for policymakers to account for spatial linkage effects to optimize regionally coordinated development pathways.

Table 9. Moran's I of urban economic resilience and real estate health.

Year	Urban Economic Resilience			Real Estate Health Development		
Principle layer	Adjacency Matrix	Inverse Distance Matrix	Economic-Nested Matrix	Adjacency Matrix	Inverse Distance Matrix	Inverse Distance Matrix
2012	0.256***	0.170***	0.354***	0.086***	0.078***	0.166**
	(6.586)	(9.591)	(12.755)	(2.245)	(4.475)	(4.206)
2013	0.254***	0.176***	0.331***	0.208***	0.153***	0.151***
	(5.515)	(9.881)	(11.888)	(5.283)	(8.511)	(5.418)
2014	0.246***	0.166***	0.361***	0.0191***	0.166***	0.173***
	(6.323)	(9.326)	(12.958)	(4.582)	(9.199)	(6.159)
2015	0.255***	0.173***	0.357***	0.190***	0.169***	0.135***
	(6.527)	(9.707)	(12.813)	(4.825)	(9.336)	(4.837)
2016	0.255***	0.178***	1.349***	0.198***	0.142***	0.130***
	(6.525)	(9.974)	(12.504)	(5.012)	(7.868)	(4.663)
2017	0.253***	0.180***	0.357***	0.301***	0.198***	0.118***
	(6.440)	(10.064)	(12.726)	(7.540)	(10.886)	(4.246)
2018	0.260***	0.188***	0.347***	0.281***	0.170***	0.113***
	(6.644)	(10.503)	(12.395)	(7.042)	(9.363)	(4.059)
2019	0.240***	0.177***	0.314***	0.161***	0.085***	0.121***
	(6.147)	(9.953)	(11.280)	(4.083)	(4.793)	(4.345))
2020	0.268***	0.197***	0.314***	0.202***	0.092***	0.074***
	(6.878)	(11.035)	(11.269)	(5.008)	(5.167)	(2.706)
2021	0.251***	0.182***	0.295***	0.233***	0.106***	0.085***
	(6.436)	(10.216)	(10.602)	(5.616)	(5.892)	(3.080)

Note: Z-statistics are reported in parentheses, The Moran's I statistic tests the null hypothesis of no spatial autocorrelation, ***, * *, * respectively indicate significant at the 1%, 5%, and 10% levels, respectively, indicating rejection of the null hypothesis.

5.6.2. Test of spatial spillover effects

To determine the appropriate spatial econometric model, Lagrange Multiplier (LM) tests were performed. From the data results in Table 10, both the LM-lag and LM-error tests were statistically significant under all three spatial weight matrices, supporting the selection of the spatial Durbin model (SDM) for estimation.

Table 10. Results of Lagrange Multiplier (LM) tests.

Test	Adjacency Matrix	Inverse Distance Matrix	Economic-Geographical Nested Matrix
LM (error) Test	525.526***	849.274***	432.769***
LM (lag) Test	67.022***	159.307***	932.432***

Note: The table presents the results of the Lagrange Multiplier (LM) tests for spatial dependence, LM (error) and LM (lag) tests the null hypothesis of no spatial error dependence and no spatial lag dependence, respectively， *** denotes statistical significance at the 1% level.

Table 11. Spatial spillover effects of real estate health on urban economic resilience.

Type of Spatial Weight Matrix	Adjacency Matrix	Inverse Distance Matrix	Economic-Geographical Nested Matrix
Rh	2.560*** (20.81)	2.689*** (21.33)	2.225*** (19.26)
W×*Rh*	−0.497** (−2.81)	−0.983** (−2.13)	0.705*** (0.042)
Spatial Autoregressive Coefficient	0.460*** (20.13)	0.786*** (23.88)	0.556*** (18.87)
Control Variables	YES	YES	YES
Fixed Effects	YES	YES	YES
Direct Effect	2.654*** (20.71)	2.771*** (21.56)	2.383*** (19.35)
Indirect Effect (Spillover)	1.148*** (2.92)	5.415*** (2.49)	4.209*** (5.43)
Total Effect	3.801*** (8.58)	8.158*** (3.72)	6.592*** (7.97)
R^2	0.187	0.378	0.597
Log-likelihood	−1555.1469	−1611.1864	−1442.7377

Note: The table presents the estimation results of the SDM, t-statistics are reported in parentheses, ***, **, * respectively indicate significant at the 1%, 5%, and 10% levels, respectively; The direct effect captures the impact within a city, the indirect effect measures the spillover impact on neighboring cities, and the total effect is their sum.

As presented in Table 10, the magnitude and direction of spillovers vary significantly across spatial weight specifications, indicating context-dependent transmission mechanisms.

Taking the adjacency matrix as an example, both the direct (2.654***) and indirect (1.148***) effects of real estate health are significant at the 1% level. This indicates that geographical proximity serves as a critical channel for its impact. This mechanism may originate from the centripetal forces of economic agglomeration, whereby neighboring cities generate positive spillovers through factor mobility (e.g., cross-regional allocation of labor and capital), technology diffusion (e.g., localization and application of innovations), and resource sharing (e.g., networked infrastructure).

Under the inverse distance matrix, the direct effect (2.771***), indirect effect (5.415***) and total effect (8.158***) are all significantly positive at the 1% level, with their intensity notably higher than that under the adjacency matrix. This result is consistent with the "core-periphery" structure of spatial knowledge spillover: regions with high economic relevance strengthen the spatial transmission effect of

real estate health through technological spillovers (e.g., the docking of technical standards in the upper and lower industrial chains) and optimized resource allocation (e.g., cross-regional supply chain integration). In addition, the spatial autoregressive coefficients (rho) of the three types of matrices are all highly significant, indicating the widespread existence of spatial dependence in urban economic resilience, that is, urban economic resilience is not only affected by its own real estate health but also significantly influenced by the economic status of surrounding cities. Overall, compared with pure geographical proximity or distance, economic relevance can better amplify the positive spillover effect of real estate health on urban economic resilience, highlighting the important significance of in-depth nesting of economic networks for regional coordinated development (Zhou et al., 2021; Wang et al., 2025).

In summary, the spatial spillover effects of a healthy real estate sector on urban economic resilience exhibit significant heterogeneity. The magnitude and direction of these effects are closely associated with the choice of spatial weight matrix. Policy design should prioritize regionally coordinated strategies underpinned by strong institutional foundations. For instance, judicial independence enhances corporate accountability and resource allocation efficiency (Miao et al., 2024), while legal certainty reduces distortions in credit allocation across regions (Miao et al., 2024). Such institutions enable effective cross-regional industrial alliances and technology-sharing platforms. By improving information transparency, such as through investor site visits that accelerate corporate adjustment to local conditions (Cao et al., 2025) and aligning shareholder incentives with long-term performance (Zhang et al., 2024), cities can optimize the allocation of key factors (e.g., human capital and innovation infrastructure), thereby amplifying positive spatial spillovers. Concurrently, vigilance is required against potential competitive effects that may arise under geographically inverse-distance-based weights, such as resource competition stemming from policy convergence in subsidy schemes or land-use regulations. These findings provide an empirical basis for formulating differentiated regional development policies and underscore the critical role of dense interregional economic linkages in fostering regional synergistic development.

5.7. Core results summary

Based on the empirical analysis above, the core empirical results of the entire study are systematically sorted out and summarized in Table 12. The results show that the healthy development of real estate has a significantly positive impact on urban economic resilience, which is transmitted through two paths: per capita infrastructure capital stock and innovation and entrepreneurship vitality. The effect exhibits obvious heterogeneity in geographical location, resource endowment, administrative level and economic development stage, and there is a significant positive spatial spillover effect.

Table 12. Summary of key empirical results.

Empirical Test	Key Variables	Key Coefficient and Significance	Core Conclusion
Baseline Regression	Real Estate Healthy Development	2.117***	Healthy real estate development Exerts a significant positive effect on urban economic resilience.
Mediation Analysis	Per Capita Infrastructure Capital Stock	Mediation effect = 0.233***, Mediation ratio = 0.110	Mediation accounts for 11.0%, indicating effective transmission.
	Innovation and Entrepreneurship Activity	Mediation effect = 0.841***, Mediation ratio = 0.397	Mediation accounts for 39.7%, indicating effective transmission.
Regional Heterogeneity	Eastern > Central > Western	2.980*** > 1.238* > 1.880***	Significant disparities exist across geographic locations.
	Resource-based > Non-resource-based	-1.880*** > 0.599***	Significant differences are observed based on urban resource endowments.
	Provincial capitals cities > Non-provincial capital cities	1.184*** > 1.199	Significant differences are associated with administrative level
	Economic Resistance Period > Recover Period	1.825*** > 0.445	Significant variation is evident across distinct phases of the economic cycle.
Spatial Spillover Effect	Direct effect, Indirect effect, Total effect	All coefficients significant	Significant spatial spillovers are present in both local and adjacent regions.

Note: ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

6. Research conclusions and policy recommendations

Based on panel data of 278 prefecture-level and above cities in China (2012–2021), this study explores the relationship, mechanism, and spatial spillover effect between real estate health and urban economic resilience. It finds that real estate health significantly enhances urban economic resilience, acts indirectly through infrastructure and entrepreneurship, shows heterogeneous effects across city types, and has positive spatial spillover, the following policy recommendations can be drawn:

(1) Building real estate-industry linkage for resource-based cities

In response to the empirically proven significant positive effect of real estate health on economic resilience in resource-based cities, the risk of resource depletion should be mitigated through the coordinated development of real estate and industries. It is recommended to introduce industrial guidance requirements in the land transfer process, allocate a portion of land transfer proceeds directly to the urban transformation guidance fund, and specifically support the incubation of non-resource-based industries. Meanwhile, encourage pilot projects of customized real estate, guide developers to construct industrial complexes integrating research and development offices and high-quality

residential spaces, and leverage the investment-driven effect of the real estate industry to provide physical carriers and financial buffers for industrial diversification, thereby enhancing the city's systemic resilience during the dynamic transition period.

(2) Improving infrastructure connectivity in central-west

Given that the real estate spillover effect verified by the spatial Durbin model is limited by geographical friction in central and western regions, priority should be given to enhancing the capacity of these regions to absorb spillover dividends from eastern China. It is suggested to increase investment in cross-regional high-speed rail lines and national-level computing power hubs, construct a dual connectivity network of transportation and data, and substantially reduce the spatial friction coefficient. The policy focus should shift from isolated local development to deepening the nesting of cross-regional economic networks. By shortening the temporal and spatial distance from high-energy cities in the east, it can effectively attract the talent and capital flows released by the mature real estate market and realize regional coordinated growth through the spatial spillover mechanism.

(3) Adopting city-specific dynamic real estate regulation

Based on the differentiated results of the heterogeneity test across cities of different levels, a more precise linked regulation mechanism for the real estate market should be established in conjunction with the dynamic early-warning indicators of urban economic resilience. For cities with low resilience and high real estate dependence, strict restrictions on land transfer premiums and emphasis on building quality should be imposed at the land transfer stage to prevent speculative bubbles from crowding out innovative resources. For cities with strong resilience and mature market development, efforts should be made to promote a flexible housing supply system that balances rental and purchase, stabilize the city's talent base by protecting the residential rights and interests of new urban residents, and promote the transformation of real estate from a mere asset investment attribute to a public service attribute that supports high-quality development.

(4) Strengthen the transmission function of mediating paths and synergistically enhance innovation vitality and infrastructure quality.

To activate the transmission chain of "real estate — infrastructure/innovation — resilience", it is recommended to mandate the supporting construction of inclusive public service facilities and digital shared office spaces at the project planning stage, and incorporate "integration of industry, city, and people" into the development access evaluation. This approach has been successfully verified in Tianjin Binhai New Area: by stabilizing talent expectations through high-quality residential housing and improved supporting facilities, the area has attracted the agglomeration of a large number of technology enterprises and high-skilled labor, which in turn has spawned multiple innovation parks and entrepreneurship incubation platforms, forming a virtuous cycle of "real estate supporting livable environment — talent inflow — innovation emergence — industrial upgrading". This case fully proves that if the healthy development of real estate is deeply coupled with the upgrading of urban functions, it can not only improve residential quality but also become a core engine driving the leap of economic resilience.

Author Contributions

Hua Qian and Qian Sun contributed to the conception and design of the study. Yong Tang collected the data. Lanzhi Mei and Ju Wei performed the statistical analysis and wrote the first draft

of the manuscript. Qian Sun and Fangya Li contributed to manuscript revision. All authors read and approved the final submitted version.

Use of AI tools declaration

The authors used AI tools for language and readability enhancement, and take full responsibility for the final content after review and revision.

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Conflict of Interest

The authors declare that there are no conflicts of interest related to this study.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request. Restrictions apply to the availability of these data, which were used under license for this study, and so are not publicly available.

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