frontiers | Frontiers in Sustainable Food Systems

TYPE Original Research
PUBLISHED 06 January 2026
DOI 10.3389/fsufs.2025.1743334



OPEN ACCESS

EDITED BY
Liye Wang,
Shandong University of Finance and Economics, China

REVIEWED BY
Shengpeng Wang,
East China Normal University, China
Songpei Zhang,
Renmin University of China, China

*CORRESPONDENCE
Qiong Deng
✉ d201981175@hust.edu.cn
Xinhai Lu
✉ xinhailu@163.com

†These authors have contributed equally to this work and share first authorship

RECEIVED 10 November 2025
REVISED 27 November 2025
ACCEPTED 03 December 2025
PUBLISHED 06 January 2026

CITATION
Zheng W, Deng Q, Zou X, Baker D and Lu X (2026) Economic growth targets and urban sprawl: evidence from the Yangtze River economic belt, China.
*Front. Sustain. Food Syst.* 9:1743334.
doi: 10.3389/fsufs.2025.1743334



# Economic growth targets and urban sprawl: evidence from the Yangtze River economic belt, China

Weibo Zheng[1†], Qiong Deng[1*†], Xianming Zou[1,2], Douglas Baker[3] and Xinhai Lu[1*]

[1]College of Public Administration, Huazhong University of Science and Technology, Wuhan, China, [2]Lianyungang Housing and Urban Rural Development Bureau, Lianyungang, China, [3]School of Architecture & Built Environment, Queensland University of Technology, Brisbane, QLD, Australia

Urban sprawl has become a major challenge for sustainable development in the Yangtze River Economic Belt (YREB). This study examines how economic growth targets set by local governments influence urban sprawl and explores the underlying mechanisms. Using panel data for 110 cities from 2006 to 2022, we apply a two-way fixed effects model and incorporate land finance dependence as a mediating variable. The results show that: (1) higher economic growth targets significantly increase urban sprawl, and this conclusion is robust to endogeneity and multiple sensitivity tests; (2) the effect displays clear spatial and temporal heterogeneity—positive in upstream regions and before 2018, but weaker or reversed in later years; and (3) economic growth targets intensify reliance on land finance, which partially mediates their impact on urban sprawl. These findings highlight the need for integrated land-use planning, reforms in performance evaluation systems, and more flexible and sustainable growth target management to curb disorderly land expansion and strengthen food system and land resource sustainability in the YREB.

KEYWORDS

**economic growth target, land finance dependence, two-way fixed effects model, urban sprawl, Yangtze River economic belt**

## 1 Introduction

Urban sprawl has long been recognized as a widespread phenomenon accompanying rapid urbanization. Its characteristics include low-density expansion, decentralized development, and extensive consumption of land resources, posing serious challenges to sustainable spatial and economic development (Brueckner, 2000; Whyte, 1958). As the problems associated with Urban sprawl became increasingly evident, the phenomenon began to attract growing scholarly attention, and its connotations have since been greatly enriched. Scholars have examined Urban sprawl from various perspectives, including the spatial development patterns of cities, the characteristics of sprawl, and the social and environmental issues it engenders (Ewing et al., 2003; Downs, 1994; Galster et al., 2001). Overall, Urban sprawl can be understood as a spatial development pattern in the urbanization process that is characterized by low density, disorder, lack of planning, and dependence on private transportation, typically expanding from the urban core toward the suburban periphery.

Urban sprawl is not only a challenge for urban spatial governance but also poses direct threats to agricultural land protection and regional food system sustainability. In rapidly urbanizing regions such as the Yangtze River Economic Belt (YREB), the outward expansion

of built-up areas frequently encroaches on high-quality arable land located at the urban fringe, reducing the land available for peri-urban food production and weakening the ecological functions that support local food systems. The loss and fragmentation of agricultural land can undermine regional food self-sufficiency, increase dependence on distant food sources, and elevate the environmental costs of food transportation. Furthermore, unplanned low-density development may disrupt the spatial contiguity of farmland, hinder agricultural logistics, and elevate land-use conflicts between urban construction and agricultural preservation. Therefore, examining the institutional and policy drivers of urban sprawl is crucial not only for understanding urban spatial dynamics but also for ensuring sustainable land management and strengthening the resilience of regional food systems.

Economic growth targets are a distinctive feature of China's governance system. Although performance assessments have gradually diversified, GDP-related indicators continue to shape the incentives and behaviors of local governments (Wang et al., 2021; Bai et al., 2025). For a long time, governments at all levels in China have set relatively clear economic growth targets in their annual government work reports, using these targets to guide the economic development of their jurisdictions (Guo et al., 2024). Research has shown that economic growth targets not only serve as an important instrument for higher-level governments to manage and incentivize subordinate officials, but also provide local officials with a tool to vigorously develop the local economy and demonstrate their proactive stance to superiors (Du and Yi, 2021). However, some scholars argue that economic growth targets are a double-edged sword, often inducing resource misallocation, excessive infrastructure investment, and a boom in new city construction, reflecting short-sighted behaviors of officials (Chen and Jia, 2021; Peng and Lu, 2019). Evidently, after setting economic growth targets, local governments—driven by the target responsibility system and promotion incentives—may use these targets as a means to guide or even intervene in the allocation of local resources, thereby influencing urban sprawl. This raises the question: does achieving economic growth targets inevitably come at the cost of extensive urban sprawl? To address this question, the research examines 110 cities in the YREB from 2006 to 2022, employing pooled OLS and fixed-effects models to investigate the mechanisms through which economic growth targets affect urban sprawl.

Existing literature closely related to this study can be categorized into three main streams. First, urban sprawl has long been a focal topic in academia, with both its theoretical connotations and measurement approaches continuously expanding and deepening. Urban sprawl research has evolved from describing spatial expansion patterns to identifying its socioeconomic and institutional determinants. Existing scholarship provides multiple approaches to measure sprawl, including fractal dimension methods, population–land growth ratios, multidimensional compactness indicators, and more recently, remote-sensing-based techniques that leverage night-time light data to delineate urban boundaries (Yasin et al., 2021; Torrens, 2006; Zhang L. et al., 2023; Lopez and Hynes, 2003; Frenkel and Ashkenazi, 2008; Hamidi and Ewing, 2014; Sutton, 2003; Ehrlich et al., 2018). These methods collectively demonstrate that urban sprawl is shaped by a combination of transportation development, market forces, household preferences, and environmental amenities (Galster et al., 2001; Zhang Y. et al., 2023; Sutton, 2003; Pourtaherian and Jaeger, 2022; Monica and Paolo, 2015). However, a growing body of work highlights the critical role of governance structures—particularly land-use regulation and fiscal incentives—in shaping the extent and form of spatial expansion (Yasin et al., 2021; Pourtaherian and Jaeger, 2022; Huang et al., 2021).

Second, institutional and governance dynamics have emerged as central drivers of land development in China. Studies on land-based finance, intergovernmental competition, and fiscal decentralization show that local governments frequently accelerate land conversion to meet fiscal needs and stimulate investment (Faber, 2014; Amedzro et al., 2024; Cho, 2001; Wu, 2006; Hassan et al., 2023; Mills, 1967; Brueckner, 2000; Dadi et al., 2016). These governance incentives often weaken planning constraints, disrupt the protection of agricultural land, and fuel leapfrog suburban development (Wu, 2006; Xu and Gao, 2021; Zhou et al., 2015; Nazarnia et al., 2016). Existing research thus underscores that urban sprawl in China is not merely a market-driven spatial outcome but a product of policy and institutional arrangements (Zhou et al., 2015; Lu et al., 2023; Zhang et al., 2022; Zhang L. et al., 2023).

Third, economic growth targets represent a particularly influential institutional mechanism shaping local government behavior. Prior studies show that economic growth targets can stimulate short-term growth but also lead to resource misallocation, excessive infrastructure investment, environmental degradation, and distortion of industrial structure (Wang et al., 2023; Sun et al., 2023; Sun et al., 2024; Li H. et al., 2023). Despite extensive research on their economic and environmental consequences, the relationship between economic growth targets and urban spatial expansion remains insufficiently explored. Specifically, existing literature does not systematically analyze how growth targets influence land development incentives, nor how these targets interact with land finance to drive urban sprawl (Zheng et al., 2014; Yang et al., 2023; He et al., 2016; Yu et al., 2022). Moreover, few studies examine the regional and temporal heterogeneity of this relationship within major national development corridors such as the YREB.

Overall, existing research has become relatively extensive; however, few studies have examined the impact of economic growth targets on urban sprawl. Therefore, this study focuses on the relationship between economic growth targets and urban sprawl, employing pooled OLS and fixed-effects models to investigate the effects of economic growth targets on urban sprawl, as well as the mediating role of land finance. By addressing this gap, the study aims to both extend and deepen the scope of urban sprawl research and broaden the analytical perspective on economic growth targets, providing a reference for future related studies and offering theoretical support for promoting healthy urbanization.

## 2 Theoretical and hypotheses

### 2.1 Economic growth targets and urban sprawl

Under the management model of economic growth targets, local governments are strongly motivated to set relatively high targets due to promotion incentives. In order to achieve short-term economic growth and meet the predetermined targets, local governments often adopt a series of myopic economic behaviors, which distort fiscal expenditure structures and may introduce certain preferences in industrial selection, further contributing to urban sprawl.

On one hand, the setting of economic growth targets directly influences the allocation of local government fiscal expenditures, leading to distortions that can trigger urban sprawl. Fiscal expenditure constitutes an important component of local government financial activities. Under the promotion incentive mechanism, local officials tend to prioritize projects with high short-term returns to achieve the economic growth targets established at the beginning of the year. Infrastructure investment, as the most controllable and directly effective tool for promoting regional economic growth, is often the preferred direction for fiscal resource allocation (Zhou et al., 2021). In contrast, expenditures on public services such as healthcare, social security, and education, which are less effective in driving short-term economic growth, are frequently neglected, thereby constraining the process of population urbanization to some extent (Bai et al., 2025). Consequently, under the drive of economic growth targets, the distortion of local government expenditure structures is a predictable factor contributing to low-density and disorderly urban expansion.

On the other hand, economic growth targets also influence local governments' industrial selection, shaping preferences that further induce urban sprawl. To achieve higher growth targets, local governments tend to favor industries that require relatively low investment but yield quick returns in the short term (Liao et al., 2019). In contrast, high-risk, high-investment, and long-cycle technology-based enterprises are less likely to be prioritized under high growth pressure. Such industrial preference not only suppresses technological innovation and creates development bottlenecks and diseconomies of scale but also crowds out investment in producer services such as R&D and logistics, in favor of capital-intensive sectors represented by real estate. From a spatial perspective, compared to technology-oriented enterprises, production-oriented industries typically occupy larger land areas and are more sensitive to costs, leading them to locate in relatively low-cost suburban areas, thereby exacerbating urban sprawl.

Based on the above, this study proposes,

> *Hypothesis* 1 (H1): Economic growth targets have a positive effect on urban sprawl.

## 2.2 The mediation role of land finance

Land finance has exerted profound effects on economic development, urban construction, and social transformation. Since China's primary land market is entirely monopolized by the government, land transfers have become a crucial means for local governments to generate short-term fiscal revenue and fill budget gaps. The motivation and scale of land transfers are also closely related to the magnitude of local fiscal deficits—the larger the deficit, the stronger the incentive for land transfers (Huang et al., 2021).

Based on the above analysis, to maximize short-term revenue through higher land finance income, local governments tend to expand the scale of land transfers. Specifically, because the costs of acquiring peripheral farmland are relatively low and the resistance to relocation is minimal, the net revenue from land transfers in new urban areas is significantly higher than that from urban redevelopment. Consequently, local governments are strongly motivated to prioritize the development of new urban districts over the renewal of existing land stock. This practice continuously pushes the boundaries of existing cities, thereby triggering disorderly urban sprawl.

Moreover, under the promotion tournament system, if a local government expands land transfers to increase fiscal revenue, competing jurisdictions are likely to adopt similar strategies to achieve their economic growth targets. To gain a competitive advantage, local governments may even lower the unit price of land transfers. Clearly, lower land costs inevitably result in land development proceeding faster than actual population demand, further exacerbating disorderly urban expansion. Additionally, under the dual pressures of increasing fiscal revenue and promoting regional economic growth, local governments often adopt preferential policies for selling industrial land at low prices to attract firms that offer short investment return cycles, high revenue rates, and substantial taxable income (Sun et al., 2020). Industrial agglomeration, in turn, attracts labor inflows, increasing demand for residential land in surrounding areas and stimulating the real estate market (Liu et al., 2016). Facing strong housing demand, to subsidize industrial land development costs, local governments usually adopt high-price strategies for residential land. This directly increases urban residents' housing costs, prompting population migration to urban peripheries and further driving spatial expansion.

Based on the above analysis, this study proposes,

> *Hypothesis* 2 (H2): Land finance mediates the relationship between economic growth targets and urban sprawl.

This study constructed a theoretical framework for the impact of economic growth targets on urban sprawl, as shown in Figure 1.

# 3 Research design

## 3.1 Research area and data sources

As one of China's most important national development corridors, the YREB accounts for more than 40% of the country's GDP, contains several of its largest metropolitan clusters, and is a key engine of technological and industrial upgrading. Rapid economic development in this region has been accompanied by extensive land conversion, strong reliance on land-based revenues, and significant pressures on agricultural land and ecological systems. It also faces challenges such as rapid urban expansion, suboptimal urban spatial structures, and uncoordinated and uneven development (Xu et al., 2023). Approximately 95% of cities in the YREB have already experienced urban sprawl, severely constraining the sustainable development of cities and regions (Yue et al., 2016; Guan et al., 2020). The YREB is also a strategic region for national food security and ecological protection. The middle and lower reaches contain some of China's highest-quality arable land, yet they also face intense land conversion pressures due to rapid industrial and urban growth. Against this backdrop, a thorough investigation of urban sprawl in the YREB and an understanding of the relationship between economic growth targets and urban sprawl are crucial for comprehending regional urbanization, curbing disorderly urban land expansion, and promoting regional sustainable development.

The YREB spans the eastern, central, and western regions of China, encompassing 11 provinces and municipalities, including

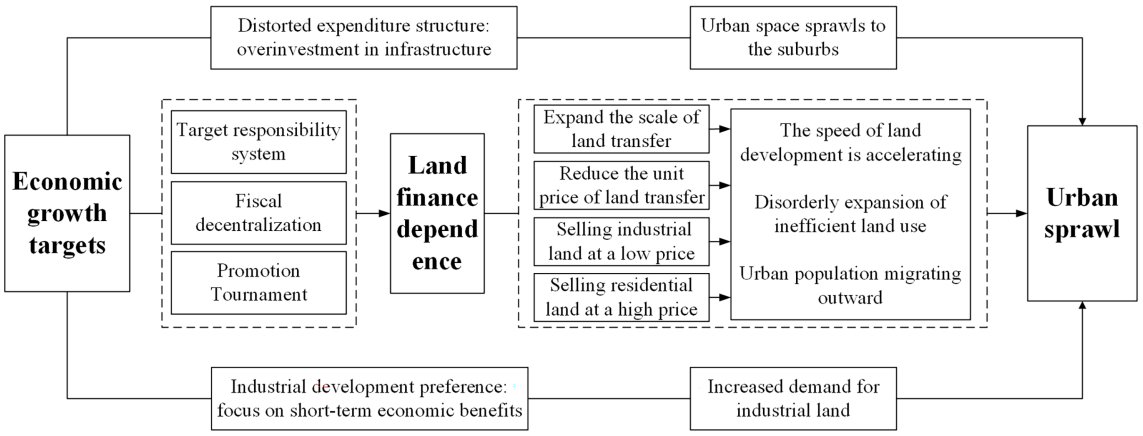


FIGURE 1
Theoretical framework of the impact of economic growth targets on urban sprawl.

Shanghai, Jiangsu, Zhejiang, Anhui, Jiangxi, Hubei, Hunan, Chongqing, Sichuan, Yunnan, and Guizhou. Covering an area of approximately 2.0523 million square kilometers—accounting for 21.4% of China's territory—the region contributes more than 40% of the country's population and GDP. This study focuses on 110 prefecture-level and above cities in the YREB during 2006–2022, excluding a few ethnic autonomous prefectures such as Enshi Tujia and Miao Autonomous Prefecture in Hubei and Dali Bai Autonomous Prefecture in Yunnan due to substantial data gaps, as well as provincial-level county cities and regions that have undergone administrative adjustments. Based on their location within the river basin, the YREB is divided into upstream, midstream, and downstream regions, as illustrated in Figure 2.

The nighttime light data used in this study were obtained from the NPP-VIIRS-like dataset, while population density data were sourced from the LandScan dataset. Data on economic growth targets were collected from annual government work reports published by local governments at various levels. The mediating and control variables were obtained from the China Land and Resources Statistical Yearbook, China Statistical Yearbook, China Urban Statistical Yearbook, the statistical bureaus of individual cities, and the China Economic and Social Big Data Research Platform. Missing data were supplemented using linear interpolation or mean imputation. In addition, per capita disposable income of urban households was deflated to 2006 constant prices using the Consumer Price Index (CPI). To mitigate the influence of extreme values, all continuous variables were winsorized at the 1% level on both tails.

## 3.2 Model

To examine the impact of economic growth targets on urban sprawl, this study establishes the following fixed effects model. The model Equation 1 is as follows

$$sprawl_{i,t} = b_0 + b_1 target_{i,t} + gX_{i,t} + l_i + m_t + e_{i,t} \quad (1)$$

In the Equation 1, *sprawl* represents the degree of urban sprawl, *target* denotes the economic growth target, and *X* is a set of control variables, including city population size (*cpop*), urban residents' income level (*income*), industrial structure (*struc*), transportation infrastructure level (*traffic*), commuting cost (*commute*), and local fiscal pressure (*fiscal*). The subscript *i* refers to the sampled city, and *t* refers to the year. $\beta_0$ is the constant term; $\beta_1$ and $\gamma$ represent the coefficients for the core explanatory variable and the control variables, respectively; $\lambda_i$ and $\mu_t$ denote city and year fixed effeScts; and $\varepsilon_{it}$ is a random disturbance term assumed to follow a normal distribution N $(0, \sigma^2)$.

To comprehensively characterize the intrinsic relationships among economic growth targets, land finance dependence, and urban sprawl, as well as between economic growth targets, industrial structural changes, and urban sprawl, and to better identify causal relationships and indirect mechanisms, this study follows the approach proposed by Fan and Zhou (2019) to construct the following mediating effect models. The model Equations 2–4, are as follows

$$sprawl_{i,t} = b_0 + b_1 target_{i,t} + g_1 X_{i,t} + l_i + m_t + e_{i,t} \quad (2)$$

$$M_{i,t} = a_0 + a_1 target_{i,t} + g_2 X_{i,t} + l_i + m_t + e_{i,t} \quad (3)$$

$$sprawl_{i,t} = j_0 + j_1 target_{i,t} + j_2 M_{i,t} + g_3 X_{i,t} + l_i + m_t + e_{i,t} \quad (4)$$

In the Equations 2–4, *M* represents the mediating variable, land finance dependence (LFD), while $\alpha_0$ and $\varphi_0$ are the constant terms. $\alpha_1$ and $\varphi_1$ denote the coefficients of the independent variable, economic growth target, and $\varphi_2$ represents the coefficient of the mediating variable. $\gamma_1$, $\gamma_2$, and $\gamma_3$ are the coefficients of the control variables. Specifically, $\alpha_1$ captures the effect of economic growth targets on the mediating variable; $\varphi_1$ and $\varphi_2$ represent the direct effects of economic growth targets and the mediating variable on urban sprawl, respectively; and the product $\alpha_1\varphi_2$ reflects the mediating effect. When $\beta_1$, $\alpha_1$, and $\varphi_2$ are all statistically significant, a mediating effect is present. If $\beta_1$ is significant while $\alpha_1$ or $\varphi_2$ is not, the significance of $\alpha_1\varphi_2$ should be tested; if significant, a mediating effect exists. In cases where a mediating effect is present, if $\varphi_1$ is not significant, it indicates a full mediation effect; otherwise, it represents a partial mediation effect.

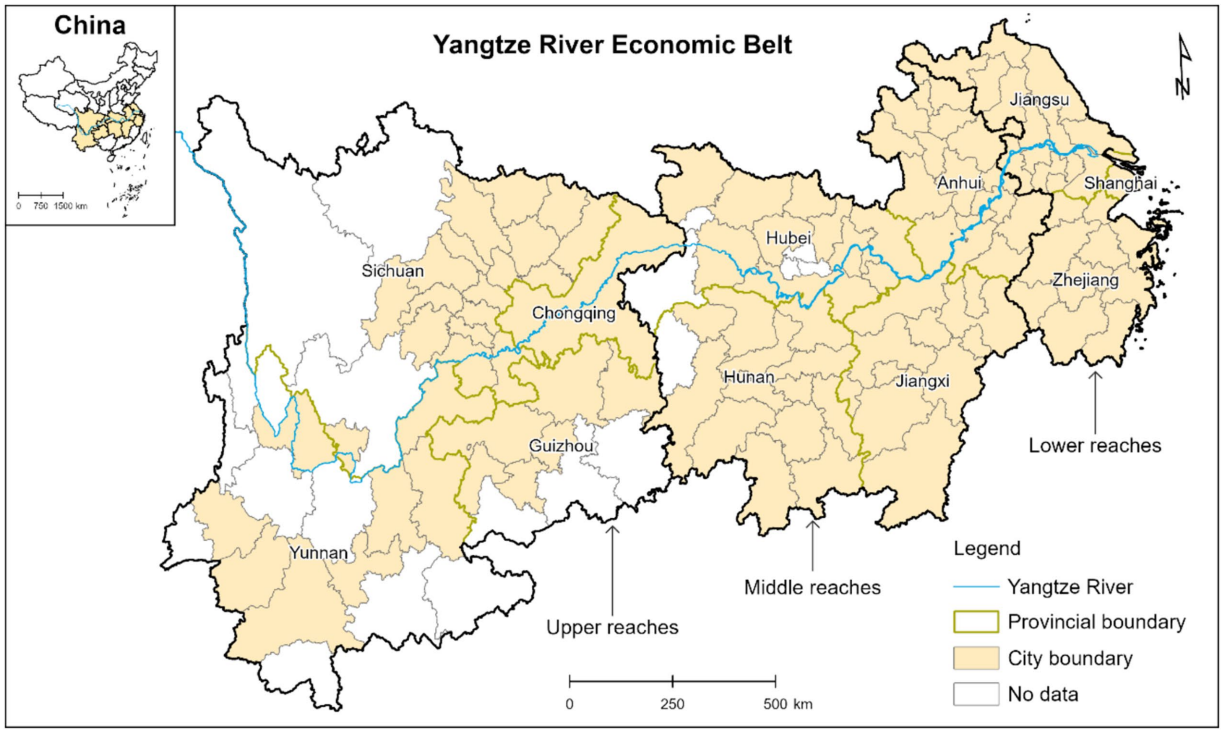


FIGURE 2
Research area.

## 3.3 Variable selection

### 3.3.1 Urban sprawl

Urban sprawl refers to the phenomenon of declining population density and decreasing land-use intensity accompanying urban expansion, rather than a mere increase in urban area or population size. Existing measurement approaches for urban sprawl primarily include the fractal dimension method, single-dimensional indicator method, multi-dimensional indicator method, and remote sensing data analysis method. Both the single- and multi-dimensional indicator methods may suffer from inaccuracies in defining urban boundaries and are often susceptible to statistical inconsistencies or data interference. In contrast, the remote sensing data analysis method has been increasingly recognized by scholars in recent years due to its strong visual interpretability, independence from statistical distortions, and ability to effectively extract urban spatial in-formation across large spatial and temporal scales. Based on these considerations, this study adopts the urban sprawl measurement approach proposed by Qin et al. (2019), which integrates global night-time light data with LandScan population data. The calculation formula is shown in Equation 5:

$$sprawl_{i,t} = 0.5 * \left( LA_{i,t} - HA_{i,t} \right) + 0.5 \quad (5)$$

In the Equation 5, *sprawl* denotes the degree of urban sprawl; *LA* and *HA* represent the proportions of areas within the city where the population density is lower and greater than or equal to the national average population density, respectively, relative to the total urban area. The subscript *i* indicates the sample city, and *t* denotes the year. The value of this index ranges from 0 to 1, with smaller values indicating a lower degree of urban sprawl.

This index effectively captures the spatial differentiation characteristics of urban population distribution, rather than treating the urban population as a homogeneous whole, thus providing a more precise measure of sprawl. Meanwhile, by defining urban areas as those with corrected nighttime light brightness (DN) values greater than or equal to 10 and population density greater than or equal to 1,000 persons per square kilometer, this method largely mitigates statistical biases and the effects of light spillover, allowing for a more accurate delineation of actual urban boundaries.

### 3.3.2 Economic growth target

The economic growth target is measured by the annual economic growth target values announced in the local governments' Government Work Reports. In certain years, some cities did not explicitly specify numerical targets in their reports. To ensure consistency and comparability, this study applied a standardized adjustment procedure. Specifically, when the growth target was described with modifiers such as "around," "approximately," or "above," the corresponding numerical value was directly adopted as the economic growth target. For targets expressed as an interval (e.g., "between X% and Y%"), the lower bound of the interval was selected as the city's economic growth target for that year.

This treatment is justified for two main reasons. First, the use of interval expressions is relatively uncommon, appearing only in a small subset of years and accounting for a negligible proportion of the 1,870 total samples. Second, given China's long-term economic performance, it is rare for a city's actual GDP growth rate to exceed the upper limit of the announced target range. Therefore, the lower bound can be reasonably interpreted as representing a target "above" a specific threshold, and serves as a consistent and

conservative measure of the local government's economic growth target.

### 3.3.3 Mediating variable

Based on the preceding theoretical analysis and relevant studies, this research selects land finance dependence (LFD) as the mediating variable. The concept of land finance revenue can be defined in both a narrow and a broad sense. In the narrow sense, it refers solely to land transfer fees (revenues from land-use rights transfers), whereas in the broad sense, it encompasses not only land transfer fees but also various land-related taxes and fees.

However, on one hand, land-related taxes and fees are complex in structure and difficult to obtain consistently across cities; on the other hand, land transfer fees constitute the principal component of broad land finance revenue. Given the substantial magnitude of land transfer fees, the contribution of land-related taxes and fees is negligible (Guo and Shi, 2018). Therefore, this study adopts land transfer fees as the measure of land finance revenue.

Moreover, under China's current fiscal budget system, state-owned capital operation income and social security fund income account for only a small proportion of local government revenues, whereas land transfer fees represent a substantial share of government fund budget revenues. Taking into account both theoretical considerations and data availability, this study measures local government fiscal revenue as the sum of general public budget revenue and land transfer fees.

Accordingly, the degree of land finance dependence is calculated using the Equation 6:

$$LFD_{i,t} = LTP_{i,t} / \left(GPBR_{i,t} + LTP_{i,t}\right) \tag{6}$$

In the Equation 6, *LFD* represents the degree of dependence on land finance; *LTP* stands for land transfer fee; *GPBR* stands for General Public Budget Revenue; *i* represents the sample city; *t* represents the year. The range of values for this indicator is (0,1), and the closer the value is to 1, the higher the dependence on land finance.

### 3.3.4 Control variable

The control variables are defined as follows:

(1) City population size (*cpop*): measured by the logarithm of the urban resident population.
(2) Urban household income level (*income*): measured by the logarithm of per capita disposable income of urban households.
(3) Industrial structure (*struc*): measured by the share of the secondary industry in the local GDP.
(4) Transportation infrastructure (*traffic*): measured by the per capita road area.
(5) Commuting cost (*commute*): measured by the number of public buses per 10,000 people within the municipal districts.
(6) Fiscal pressure (*fiscal*): measured by the ratio of the difference between general public budget revenue and expenditure to general public budget revenue.

The descriptive statistics of the main variables are shown in Table 1.

## 4 Empirical analysis

### 4.1 Baseline regression

This study performed correlation analysis and multicollinearity tests for all variables before the regression analysis. As shown in Table 2, the correlation coefficients between variables range from −0.691 to 0.635, with the absolute values of all coefficients below the critical threshold of 0.7, preliminarily indicating that there is no strong linear relationship among the explanatory variables.

While the correlation matrix provides an initial diagnostic, multicollinearity tests offer a more comprehensive assessment of the cumulative linear relationships among variables. To further ensure the stability of model estimates and to avoid potential distortions in coefficient estimation caused by high linear dependence among variables, this study conducted additional multicollinearity tests on the sample data. As shown in Table 3, no serious multicollinearity issues were detected among the variables.

Table 4 reports the estimation results of the pooled OLS model and the fixed-effects model, both without and with the inclusion of control variables. The empirical results indicate that the coefficients of economic growth targets on urban sprawl are positive and statistically significant at the 5% level across all model specifications, demonstrating that economic growth targets have a certain promoting effect on urban sprawl.

Specifically, Models (1) and (2) present the estimation results of the pooled OLS model. It is worth noting that even after including

TABLE 1 Descriptive statistics of the main variables.

| Variables | | N | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|---|
| Explained variable | sprawl | 1870 | 0.761 | 0.128 | 0.313 | 0.939 |
| Core explanatory variable | target | 1870 | 0.103 | 0.025 | 0.029 | 0.180 |
| Mediating variable | LFD | 1870 | 0.402 | 0.138 | 0.095 | 0.699 |
| Control variables | cpop | 1870 | 5.994 | 0.625 | 4.680 | 7.819 |
| | income | 1870 | 9.875 | 0.415 | 9.008 | 10.795 |
| | struc | 1870 | 0.464 | 0.090 | 0.247 | 0.680 |
| | traffic | 1870 | 17.609 | 7.369 | 4.110 | 40.432 |
| | commute | 1870 | 1.544 | 2.590 | 0.054 | 15.903 |
| | fiscal | 1870 | 1.696 | 1.396 | −0.072 | 6.522 |

10.3389/fsufs.2025.1743334

TABLE 2 The results of correlation analysis.

| Variables | sprawl | target | cpop | income | struc | traffic | commute | fiscal |
|---|---|---|---|---|---|---|---|---|
| sprawl | 1.000 | | | | | | | |
| target | 0.274*** | 1.000 | | | | | | |
| cpop | −0.318*** | −0.097*** | 1.000 | | | | | |
| income | −0.407*** | −0.691*** | 0.179*** | 1.000 | | | | |
| struc | −0.128*** | 0.279*** | −0.202*** | −0.054** | 1.000 | | | |
| traffic | −0.222*** | −0.378*** | −0.067*** | 0.492*** | −0.041* | 1.000 | | |
| commute | −0.353*** | −0.232*** | 0.635*** | 0.407*** | −0.133*** | −0.082*** | 1.000 | |
| fiscal | 0.330*** | 0.030 | −0.186*** | −0.392*** | −0.450*** | −0.206*** | −0.387*** | 1.000 |

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

TABLE 3 The results of multicollinearity tests.

| Variables | target | cpop | income | struc |
|---|---|---|---|---|
| VIF | 2.29 | 1.75 | 3.12 | 1.64 |
| | traffic | commute | fiscal | Mean |
| VIF | 1.58 | 2.47 | 2.06 | 2.13 |

TABLE 4 The results of baseline regression.

| Variables | sprawl | | | |
|---|---|---|---|---|
| | Pooled OLS Model | | Fixed-effects Model | |
| | (1) | (2) | (3) | (4) |
| target | 1.4171*** | 0.6439*** | 0.1738*** | 0.1144** |
| | (12.3196) | (4.2143) | (3.2809) | (2.2245) |
| cpop | | −0.0494*** | | −0.0448*** |
| | | (−9.3472) | | (−5.0557) |
| income | | −0.0495*** | | 0.0847*** |
| | | (−4.6507) | | (6.0834) |
| struc | | −0.3171*** | | −0.0072 |
| | | (−8.9136) | | (−0.4491) |
| traffic | | −0.0021*** | | 0.0008*** |
| | | (−5.0148) | | (4.7577) |
| commute | | −0.0064*** | | −0.0040*** |
| | | (−4.1861) | | (−4.0492) |
| fiscal | | 0.0040 | | 0.0044*** |
| | | (1.5375) | | (3.9011) |
| _cons | 0.6156*** | 1.6679*** | 0.7434*** | 0.1695 |
| | (50.6302) | (13.7650) | (135.7486) | (1.1355) |
| City FE | NO | NO | Yes | Yes |
| Year FE | NO | NO | Yes | Yes |
| $R^2$ | 0.075 | 0.291 | 0.961 | 0.964 |
| N | 1870 | 1870 | 1870 | 1870 |

***, **, and * indicate significance at the 1, 5 and 10%, respectively. Standard errors in parentheses.

the control variables, the model's goodness-of-fit is only 0.291, indicating that its explanatory power for the dependent variable remains limited. In addition, a notable limitation of the pooled OLS model is that it assumes all individuals share the same intercept, an assumption that ignores potential heterogeneity among cities and may introduce estimation bias. To identify the model most suitable for the characteristics of this study's sample data among the pooled OLS, random-effects, and fixed-effects models, a Hausman test was conducted. The results indicate that the null hypothesis - "the estimates of the random-effects model are consistent and efficient" - is rejected at the 1% significance level. This finding suggests that, compared with the random-effects model, the fixed-effects model more effectively captures the influence of individual heterogeneity, making it the preferred choice for this study.

Models (3) and (4) present the estimation results of the fixed-effects model. Consistent with the results of the pooled OLS models, the fixed-effects models also indicate that economic growth targets have a significant positive effect on urban sprawl, with the effect being statistically significant at the 5% level. Based on the results of the model with the highest goodness-of-fit (Model 4), a 1% increase in the economic growth target corresponds to a 0.1144% increase in the degree of urban sprawl. Regarding the control variables, city population size, urban residents' income level, industrial structure, transportation infrastructure, commuting cost, and local fiscal pressure are significant in at least one model, suggesting that the selection of control variables in this study is reasonable.

These findings not only further confirm the positive association between economic growth targets and urban sprawl but also provide valuable quantitative evidence for policymakers. Such evidence allows policymakers to more precisely understand the specific impact of setting economic growth targets on urban spatial development. Consequently, urban development policies can be designed based on this scientifically quantified relationship, enabling the formulation of more rational, practical, and effective measures to guide cities toward sustainable development.

## 4.2 Endogeneity analysis and robustness test

To address potential endogeneity arising from the possible bidirectional causality between economic growth targets and urban sprawl, this study employs the instrumental variable (IV) approach to test the baseline regression results. Drawing on the methodology of Huang et al. (2021), the economic growth targets set by higher-level governments are selected as the IV.

The reasons for using higher-level government targets as an instrument are as follows. Provincial growth targets are set during provincial People's Congress meetings at the beginning of the year and precede the formulation of municipal targets. Given the strict top-down governance system, provincial targets act as political signals that guide, but do not directly intervene in, city-level economic or land-use policies. Importantly, a province-level target is a broad macroeconomic benchmark that does not contain spatially explicit directives regarding land conversion, construction land quotas, or city-specific development strategies. Therefore, provincial targets cannot plausibly influence a specific city's urban sprawl except through their impact on the city's own growth target. Moreover, the large scale and internal heterogeneity of provinces make it unlikely that a single province-wide target, which reflects aggregated macroeconomic expectations, would directly shape the land development process of individual municipalities. This institutional and spatial disconnect supports the exclusion restriction.

To further ensure validity, we additionally control for city and year fixed effects, and conduct weak-IV and under-identification tests, all of which confirm the strength and appropriateness of the instrument. From a theoretical perspective, the economic growth targets of higher-level governments during the period 2006–2022 constitute an ideal instrumental variable. The results of the endogeneity test are presented in Table 5.

The results reported in Table 5 show that, in Column (1), the first-stage regression indicates that the IV has a significant positive effect on the economic growth target of the local government, which is highly consistent with theoretical expectations. Furthermore, the underidentification test, as indicated by the Anderson canon. Corr. LM statistic, is significant at the 1% level, strongly confirming a significant correlation between the IV and the economic growth target. In addition, the weak IV test shows that the F-statistic far exceeds the 10% critical value of 16.38 specified by the Stock-Yogo test, further demonstrating that the instrument is not weak and has a strong correlation with the economic growth target, ensuring the validity of the selected IV.

Column (2) presents the second-stage regression results, which indicate that economic growth targets have a significantly positive effect on urban sprawl, consistent with the baseline estimates. Notably, the coefficient of the IV regression is 0.8863, substantially higher than the baseline OLS estimate of 0.1144. This difference suggests that, without accounting for endogeneity, the baseline estimates tend to underestimate the true effect of local government economic growth targets on urban sprawl.

TABLE 5 The results of instrumental variable.

| Variables | First-stage | Second-stage |
|---|---|---|
| | (1) | (2) |
| | target | sprawl |
| IV | 0.0076*** | |
| | (23.1360) | |
| target | | 0.8863*** |
| | | (8.2510) |
| Underidentification test | 473.303*** | |
| Weak IV test | 643.945 <16.38> | |
| Control variables | Yes | Yes |
| City FE | Yes | Yes |
| Year FE | Yes | Yes |
| $R^2$ | 0.842 | 0.451 |
| N | 1870 | 1870 |

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

To further verify the robustness of the baseline regression results, several robustness checks were conducted. First, the core explanatory variable was lagged by one and two periods, respectively, to mitigate potential simultaneity bias. Second, special samples were excluded. Metropolitan cities such as municipalities directly under the central government, provincial capitals, and sub-provincial cities - referred to as "central cities" - possess relatively higher political and economic status, which may bias the estimation results. Therefore, these cities were removed, and the models were re-estimated. Third, outliers were excluded. Although all continuous variables in the baseline regression were winsorized at the 1% level on both tails, some data exhibit heavy-tailed distributions. To further eliminate the influence of extreme values, following Lu and Tao (2024), and Li N. et al. (2023), all continuous variables were winsorized at the 5% level. As shown in Table 6, after performing the above robustness checks, the estimated coefficients of economic growth targets on urban sprawl remain significantly positive across all model specifications, once again confirming the robustness and reliability of the baseline regression results.

## 4.3 Mechanism analysis

According to the preceding theoretical analysis, in order to achieve predetermined economic growth targets, local governments urgently require sufficient and stable fiscal support in the short term to stimulate economic expansion. However, due to the limited capacity of local fiscal revenues, land conveyance has become an important channel for local governments to obtain fiscal income and fill budgetary gaps within a short period. Since the implementation of the 1994 tax-sharing reform, the fiscal relationship between the central and local governments has become more clearly delineated. This reform, while clarifying fiscal authority, also significantly altered the fiscal structure of local governments—tightening their financial resources and increasing fiscal pressure. In this context, land finance, capable of generating substantial fiscal revenue in a relatively short period, has greatly alleviated fiscal stress and, consequently, intensified local governments' dependence on land-based revenues. As local governments' reliance on land finance deepens, they exhibit increasingly strong incentives to promote land development, leading to large-scale land conversion and development activities. Such extensive land development directly drives the continuous and rapid expansion of urban built-up areas, thereby exacerbating urban sprawl.

Based on the above reasoning, to rigorously test whether this transmission mechanism indeed exists, this study incorporates land finance dependence as a mediating variable into the baseline model, aiming to further examine the internal relationship among the variables. The results of the mediation effect test are presented in Table 7.

The regression results of Model (1) in Table 7 show that the coefficient of the economic growth target ($\beta_1$) is 0.1144, which is significantly positive at the 5% significance level. This finding indicates

10.3389/fsufs.2025.1743334

TABLE 6 The results of robustness test.

| Variables | sprawl | | | |
|---|---|---|---|---|
| | L.target | L2.target | Exclude special samples | Exclude outliers |
| | (1) | (2) | (3) | (4) |
| L.target | 0.1427*** | | | |
| | (2.6917) | | | |
| L2.target | | 0.1208** | | |
| | | (2.1879) | | |
| target | | | 0.1302** | 0.2000*** |
| | | | (2.4305) | (3.9696) |
| cpop | −0.0482*** | −0.0547*** | −0.0535*** | −0.0205*** |
| | (−5.0788) | (−5.3017) | (−5.3990) | (−2.7306) |
| income | 0.1056*** | 0.1315*** | 0.0569*** | 0.0901*** |
| | (6.6365) | (7.0188) | (3.9490) | (9.5844) |
| struc | −0.0205 | −0.0352* | −0.0041 | 0.0214 |
| | (−1.1950) | (−1.9036) | (−0.2507) | (1.5562) |
| traffic | 0.0009*** | 0.0009*** | 0.0009*** | 0.0001 |
| | (4.9840) | (4.9056) | (4.8444) | (0.6868) |
| commute | −0.0037*** | −0.0029*** | −0.0163*** | −0.0089*** |
| | (−3.4381) | (−2.5935) | (−8.9748) | (−7.0324) |
| fiscal | 0.0044*** | 0.0041*** | 0.0038*** | 0.0046*** |
| | (3.7354) | (3.4149) | (3.3264) | (4.0542) |
| _cons | −0.0218 | −0.2389 | 0.5006*** | −0.0301 |
| | (−0.1281) | (−1.1950) | (3.2049) | (−0.2825) |
| City FE | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes |
| $R^2$ | 0.965 | 0.966 | 0.964 | 0.971 |
| N | 1760 | 1,650 | 1,666 | 1870 |

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

TABLE 7 The results of mediation effect test.

| Variables | (1) | (2) | (3) |
|---|---|---|---|
| | sprawl | LFD | sprawl |
| target | 0.1144** | 0.7169*** | 0.1047** |
| | (2.2245) | (3.4173) | (2.0329) |
| LFD | | | 0.0134** |
| | | | (2.2858) |
| cpop | −0.0448*** | −0.1107*** | −0.0433*** |
| | (−5.0557) | (−3.0607) | (−4.8809) |
| income | 0.0847*** | 0.1672*** | 0.0824*** |
| | (6.0834) | (2.9440) | (5.9145) |
| struc | −0.0072 | −0.0924 | −0.0060 |
| | (−0.4491) | (−1.4122) | (−0.3720) |
| traffic | 0.0008*** | −0.0004 | 0.0008*** |
| | (4.7577) | (−0.5404) | (4.7927) |
| commute | −0.0040*** | 0.0009 | −0.0041*** |
| | (−4.0492) | (0.2255) | (−4.0664) |
| fiscal | 0.0044*** | 0.0180*** | 0.0042*** |
| | (3.9011) | (3.8960) | (3.6762) |
| _cons | 0.1695 | −0.6416 | 0.1781 |
| | (1.1355) | (−1.0536) | (1.1942) |
| City FE | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes |
| $R^2$ | 0.964 | 0.490 | 0.965 |
| N | 1870 | 1870 | 1870 |

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

that the total effect of the economic growth target on urban sprawl is 0.1144. Model (2) examines the specific impact of the economic growth target on land finance dependence. The results show that the coefficient of the economic growth target ($\alpha_1$) is 0.7169, and it is significantly positive at the 1% level, suggesting that higher economic growth targets significantly increase local governments' dependence on land-based revenues. In other words, as local governments pursue more ambitious growth objectives, their reliance on land finance deepens notably. Model (3) investigates the joint effects of the economic growth target and land finance dependence on urban sprawl. The results reveal that the coefficients of the economic growth target ($\varphi_1$) and land finance dependence ($\varphi_2$) are 0.1047 and 0.0134, respectively, both of which are significantly positive at the 5% level. This suggests that increases in either the economic growth target or land finance dependence will contribute to the intensification of urban sprawl.

Moreover, the estimated coefficient of the economic growth target decreases slightly compared with Model (1), implying that after introducing land finance dependence as a mediating variable, the direct effect of the economic growth target on urban sprawl becomes weaker. This finding further confirms that land finance dependence plays a partial mediating role in the relationship between economic growth targets and urban sprawl. Specifically, $\varphi_1$ represents the direct effect of the economic growth target on urban sprawl, with a value of 0.1047; $\alpha_1\varphi_2$ represents the indirect (mediating) effect through land finance dependence, with a value of 0.0096, accounting for 8.40% of the total effect. These results are consistent with the theoretical analysis discussed earlier.

## 4.4 Heterogeneity analysis

### 4.4.1 Regional heterogeneity analysis

The YREB spans China's eastern, central, and western regions, covering nine provinces and two municipalities. Significant disparities exist among these regions in terms of economic development, resource endowment, and policy orientation. To account for such regional heterogeneity, this study divides the research sample into three subgroups - upstream, midstream, and downstream areas - and conducts separate regressions for each group. The regional regression results are presented in Table 8, where Models (1)–(3) illustrate the effects of economic growth targets on urban sprawl in the upstream, midstream, and downstream regions of the YREB, respectively.

From the regression results, it can be observed that the impact of economic growth targets on urban sprawl is significantly positive in the

10.3389/fsufs.2025.1743334

TABLE 8 The results of regional heterogeneity analysis.

| Variables | sprawl | | |
|---|---|---|---|
| | Upstream | Midstream | Downstream |
| | (1) | (2) | (3) |
| target | 0.2378*** | −0.0252 | 0.0725 |
| | (4.5052) | (−0.3515) | (0.5921) |
| cpop | 0.0203** | −0.0425*** | −0.0297* |
| | (1.9901) | (−2.7465) | (−1.9374) |
| income | −0.0433** | −0.0139 | 0.1131*** |
| | (−2.3198) | (−0.9212) | (3.7197) |
| struc | 0.0457*** | 0.0400* | 0.0231 |
| | (2.8100) | (1.8894) | (0.6653) |
| traffic | −0.0004** | 0.0003 | 0.0013*** |
| | (−1.9812) | (1.5898) | (3.1749) |
| commute | −0.0054*** | −0.0002 | −0.0049** |
| | (−5.9490) | (−0.1581) | (−2.4332) |
| fiscal | 0.0032*** | 0.0017 | 0.0115*** |
| | (3.4724) | (1.2383) | (3.1030) |
| _cons | 1.0527*** | 1.1751*** | −0.3080 |
| | (5.2511) | (7.0625) | (−1.0048) |
| City FE | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes |
| $R^2$ | 0.990 | 0.956 | 0.948 |
| N | 561 | 612 | 697 |

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

TABLE 9 The results of temporal heterogeneity analysis.

| Variables | sprawl | |
|---|---|---|
| | 2006–2017 | 2018–2022 |
| | (1) | (2) |
| target | 0.1871*** | −0.4089*** |
| | (5.1674) | (−2.5889) |
| cpop | 0.0331*** | −0.2472*** |
| | (4.5421) | (−5.6449) |
| income | −0.0058 | 0.1764** |
| | (−0.5990) | (2.1476) |
| struc | 0.0728*** | −0.0974* |
| | (5.1940) | (−1.8336) |
| traffic | −0.0001 | 0.0006 |
| | (−0.4442) | (1.5836) |
| commute | −0.0074*** | 0.0069 |
| | (−8.1927) | (1.6126) |
| fiscal | 0.0021** | 0.0020 |
| | (2.4110) | (0.4614) |
| _cons | 0.5824*** | 0.4471 |
| | (5.7210) | (0.5007) |
| City FE | Yes | Yes |
| Year FE | Yes | Yes |
| $R^2$ | 0.985 | 0.977 |
| N | 1,320 | 550 |

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

upstream region of the YREB, while the effect is not statistically significant in the midstream and downstream regions. A plausible explanation for this finding is that the downstream region already possesses a relatively high level of economic development and enjoys a diversified range of pathways to promote growth. Its industrial structure is dominated by high-tech industries and service sectors, both of which have relatively low demand for land. Moreover, local governments in these areas face less pressure to achieve economic growth targets and therefore tend to prioritize the quality and sustainability of urban development. As a result, the influence of economic growth targets on urban sprawl in the downstream region is limited.

Similarly, the midstream region exhibits a trend toward industrial diversification, yet it lacks dominant industries with strong competitive advantages or spatial spillover effects. This diversified but weakly driven industrial structure disperses the pathways for achieving growth targets, making it difficult to generate a concentrated force that could stimulate urban expansion. In addition, traditional industries still account for a large proportion of the midstream economy. Under the guidance of national policies, local governments in this region may rely more on upgrading and transforming traditional industries rather than pursuing extensive urban land expansion to fulfill economic growth objectives. This helps explain why the relationship between growth targets and urban sprawl in the midstream region is not significant.

In contrast, the upstream region features more challenging geographical conditions and lower levels of economic development compared with the midstream and downstream areas, resulting in greater pressure to achieve economic growth. To meet established growth targets, local governments in this region often resort to large-scale land development, the construction of new industrial parks, and continuous improvements in urban infrastructure. These strategies inevitably drive outward urban expansion, leading to a more pronounced phenomenon of urban sprawl.

### 4.4.2 Temporal heterogeneity analysis

From the perspective of China's economic development history, 2017 represents a critical turning point. The report of the 19th National Congress of the Communist Party of China highlighted that "China's economy has shifted from a stage of high-speed growth to a stage of high-quality development." This major transition has brought about a series of significant changes, the most prominent of which is the decline in China's GDP growth rate from approximately 9% during the high-speed growth period to around 6% in recent years. Considering the implementation and effects of economic growth targets may exhibit certain lags, this study selects 2018 as the temporal break-point and separately examines the impact of economic growth targets on urban sprawl before and after this year. The time-specific regression results are presented in Table 9.

The results indicate that during the period 2006–2017, economic growth targets had a significant positive effect on urban sprawl. However, in the period 2018–2022, the impact of economic growth targets on urban sprawl changed noticeably, exhibiting a certain

inhibitory effect. A plausible explanation for this shift is that after 2017, with China's economy transitioning into a stage of high-quality development, local governments' development concepts and strategies underwent important adjustments. Local authorities no longer focused solely on the speed of economic growth but began allocating more attention and resources to improving the quality of growth. And although high-speed economic growth yielded some development achievements, it also generated a series of deep-rooted problems, such as overcapacity, low economic efficiency, and insufficient market competitiveness. To promote high-quality development, foster a virtuous economic cycle, and enhance overall competitiveness, local governments shifted their focus toward addressing the accumulated issues from the prior rapid-growth period rather than continuing to rely on traditional stimulus measures aimed at maintaining high growth rates. This strategic adjustment, to a certain extent, has effectively mitigated the trend of urban sprawl.

## 5 Conclusion and discussion

Based on a sample of 110 cities in the YREB from 2006 to 2022, this study constructs a theoretical framework to analyze the impact of economic growth targets on urban sprawl using multidisciplinary theories and methods. On this basis, model specification and variable selection were conducted, followed by empirical analysis using a two-way fixed effects model to test the rationality and validity of the theoretical mechanism. A series of robustness and endogeneity checks were subsequently performed, and finally, land finance dependence was introduced as a mediating variable to examine the transmission mechanism of economic growth targets on urban sprawl. The main findings are summarized as follows: (1) Baseline regression results indicate that economic growth targets have a significantly positive impact on urban sprawl, and this conclusion remains robust after a series of tests addressing potential endogeneity and other econometric concerns. (2) The effect of economic growth targets on urban sprawl exhibits pronounced regional and temporal heterogeneity. Regarding regional heterogeneity, economic growth targets have a significant positive impact on urban sprawl in the upstream region of the YREB, whereas their effects in the midstream and downstream regions are not significant. In terms of temporal heterogeneity, during 2006–2017, economic growth targets significantly promoted urban sprawl in cities along the YREB, while in the period 2018–2022, economic growth targets exerted a significant inhibitory effect on urban sprawl. (3) Mediation analysis shows that higher economic growth targets in-crease local governments' dependence on land finance, which in turn promotes urban sprawl. Land finance dependence thus plays a partial mediating role in the impact of economic growth targets on urban sprawl.

Theoretically, this study enriches the understanding of how governance incentives influence urban spatial development. By linking economic growth targets with land finance dependence and urban sprawl, the paper enriches the political economy framework of urban expansion. Prior research has documented the economic and environmental consequences of economic growth targets, yet their spatial implications have received limited attention. Our findings demonstrate that economic growth targets constitute an institutional force that systematically influences land development decisions under fiscal pressure, thereby contributing to a governance-based explanation of urban sprawl. The mediating role of land finance further clarifies the mechanisms through which political incentives translate into physical changes in urban form. These insights help bridge urban governance, fiscal behavior, and spatial development literatures.

The heterogeneity analysis provides additional theoretical and practical insights. The stronger positive effect of economic growth targets on urban sprawl in the upstream region indicates that local governments with greater fiscal constraints or lower administrative capacity may be more inclined to rely on land expansion to meet growth expectations. In contrast, the downstream region—with more diversified economic structures and stricter land-use controls—shows a weaker or even negligible effect. Temporally, the decline in the economic growth targets–sprawl relationship after 2018 reinforces the idea that institutional reforms such as stricter environmental targets, farmland protection policies, and softened growth pressures can weaken the traditional "growth-through-land-expansion" model. These patterns confirm that the effects of economic growth targets are not uniform but contingent on fiscal, institutional, and developmental contexts.

The findings of this study offer several important policy insights for promoting sustainable urban development in the YREB. First, since economic growth targets significantly contribute to urban sprawl, reforming the performance evaluation system is essential. Policymakers should further reduce the weight of GDP-based indicators and strengthen multidimensional assessments incorporating environmental protection, farmland protection, food system resilience, and high-quality development goals. Encouraging more flexible and realistic target-setting may help alleviate the incentive for local governments to pursue land-intensive expansion. Second, the mediating role of land finance indicates that excessive reliance on land-transfer revenues remains a major structural driver of urban sprawl. Fiscal reforms should increasingly diversify local revenue sources to reduce land-based fiscal dependence. Strengthening the supervision of construction land quotas and improving land-use approval processes will also help curb disorderly expansion. Third, the heterogeneity analysis provides clear support for region-specific policy design. Upstream cities, which exhibit the strongest economic growth targets–sprawl relationship and face tighter fiscal constraints, should prioritize reducing land-dependent growth models by expanding central transfers, improving administrative capacity, and promoting compact, cost-effective urban development. Strengthening farmland protection and enforcing urban growth boundaries are particularly important in these areas. Midstream cities, located at the intersection of industrial upgrading and spatial expansion, should enhance coordination between development zones, transportation corridors, and agricultural land management. Policies should focus on balancing economic dynamism with the preservation of ecological and agricultural functions. Downstream cities, where the influence of economic growth targets is weaker and administrative systems are more mature, should shift toward optimizing existing built-up areas through redevelopment, smart growth planning, and improved land-use efficiency rather than outward expansion.

In addition to its implications for urban spatial governance, the findings of this study carry important relevance for land-use planning and food system sustainability. As economic growth targets intensify land finance dependence and stimulate extensive land development, they indirectly accelerate the conversion of peri-urban agricultural land into construction land. This process

threatens long-term agricultural productivity, increases the vulnerability of regional food supply chains, and undermines the ecological foundations of sustainable food systems. Therefore, land-use planning reforms should prioritize protecting high-quality farmland, safeguarding peri-urban agricultural zones, and establishing strict red-line controls to prevent the premature conversion of agricultural land. Integrating food system considerations into territorial spatial planning can help cities achieve balanced development while maintaining regional food security. Policymakers should also reduce local governments' reliance on land-based revenues, strengthen cross-sector coordination between urban planning and agricultural departments, and adopt more flexible economic growth targets that align with long-term sustainability objectives.

It is important to note that economic growth targets and urban sprawl constitute a complex systemic issue, and urban sprawl itself is driven by multiple factors. For example, the coefficient of transportation infrastructure on urban sprawl is negative in the upstream region of the YREB but positive in the downstream region. Due to space limitations, this study does not provide further analysis of these heterogeneities. Furthermore, achieving economic growth targets does not necessarily require high levels of urban sprawl. Empirical evidence shows that high-quality economic growth can be realized without excessive reliance on land resources. However, this study does not explore in depth the growth drivers in cities with relatively high economic development levels but relatively low urban sprawl. These limitations provide avenues for future research in this field.

## Data availability statement

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

## Author contributions

WZ: Conceptualization, Methodology, Writing – original draft, Writing – review & editing. QD: Writing – original draft, Conceptualization, Methodology, Writing – review & editing. XZ: Data curation, Formal analysis, Software, Writing – original draft. DB: Funding acquisition, Writing – review & editing, Resources. XL: Funding acquisition, Supervision, Validation, Visualization, Writing – review & editing.

## Funding

The author(s) declared that financial support was received for this work and/or its publication. This paper was funded by the 'Fundamental Research Funds for the Central Universities' (No. 2023WKFZZX102), the 'Research Project of The Institute of Human Rights Law at Huazhong University of Science and Technology' (No. 2024RQJD006), and the 'National Natural Science Foundation of China' (No. 42201291). We also thank the Future Food Systems Cooperative Research Centre (FFS CRC), established under the Australian Government's CRC Program, for financial and other support.

## Conflict of interest

The author(s) declared that this work was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

## Generative AI statement

The author(s) declared that Generative AI was not used in the creation of this manuscript.

Any alternative text (alt text) provided alongside figures in this article has been generated by Frontiers with the support of artificial intelligence and reasonable efforts have been made to ensure accuracy, including review by the authors wherever possible. If you identify any issues, please contact us.

## Publisher's note



## Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fsufs.2025.1743334/full#supplementary-material

## References

Amedzro, K., Essien, R., Issah, M., Amedzro, K. K., Essien, R. S., Issah, M. A., et al. (2024). Large-scale urban road corridors development and urban sprawl in the Greater Accra metropolitan area, Ghana. *Int. Dev. Plan. Rev.* 46, 175–198. doi: 10.3828/idpr.2024.2

Bai, Z., Zhang, P., and Yi, H. (2025). Political career incentives and multitasking trade-off: evidence from setting performance targets in Chinese cities. *China Econ. Rev.* 94:102537. doi: 10.1016/j.chieco.2025.102537

Brueckner, J. K. (2000). Urban sprawl: diagnosis and remedies. *Int. Reg. Sci. Rev.* 23, 160–171.

Chen, S., and Jia, K. (2021). How local governments prioritize multiple conflicting goals: beyond the sole-goal perspective. *Public Adm.* 101, 522–538. doi: 10.1111/padm.12807

Cho, C. (2001). Amenities and urban residential structure: an amenity - embedded model of residential choice. *Reg. Sci.* 80, 483–498. doi: 10.1007/PL00013649

Dadi, D., Azadi, H., Senbeta, F., Abebe, K., Taheri, F., and Stellmacher, T. (2016). Urban sprawl and its impacts on land use change in Central Ethiopia. *Urban For. Urban Green.* 16, 132–141. doi: 10.1016/j.ufug.2016.02.005

Downs, A. (1994). New visions for metropolitan America. Washington, D.C: The Brookings Institution and Lincoln Institution of Land Policy.

Du, J., and Yi, H. (2021). Target-setting, political incentives, and the tricky trade-off between economic development and environmental protection. *Public Adm.* 100, 923–941. doi: 10.1111/padm.12768

Ehrlich, M. V., Hilber, C. A. L., and Schöni, O. (2018). Institutional settings and urban sprawl: evidence from Europe. *J. Hous. Econ.* 42, 4–18. doi: 10.1016/j.jhe.2017.12.002

Ewing, R., Pendall, R., and Chen, D. (2003). Measuring sprawl and its transportation impacts. *Transp. Res. Rec.* 1831, 175–183. doi: 10.3141/1831-20

Faber, B. (2014). Trade integration, market size, and industrialization: evidence from China's national trunk highway system. *Rev. Econ. Stud.* 81, 1046–1070. doi: 10.1093/restud/rdu010

Fan, J., and Zhou, L. (2019). Three-dimensional intergovernmental competition and urban sprawl: evidence from Chinese prefectural-level cities. *Land Use Policy* 87:104035. doi: 10.1016/j.landusepol.2019.104035

Frenkel, A., and Ashkenazi, M. (2008). The integrated sprawl index: measuring the urban landscape in Israel. *Ann. Reg. Sci.* 42, 99–121. doi: 10.1007/s00168-007-0137-3

Galster, G., Hanson, R., Ratcliffe, M. R., Wolman, H., Coleman, S., and Freihage, J. (2001). Wrestling sprawl to the ground: defining and measuring an elusive concept. *Hous. Policy Debate* 12, 681–717. doi: 10.1080/10511482.2001.9521426

Guan, D., He, X., He, C., Cheng, L., and Qu, S. (2020). Does the urban sprawl matter in Yangtze River Economic Belt, China? An integrated analysis with urban sprawl index and one scenario analysis model. *Cities* 99:102611. doi: 10.1016/j.cities.2020.102611

Guo, S., and Shi, Y. (2018). Infrastructure investment in China: a model of local government choice under land financing. *J. Asian Econ.* 56, 24–35. doi: 10.1016/j.asieco.2018.04.001

Guo, L., Yang, M., Su, M., and Li, H. (2024). Hidden environmental costs of economic ambitions: an empirical study of pollution emissions in the wake of growth targets. *J. Clean. Prod.* 450:141925. doi: 10.1016/j.jclepro.2024.141925

Hamidi, S., and Ewing, R. (2014). A longitudinal study of changes in urban sprawl between 2000 and 2010 in the United States. *Landsc. Urban Plan.* 128, 72–82. doi: 10.1016/j.landurbplan.2014.04.021

Hassan, M., Ling, G. H. T., Rusli, N., Hassan, M. O., Mokhtar, S., Wider, W., et al. (2023). Urban sprawl patterns, drivers, and impacts: the case of Mogadishu, Somalia using geo-spatial and SEM analyses. *Land* 12:783. doi: 10.3390/land12040783

He, C., Zhou, Y., and Huang, Z. (2016). Fiscal decentralization, political centralization, and land urbanization in China. *Urban Geogr.* 37, 436–457. doi: 10.1080/02723638.2015.1063242

Huang, L., Wang, X., and Liu, S. (2021). Economic growth target and radical urbanisation: evidence from satellite night-light data. *World Econ.* 44, 97–122. doi: 10.19985/j.cnki.cassjwe.2021.06.006 (In Chinese).

Li, H., Guo, H., and Zhang, P. (2023). The fiscal impact of county-to-urban district conversion in China. *Urban Aff. Rev.* 59, 892–917. doi: 10.1177/10780874221098152

Li, N., Xu, Z., and Li, S. (2023). Is corporate financialization inhibiting low-carbon technology innovation? Observations and interpretations from a motivational context' perspective. *China Popul. Resour. Environ.* 33, 34–46. (In Chinese).

Liao, L., Du, M., Wang, B., and Yu, Y. (2019). The impact of educational investment on sustainable economic growth in Guangdong, China: a cointegration and causality analysis. *Sustainability* 11:766. doi: 10.3390/su11030766

Liu, Y., Yue, W., Fan, P., Peng, Y., and Zhang, Z. (2016). Financing China's suburbanization: capital accumulation through suburban land development in Hangzhou. *Int. J. Urban Reg. Res.* 40, 1112–1133. doi: 10.1111/1468-2427.12454

Lopez, R., and Hynes, H. P. (2003). Sprawl in the 1990s: measurement, distribution, and trends. *Urban Aff. Rev.* 38, 325–355. doi: 10.1177/1078087402238805

Lu, Y., He, T., Yue, W., Li, M., Shan, Z., and Zhang, M. (2023). Does cropland threaten urban land use efficiency in the peri-urban area? Evidence from metropolitan areas in China. *Appl. Geogr.* 161:103124. doi: 10.1016/j.apgeog.2023.103124

Lu, X., and Tao, X. (2024). Local government environmental attention and urban land green use efficiency in China: the intermediary role of industrial restructuring. *Land* 13:21. doi: 10.3390/land13010021

Mills, E. S. (1967). An aggregative model of resource allocation in a metropolitan area. *Am. Econ. Rev.* 57, 197–210.

Monica, B., and Paolo, V. (2015). Assessing polycentric urban systems in the OECD: country, regional and metropolitan perspectives. *Eur. Plan. Stud.* 23, 1128–1145. doi: 10.1080/09654313.2014.905005

Nazarnia, N., Schwick, C., and Jaeger, J. A. G. (2016). Accelerated urban sprawl in Montreal, Quebec City, and Zurich: investigating the differences using time series 1951–2011. *Ecol. Indic.* 60, 1229–1251. doi: 10.1016/j.ecolind.2015.09.020

Peng, C., and Lu, M. (2019). Governance and new towns: the city construction fever pursuing short-term growth and its consequences. *J. Manag. World.* 35, 44–57+190-191. doi: 10.19744/j.cnki.11-1235/f.2019.0104 (In Chinese).

Pourtaherian, P., and Jaeger, J. A. G. (2022). How effective are greenbelts at mitigating urban sprawl? A comparative study of 60 European cities. *Landsc. Urban Plan.* 227:104532. doi: 10.1016/j.landurbplan.2022.104532

Qin, M., Liu, X., and Li, S. (2019). The impact of urban sprawl on regional economic growth: empirical researches based on DMSP night-time light data. *China Econ. Q.* 18, 527–550. doi: 10.13821/j.cnki.ceq.2019.01.06 (In Chinese).

Sun, Y., Chen, Y., and Wu, W. (2024). Short-term success and long-term failure? The case of GDP growth targets and corporate innovation. *Pac. Basin Financ. J.* 84:102308. doi: 10.1016/j.pacfin.2024.102308

Sun, W., Song, Z., and Xia, Y. (2020). Government-enterprise collusion and land supply structure in Chinese cities. *Cities* 105:102849. doi: 10.1016/j.cities.2020.102849

Sun, Y., Tang, Y., and Li, G. (2023). Economic growth targets and green total factor productivity: evidence from China. *J. Environ. Plan. Manag.* 66, 2090–2106. doi: 10.1080/09640568.2022.2061335

Sutton, P. C. (2003). A scale-adjusted measure of "urban sprawl" using nighttime satellite imagery. *Remote Sens. Environ.* 86, 353–369. doi: 10.1016/S0034-4257(03)00078-6

Torrens, P. M. (2006). Simulating sprawl. *Ann. Assoc. Am. Geogr.* 96, 248–275. doi: 10.1111/j.1467-8306.2006.00477.x

Wang, X., Li, J., and Wang, N. (2023). Are economic growth pressures inhibiting green total factor productivity growth? *Sustainability* 15:5239. doi: 10.3390/su15065239

Wang, X., Liu, S., and Huang, L. (2021). Economic growth pressure and regional innovation: evidence from the setting of economic growth targets. *China Econ. Q.* 21, 1147–1166. doi: 10.13821/j.cnki.ceq.2021.04.02 (In Chinese).

Whyte, W. H. (1958). The exploding Metropolis. New York: Doubleday.

Wu, J. (2006). Environmental amenities, urban sprawl, and community characteristics. *J. Environ. Econ. Manag.* 52, 527–547. doi: 10.1016/j.jeem.2006.03.003

Xu, T., and Gao, J. (2021). Controlled urban sprawl in Auckland, New Zealand and its impacts on the natural environment and housing affordability. *Comput. Urban Sci.* 1:16. doi: 10.1007/s43762-021-00017-8

Xu, H., Hu, S., and Li, X. (2023). Urban distribution and evolution of the Yangtze River Economic Belt from the perspectives of urban area and night-time light. *Land* 12:321. doi: 10.3390/land12020321

Yang, L., Fang, C., Chen, W., and Zeng, J. (2023). Urban-rural land structural conflicts in China: a land use transition perspective. *Habitat Int.* 138:102877. doi: 10.1016/j.habitatint.2023.102877

Yasin, M., Yusoff, M., and Abdullah, J. (2021). Urban sprawl literature review: definition and driving force. *Geografia-Malaysian J. Society Space.* 17, 116–128. doi: 10.17576/geo-2021-1702-10

Yu, Z., Yan, T., Liu, X., and Bao, A. (2022). Urban land expansion, fiscal decentralization and haze pollution: evidence from 281 prefecture-level cities in China. *J. Environ. Manag.* 323:116198. doi: 10.1016/j.jenvman.2022.116198

Yue, W., Zhang, L., and Liu, Y. (2016). Measuring sprawl in large Chinese cities along the Yangtze River via combined single and multidimensional metrics. *Habitat Int.* 57, 43–52. doi: 10.1016/j.habitatint.2016.06.009

Zhang, Y., Mao, W., and Zhang, B. (2022). Distortion of government behaviour under target constraints: economic growth target and urban sprawl in China. *Cities* 131:104009. doi: 10.1016/j.cities.2022.104009

Zhang, L., Shu, X., and Zhang, L. (2023). Urban sprawl and its multidimensional and multiscale measurement. *Land* 12:630. doi: 10.3390/land12030630

Zhang, Y., Wang, J., Liu, Y., and Yue, W. (2023). Quantifying multiple effects of land finance on urban sprawl: empirical study on 284 prefectural-level cities in China. *Environ. Impact Assess. Rev.* 101:107156. doi: 10.1016/j.eiar.2023.107156

Zheng, H., Wang, X., and Cao, S. (2014). The land finance model jeopardizes China's sustainable development. *Habitat Int.* 44, 130–136. doi: 10.1016/j.habitatint.2014.05.008

Zhou, J., Raza, A., and Sui, H. (2021). Infrastructure investment and economic growth quality: empirical analysis of China's regional development. *Appl. Econ.* 53, 2615–2630. doi: 10.1080/00036846.2020.1863325

Zhou, M., Tan, S., and Zhang, L. (2015). Influences of different land use spatial control schemes on farmland conversion and urban development. *PLoS One* 10:0125008. doi: 10.1371/journal.pone.0125008