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# Coupling Coordination Between Urban Shrinkage and Land Finance Dependency: Evidence from Liaoning, China

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**Abstract**

The coexistence of urban shrinkage and land finance dependency poses a distinct institutional challenge to regional development in China. However, the mechanisms linking multidimensional urban decline with reliance on land conveyance revenue remain inadequately understood. Using Liaoning Province as a case study, this research develops a comprehensive indicator system to assess urban shrinkage across demographic, economic, social, and spatial dimensions, and constructs a model to measure land finance dependency. Employing panel data from 2016 to 2023, the study evaluates urban shrinkage and land finance dependency in Liaoning and applies a coupling coordination degree model to explore their spatiotemporal evolution. The results show that 7 of the 14 prefecture-level cities in Liaoning experienced shrinkage. These cities demonstrate a distinct core–periphery spatial pattern and cluster mainly in traditional industrial and resource-dependent regions. Land finance dependency exhibits an inverted U-shaped pattern, peaking around 2020 and sharply declining from 2021 onwards, suggesting a substantial collapse in the fiscal support capacity of land finance within shrinking cities. This study argues that a structural contradiction exists between the growth-oriented land finance model and the emerging reality of urban shrinkage, with traditional fiscal tools becoming irreversibly disconnected from sustainable urban governance in the region. Therefore, a fiscal resilience framework suitable for the post-land-finance era should be established, endogenous urban renewal encouraged, and institutional adjustments tailored to population shrinkage implemented, replacing the conventional land-driven expansion model. This transition has significant implications for old industrial cities in transitional economies.

**Keywords:** urban shrinkage; land finance dependency; coupling coordination degree

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Academic Editors: Shichen Zhao, Prasanna Divigalipitiya and Xiaoyan Mi

Received: 7 May 2026
Revised: 28 May 2026
Accepted: 2 June 2026
Published: 4 June 2026

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## 1. Introduction

The concept and theory of shrinking cities originated in Germany in the late 1980s, developed to describe urban phenomena resulting from deindustrialization, population loss, and structural economic decline. Unlike urban shrinkage in developed Western countries, primarily driven by post-industrialization, suburbanization, and demographic transitions, urban shrinkage in China emerges from regional developmental imbalances and declining resource-based industries. It is characterized by concurrent urban population loss and spatial expansion. Significantly, due to institutional mechanisms related to land finance and performance-based evaluations, Chinese shrinking cities frequently exhibit a unique coupling among persistent population decline, continuous land expansion, and local fiscal reliance on land conveyance revenues. As the central area of Northeast China's traditional

industrial region, Liaoning Province experienced a notable decrease in its permanent population, dropping from 42.32 million in 2016 to 40.991 million in 2023, ranking among the provinces with the highest net population losses nationwide. Liaoning exemplifies a region with concentrated urban shrinkage, prominent contradictions in land finance, and substantial pressure in transforming old industrial bases. Consequently, examining the coordinated relationship between urban shrinkage and land finance dependency has both theoretical and practical value. Such an analysis can clarify the internal relationships between urban development and land finance in Liaoning and identifying sustainable development pathways for shrinking cities in old industrial bases.

Urban shrinkage in China is deeply embedded in institutional frameworks. The fiscal-sharing reform of 1994 centralized fiscal authority while decentralizing expenditure responsibilities, creating structural fiscal gaps for local governments. Lacking a stable local taxation system, revenues from land conveyance gradually became a critical source of local extra-budgetary income, fostering a distinctive land finance model and path-dependent urbanization patterns. This institutional environment influences the spatial expansion logic of Chinese cities: even regions experiencing sustained population declines have strong local governmental incentives to develop land and build new towns, leading to the phenomenon of simultaneous urban expansion and shrinkage.

In Liaoning Province, this issue manifests as two intertwined contradictions. On the one hand, several cities experience multiple pressures, including population outflow, economic slowdown, and spatial vacancies [1–3], that result in typical multidimensional shrinkage. On the other hand, many shrinking cities continue to depend heavily on land conveyance revenue for development, resulting in significant land finance dependency. These two phenomena overlap both spatially and temporally and are logically interconnected. Urban shrinkage objectively reduces land market demand to varying degrees, directly weakening the local fiscal base. Conversely, excessive reliance on land finance may exacerbate disorderly spatial expansion and functional hollowing, creating a governance dilemma where cities sell more land despite shrinking and shrink further as land sales increase. Following the significant adjustments in the real estate market in 2021, land conveyance revenue declined sharply, substantially reducing the fiscal support capacity of shrinking cities and highlighting the unsustainability of the traditional land-dependent development model.

Based on this awareness, this study focuses on Liaoning Province as a case study area. After reviewing theories and progress related to urban shrinkage and land finance, this research first identifies urban shrinkage within Liaoning, establishes a comprehensive four-dimensional evaluation indicator system encompassing demographic, economic, social, and spatial dimensions, and develops a model to measure land finance dependency. Subsequently, it employs a coupling coordination degree model to analyze the relationship between urban shrinkage and land finance dependency, as well as their spatial differentiation. Finally, targeted policy recommendations are proposed to support sustainable urban development in Liaoning Province and similar regions in China.

## 2. Literature Review

### *2.1. Understanding Urban Shrinkage*

Urban shrinkage is a global phenomenon that gained significant academic attention toward the end of the twentieth century, especially as many industrial cities in Europe and North America experienced pronounced population loss and spatial decline due to deindustrialization, aging populations, and economic restructuring [4–7]. Josje J. Hoekveld introduced the concept of urban shrinkage to describe cities experiencing sustained population decline and economic stagnation resulting from deindustrialization. Subsequently,

research on urban shrinkage has expanded beyond merely population decline to include economic, social, and spatial dimensions [8].

Typically, urban shrinkage involves reductions in population size, density, and economic activity intensity [9–11]. International studies on urban shrinkage began in the mid-to-late twentieth century, primarily focusing on old industrial regions undergoing post-industrial transitions, such as Germany's Ruhr region [11] and the American Rust Belt [12]. Wang et al. (2022) explored the coupling coordination among urban shrinkage, compactness, and land-use efficiency, highlighting that shrinkage extends beyond the paradox of simultaneous population decline and land expansion, encompassing intricate interactions among urban spatial compactness, land-use efficiency improvements, public service supply–demand imbalances, and ecological pressures [13,14]. Pallagst et al. (2014) further demonstrated that urban shrinkage, as a multidimensional phenomenon, varies according to national, regional, and local contexts, with globalization and deindustrialization as principal driving forces. Cities respond to shrinkage through various strategies, including urban renewal, industrial transformation, and green infrastructure [14,15].

Concerning the causes and mechanisms of shrinkage, Han et al. (2024), examining American Rust Belt cities, identified the significant relationship between industrial land transformation and urban shrinkage, arguing that the decline of traditional industrial regions stems not only from economic cycles but also from global industrial restructuring, institutional rigidities, and weakened local fiscal capacities [13,16]. Chen (2025) shows that the prefectural cities in the northeast are clusters of high spatial inequality and the low growth or actual shrinkage of economic activity and population [17]. Huang et al. (2024), studying Hegang in Northeast China, investigated the relationship between infrastructure and land use within shrinking cities [18]. Their findings revealed the coexistence of spatial vacancy and inefficient expansion during urban shrinkage.

Compared with Europe and North America, research on urban shrinkage in China began relatively recently. However, studies have rapidly increased in recent years due to the intensified population outflow in Northeast China and the decline of resource-dependent cities [19–22]. Ma Xiaosong et al. (2023), examining typical population loss areas in Northeast China, contributed significantly to methodological advancement [23]. Their spatially explicit approach enhanced the precision of population data analysis and, notably, identified the paradox of localized shrinkage occurring even within cities experiencing overall population growth. This finding illustrates complex patterns such as local growth and core-oriented population siphoning, where central cities grow by attracting population from peripheral areas and surrounding regions, while older urban districts or suburban areas experience hollowing. By precisely identifying various types of urban shrinkage, this research advanced the understanding of its multidimensional and heterogeneous nature and offered a scientific foundation for differentiated revitalization strategies applicable to both globally shrinking cities and locally declining areas within growing cities. It marks a transition in urban shrinkage research from macro-level statistical measurements to micro-level spatial analysis and from single-indicator assessments to compound classifications [23,24]. Zhang Shuai et al. (2020) comprehensively measured urban shrinkage across China, identifying spatial patterns characterized by greater shrinkage in northern versus southern regions and eastern versus western areas, predominantly in resource-based cities and old industrial bases [25]. Lin Xiongbin et al. (2017) analyzed Chinese urban shrinkage from demographic and economic perspectives, arguing that reliance solely on population metrics underestimates the complexity of shrinkage; therefore, factors like economic slowdown and industrial structural degradation should also be included [26].

### *2.2. Land Finance Model*

The practice whereby Chinese local governments generate fiscal revenue through land operations is termed land finance in the literature [27]. Land finance is a distinctive fiscal phenomenon specific to local governments in China. Narrowly defined, it refers to revenues obtained by local authorities through transferring land-use rights. Broadly defined, it encompasses not only land conveyance revenues but also taxes related to land and real estate, including property tax, urban land-use tax, land value-added tax, cultivated land occupation tax, and deed tax [28]. The emergence of land finance is closely associated with China's 1994 fiscal-sharing reform, which centralized fiscal authority at higher governmental levels while decentralizing expenditure responsibilities to local governments, thereby increasing local fiscal deficits. Consequently, land conveyance fees became essential extra-budgetary mechanisms for local governments to bridge these fiscal gaps. From an international comparative viewpoint, China's reliance on land conveyance revenue significantly differs from Western local fiscal systems, where property taxes predominate. This distinction provides an important theoretical reference for comprehending land finance dependency.

Determinants of land finance dependency display notable spatiotemporal heterogeneity and sensitivity to policy interventions. Within the context of coordinated regional development, Chen et al. (2024) indicated that urban agglomeration policies effectively reduce land finance dependency, although their efficacy varies with the development stage of urban agglomerations [29]. Mature agglomerations exert significantly stronger inhibitory effects than developing ones. Additionally, land finance dependency demonstrates an inverted U-shaped relationship with regional integration: moderate dependency promotes integration, whereas excessive dependency inhibits it, particularly through reliance on land conveyance revenue. Wang et al. (2020) further argued that reductions in land finance during periods of economic downturn accelerate urban shrinkage, especially in cities already experiencing population loss, where limited capital inflows exacerbate urban decline [30].

The negative spillover effects of land finance dependency have increasingly drawn attention, particularly regarding high-quality development. Xu et al. (2024) argued that although local governments' reliance on land-based financing can temporarily alleviate fiscal pressures, it ultimately distorts government expenditure priorities, diminishes fiscal efficiency, deteriorates the institutional environment, and significantly hampers urban innovation quality [31]. This scenario highlights a critical risk: short-term growth achieved through land finance dependency occurs at the expense of long-term innovation capacity and institutional quality.

### *2.3. Coupling Coordination Degree*

In urbanization research, the coupling coordination degree model has become an essential tool for analyzing interactions among elements such as population, land, and finance. Yuan Fangcheng et al. (2018) emphasized that healthy urbanization should achieve coordinated development across population urbanization, land urbanization, and fiscal support capacity [32]. However, Ma Wanli et al. (2018) contended that China's rapid urbanization has consistently exhibited a structural mismatch between population and land urbanization, driven by local governments' deep reliance on land finance and land-based financing due to promotion and fiscal tournaments [33]. Chen Ying et al. (2018) confirmed through provincial panel data that China's urbanization–land finance relationship transitioned from disorder to coordination between 2005 and 2015, although regional disparities persisted [34].

As certain cities, particularly resource-based and older industrial regions, enter a stage of shrinkage, the previously established growth-oriented coupling relationship faces

significant challenges. Urban shrinkage fundamentally weakens the population and demand basis necessary for sustaining land finance. Wang Yubo (2023) explicitly identified this core issue: substantial population shrinkage in the three northeastern provinces has resulted in a continuous decline in urban land demand, thereby directly undermining the foundation of the land finance model [35]. Forecasts indicate a substantial decrease in annual land finance scale compared to its peak, a direct outcome of declining land demand driven by population loss. Huang et al. (2024), using Hegang in Northeast China as an empirical case, further highlighted this dynamic: although urban construction land intensity increased from 1992 to 2020, its coupling with land-use efficiency significantly weakened after 2000 [18]. This finding suggests that under conditions of population outflow, mere land expansion no longer generates development benefits but instead exacerbates internal systemic imbalances. Wu et al. (2024) demonstrated that spatial development under urban shrinkage frequently lacks coordination with carbon emission goals, with evident developmental delays and polarization in regions such as Northeast China and the Beijing–Tianjin–Hebei region [36]. Such coordination issues are also clearly reflected in the population-land-finance relationship. Yuan Fangcheng et al. (2020) initially predicted that 2018 could represent a turning point from imbalance toward equilibrium in urbanization [37]. However, continuous population outflows in shrinking cities inevitably weaken land's supporting role, creating severe fiscal and land constraints, thus complicating balanced development. Chen et al. (2024) indirectly suggest that examining the coupling interaction between population and land urbanization from the perspective of shrinking cities is crucial for understanding contemporary regional developmental disparities [38].

Overall, the existing literature, utilizing the coupling coordination degree model, clearly demonstrates how urban shrinkage disrupts the original positive feedback mechanism of land-driven development. Wang Yubo's earlier research (2015, 2017) [39,40] examining regional differences in land finance and urban land scale relationships provided foundational insights for understanding shrinkage scenarios. Specifically, when economic growth lags and population outflow persists, the coordination between land finance and urban development may deteriorate from high or moderate coordination levels to barely or poorly coordinated states. For shrinking cities, Wang Yubo (2023) argues that land finance is increasingly unsustainable, requiring transformation beyond traditional land-expansion strategies [35]. Sustainable coupling coordination under the new reality of population shrinkage can only be achieved through institutional innovations, such as attracting population clusters and developing diversified urban infrastructure financing models.

## 3. Research Methods and Data Sources

### *3.1. Construction of the Urban Shrinkage Evaluation Indicator System*

Following previous studies [41], this research constructs a multidimensional evaluation indicator system encompassing population, economic, social, and spatial dimensions to assess urban shrinkage in 14 cities of Liaoning Province. Population indicators include permanent population [42] and the proportion of the working-age population (ages 18–59) [43]. Permanent population decline is a core feature of urban shrinkage, and a reduction in the working-age population proportion directly impacts urban productivity and economic potential, signifying shrinkage. Economic indicators comprise per capita GDP and the share of secondary and tertiary industries [44]. Per capita GDP represents the average economic output and living standards; slow growth or decline suggests urban economic recession. The proportion of secondary and tertiary industries indicates industrial structure optimization; a consistent decrease might imply structural issues or transition difficulties, reducing economic vitality. Social indicators consist of the number of service-sector en-

terprises and total retail sales of consumer goods. Changes in service-sector enterprises reflect shifts in consumption demand, employment scale, and market vitality, providing a comprehensive view of urban shrinkage. Total retail sales are critical measures of consumption capacity, with fluctuations signifying urban economic activity levels. Spatial indicators include per capita park green space [45] and built-up area [46]. Increased per capita green space typically indicates enhanced urban livability and economic performance, suggesting development rather than shrinkage. Changes in built-up area directly indicate the expansion or contraction of urban spatial scale: an increase signifies urban spatial expansion, whereas a decrease signals urban spatial contraction. Table 1 presents the detailed evaluation indicator system.

**Table 1.** Comprehensive Measurement Indicator System for Urban Shrinkage in Liaoning Province.

| Target Layer | Criterion Layer | Indicator Layer | Weight | Indicator Attribute |
|---|---|---|---|---|
| Population | Population scale | Permanent population X1 | 0.125 | + |
| | Population structure | Share of population aged 18–59 X2 | 0.127 | + |
| Economy | Economic level | Per capita GDP X3 | 0.123 | + |
| | Industrial structure | Share of secondary and tertiary industries X4 | 0.111 | + |
| Space | Activity intensity | Per capita park green space X5 | 0.108 | + |
| | Land expansion | Built-up area X6 | 0.170 | ± |
| Society | Public services | Number of service-sector enterprises X7 | 0.113 | + |
| | Consumption level | Total retail sales of consumer goods X8 | 0.123 | + |

### *3.2. Measurement of Urban Shrinkage Degree*

This study develops a comprehensive measurement indicator system structured around four dimensions, population, economy, society, and space, with eight specific indicators. Initially, data normalization is performed using the range method. Equation (1) calculates the annual arithmetic mean, $E_{(index)}$, for each indicator, reflecting the overall indicator level across the cities. Equation (2) calculates each indicator's standard deviation, $\sigma_{(index)}$, representing its dispersion across the cities. Using the standard deviation decision method, Equation (3) determines the weight coefficient, *Wj*, as each indicator's proportion of the total standard deviation sum. Equation (4) calculates the urban shrinkage index (Z) through the weighted summation of standardized indicator values for each city. Finally, the mean of the adjacent-year differences ($\Delta Z = Z_t + 1 - Z_t$) is calculated using Equation (5) to define the urban shrinkage degree.

1. Mean of the indicator variable:

$$E_{(index)} = \frac{\sum_{i=1}^{n} X_{ij}}{n} \quad (1)$$

where $E_{(index)}$ represents the arithmetic mean of an indicator for the 14 cities in Liaoning Province in a given year, n is the number of cities, *Xi* is the *i*-th city, and *j* is the indicator.

2. Standard deviation of the indicator:

$$\sigma_{(index)} = \sqrt{\frac{1}{n}\sum_{i=1}^{n}\left(X_{ij} - E_{(index)}\right)^2} \quad (2)$$

where $\sigma_{(index)}$ is the standard deviation of the indicator, reflecting its variability across all samples.

3. Indicator weight:

$$W_j = \frac{\sigma_{(index)}}{\sum_{j=1}^{m} \sigma_{(index)}} \tag{3}$$

where *Wj* denotes the weight coefficient of an indicator, and *m* denotes the total number of indicators (eight in this case).

4. Urban shrinkage index:

$$Z = \sum_{j=1}^{m} X_{ij} W_j \tag{4}$$

where *Z* denotes the urban shrinkage index, with larger values indicating healthier urban development and a lower shrinkage risk, while smaller values suggest higher shrinkage risk.

5. Urban shrinkage degree:

$$Shrinking = \frac{\sum_{i=1}^{n} \Delta Z}{n} = \frac{\sum_{i=1}^{n} (Z_{t+1} - Z_t)}{n} \tag{5}$$

where *Shrinking* denotes the urban shrinkage degree, calculated as the mean annual difference in the urban shrinkage index. A negative value classifies the city as shrinking; otherwise, it is considered non-shrinking. Here, *n* indicates the number of annual differences.

### *3.3. Measurement of Land Finance Dependency*

To assess local governments' reliance on land conveyance revenue, researchers commonly use this revenue as the primary indicator due to its substantial share, accessibility, and direct correlation with land market cycles. Consistent with existing research, this study uses the annual transaction value of state-owned construction land-use-right conveyances in Liaoning Province's cities as the main indicator of land finance.

Following Mou Yan's (2015) approach, this study quantifies land finance dependency as the ratio of land conveyance revenue to the combined total of land conveyance revenue and general public budget revenue [47]. This measure directly reflects the relative significance of land conveyance revenue within local governments' disposable fiscal resources. A higher ratio implies greater dependency on land conveyance revenue and lower fiscal resilience, whereas a lower ratio indicates more diverse fiscal sources and reduced sensitivity to fluctuations in land revenue. Land finance dependency (D) is calculated as follows:

$$\mathrm{D} = \frac{LF}{LF + GB} \tag{6}$$

where D represents land finance dependency, ranging from 0 to 1; *LF* denotes annual land conveyance revenue; and *GB* refers to the general public budget revenue of each city. The sum (*LF* + *GB*) accurately captures the weight of land conveyance revenue within local governments' fiscal resources. Land conveyance revenue (*LF*) data are derived from publicly available government records, while general budget revenue (*GB*) data are sourced from municipal statistical yearbooks and fiscal reports.

### *3.4. Construction of the Coupling Coordination Model*

This study employs the capacity coupling coefficient model widely utilized in social science system analyses [47–49]. This model differentiates between two key concepts: cou-

pling degree (C) and coordination degree (DC). Coupling degree (C) measures the intensity of interaction between the urban shrinkage and land finance systems. High coupling may occur even if both systems exhibit low development levels, provided their variations are synchronized. Coordination degree ($D_C$), however, integrates both coupling degree and the individual development levels of these systems (U) to assess their capacity to achieve coordinated and sustainable development through beneficial interactions. Distinguishing these concepts prevents misinterpreting high coupling between low-level systems as ideal coordination. Consequently, this research primarily focuses on the coordination degree ($D_C$).

Coupling degree C:

$$C = \sqrt{\frac{U_1 * U_2}{(U_1 + U_2)^2}} \tag{7}$$

where $U_1$ represents the urban shrinkage degree ($U_1 = -\Delta Z = -(Z_t + 1 - Z_t)$), and $U_2$ denotes land finance dependency ($U_2$ = D).

Coordination index (T): Urban shrinkage and land finance dependence exhibit a mutually causal and co-evolutionary relationship. Under these conditions, assigning equal weights provides an unbiased, maximally conservative approach, preventing any artificial exaggeration of either system's dominance. The coupling coordination degree model is employed to assess whether the two systems operate synchronously and engage in beneficial interactions rather than to determine the relative importance of each. Equal weighting effectively captures how much each system deviates from an ideal state of coordination. Therefore, this study equally weights urban shrinkage and land finance dependence in calculating the comprehensive coordination degree, setting $a = b = 0.5$:

$$T = aU_1 + bU_2 \tag{8}$$

Coupling coordination degree (DC):

$$D_C = \sqrt{C * T} \tag{9}$$

This study follows the ten-level classification criteria for coupling coordination degree proposed by Wang Shujia et al. (2021) [50] (Table 2).

**Table 2.** Classification of Coupling Coordination Degree (DC).

| D-Value Interval of Coupling Coordination Degree | Coordination Grade | D-Value Interval of Coupling Coordination Degree | Coordination Grade |
|---|---|---|---|
| [0.0~0.1) | Extreme disorder | [0.5~0.6) | Barely coordinated |
| [0.1~0.2) | Severe disorder | [0.6~0.7) | Primary coordination |
| [0.2~0.3) | Moderate disorder | [0.7~0.8) | Intermediate coordination |
| [0.3~0.4) | Mild disorder | [0.8~0.9) | Good coordination |
| [0.4~0.5] | Near disorder | [0.9~1.0) | High-quality coordination |

### *3.5. Study Area and Data Sources*

#### 3.5.1. Study Area

Liaoning Province is located in the central area of the Bohai Rim and the Northeast Asian economic region. It is unique in Northeast China for its combined coastal and border geographic position, making it a strategic industrial and logistical hub. The province covers approximately 148,700 $km^2$ and administers 14 prefecture-level cities. Liaoning has a robust industrial base, encompassing 40 of China's 41 major industrial categories. Its equipment manufacturing and raw material industries are highly competitive, enjoying significant market shares nationwide.

3.5.2. Data Sources

This study employs data covering population, economic, social, spatial, and land finance indicators for the 14 prefecture-level cities in Liaoning Province from 2016 to 2023. The sources of these data are detailed below:

(1) Basic socioeconomic data: Indicators such as permanent population, proportion of the population aged 18–59, per capita GDP, share of secondary and tertiary industries, total retail sales of consumer goods, number of service-sector enterprises, built-up area, and per capita park green space are sourced from the Liaoning Statistical Yearbook (2017–2024), municipal statistical yearbooks, and statistical communiqués on national economic and social development.

(2) Land finance data: Land conveyance revenue data are obtained from publicly accessible government reports on state-owned construction land-use-right transactions in Liaoning Province between 2016 and 2023. General budget revenue data are extracted from municipal statistical yearbooks and fiscal final accounts.

3.5.3. Data Processing

To mitigate the effects of varying dimensions and scales among raw data indicators, standardization was performed. This study uses the range method for standardization with translation adjustments:

Positive indicator:

$$x_{ij}^{*} = \frac{x_{ij} - min(x_j)}{max(x_j) - min(x_j)} + 0.01 \quad (10)$$

Negative indicator:

$$x_{ij}^{*} = \frac{max(x_j) - x_{ij}}{max(x_j) - min(x_j)} + 0.01 \quad (11)$$

## 4. Empirical Analysis

### *4.1. Identification Results of Urban Shrinkage in Liaoning Province*

1. Shrinkage index and temporal characteristics

From 2016 to 2023, the urban shrinkage index of Liaoning cities displayed a pattern of initial growth followed by fluctuating decline, accompanied by persistent internal disparities. Both annual variations and inter-city differences were notable. Temporally, three distinct stages emerged. Most Liaoning cities displayed a general upward trend in the shrinkage index, though this was not uniformly observed. Certain individual cities, such as Dalian and Panjin, showed slight declines during the same period, highlighting localized fluctuations. Most cities reached a peak in 2018, with Dandong, Benxi, Huludao, and Yingkou exceeding 0.7, and Fushun, Jinzhou, Fuxin, and Anshan nearing 0.7, reflecting a relatively favorable development status with lower shrinkage risk. Second, from 2019 to 2020, the index declined, marking increased shrinkage risks. The index for most cities dropped significantly in 2020, generally falling within the 0.4–0.5 range, indicating greater urban development pressures and higher shrinkage likelihood. Finally, from 2021 to 2023, the shrinkage index exhibited minor fluctuations with increasing inter-city differentiation. Post-2021 indices remained lower than their 2017–2018 peaks, except for Shenyang, which steadily rose to 0.854 by 2023, representing the highest development resilience in the province. Most other cities fluctuated between 0.4 and 0.6, indicating lower development stability compared to Shenyang (Table 3).

2. Identification results of urban shrinkage

**Table 3.** Urban Shrinkage Index and Shrinkage Degree in Liaoning Province.

| City | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | Shrinkage Degree |
|---|---|---|---|---|---|---|---|---|---|
| Shenyang | 0.325 | 0.461 | 0.580 | 0.511 | 0.563 | 0.666 | 0.707 | 0.854 | 0.529 |
| Dalian | 0.421 | 0.385 | 0.595 | 0.362 | 0.508 | 0.580 | 0.618 | 0.627 | 0.207 |
| Anshan | 0.417 | 0.706 | 0.621 | 0.564 | 0.458 | 0.501 | 0.488 | 0.539 | 0.122 |
| Fushun | 0.521 | 0.672 | 0.729 | 0.417 | 0.463 | 0.304 | 0.226 | 0.216 | −0.305 |
| Benxi | 0.389 | 0.821 | 0.711 | 0.568 | 0.493 | 0.490 | 0.494 | 0.506 | 0.167 |
| Dandong | 0.541 | 0.846 | 0.721 | 0.636 | 0.408 | 0.451 | 0.422 | 0.430 | −0.111 |
| Jinzhou | 0.579 | 0.654 | 0.710 | 0.605 | 0.409 | 0.400 | 0.325 | 0.460 | −0.119 |
| Yingkou | 0.527 | 0.713 | 0.799 | 0.551 | 0.547 | 0.564 | 0.507 | 0.557 | 0.031 |
| Fuxin | 0.579 | 0.686 | 0.647 | 0.615 | 0.411 | 0.505 | 0.493 | 0.561 | −0.018 |
| Liaoyang | 0.533 | 0.612 | 0.659 | 0.524 | 0.402 | 0.418 | 0.453 | 0.530 | −0.003 |
| Panjin | 0.580 | 0.550 | 0.643 | 0.587 | 0.466 | 0.601 | 0.570 | 0.593 | 0.013 |
| Tieling | 0.560 | 0.615 | 0.475 | 0.488 | 0.407 | 0.560 | 0.486 | 0.443 | −0.017 |
| Chaoyang | 0.399 | 0.751 | 0.642 | 0.616 | 0.442 | 0.497 | 0.463 | 0.516 | 0.117 |
| Huludao | 0.590 | 0.789 | 0.653 | 0.648 | 0.434 | 0.517 | 0.465 | 0.471 | −0.017 |

Cities were categorized as non-shrinking if their shrinkage degree was positive, and significantly shrinking if negative. The results revealed balanced differentiation among the 14 cities, characterized by clear typological distinctions:

Seven cities were classified as non-shrinking (shrinkage degree > 0), demonstrating stable development without shrinkage risk. Among these, Shenyang (0.529) and Dalian (0.207) were identified as core stable cities, ranking first and second respectively. Shenyang notably displayed the strongest resilience due to its robust population and economic agglomeration capabilities. Benxi (0.167), Anshan (0.122), Chaoyang (0.117), Yingkou (0.031), and Panjin (0.013) also exhibited stable development with positive but relatively low shrinkage degrees.

Seven cities were identified as significantly shrinking (shrinkage degree < 0), primarily traditional resource-based and industrial cities. Fushun (−0.305) showed the most pronounced shrinkage. Jinzhou (−0.119) and Dandong (−0.111) also had significant shrinkage issues. Cities such as Fuxin (−0.018), Liaoyang (−0.003), Tieling (−0.017), and Huludao (−0.017), while classified as shrinking, had comparatively mild shrinkage degrees.

From 2016 to 2023, Liaoning Province exhibited distinct spatiotemporal differentiation in urban shrinkage. Temporally, shrinkage pressures intensified in 2019–2020, following a relatively stable early stage, with increasing disparities later on. Spatially, a clear pattern emerged: core cities remained stable and non-shrinking, whereas traditional industrial cities faced significant shrinkage. The distribution showed a pronounced regional imbalance, with an equal number of non-shrinking and shrinking cities. The spatial distribution is illustrated in Figure 1.

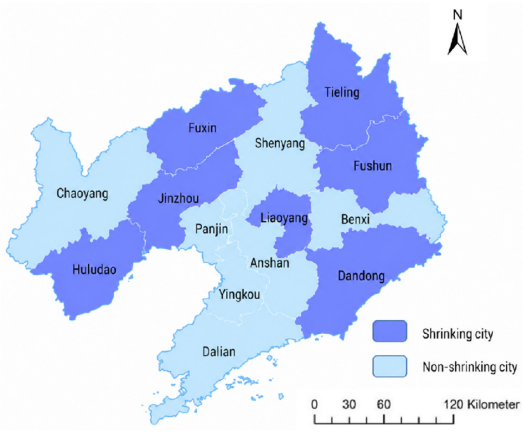



**Figure 1.** Spatial Distribution of Urban Shrinkage in Liaoning Province.

### *4.2. Measurement Results of Land Finance Dependency*

The temporal evolution of land finance dependency across cities in Liaoning Province demonstrates an inverted U-shaped trend, characterized by an initial rise, a peak during 2019–2020, followed by a sustained decline after 2021, and an accelerated decrease during 2022–2023. This trend can be divided into three distinct phases: rise, peak, and contraction. During the rising phase (2016–2020), driven by favorable real estate conditions and active urban land transactions, land finance dependency steadily increased in most cities, particularly in Shenyang, Dalian, Chaoyang, and Huludao. The peak phase occurred in 2020 due to intensified land conveyance before the pandemic and increased fiscal pressures, resulting in a provincial-wide dependency peak. During the contraction phase (2021–2023), influenced by tighter real estate policies and a cooling land market, dependency significantly decreased. This timeframe closely aligns with the financing constraints introduced by the "Three Red Lines" policy and the "centralized land supply" initiative. The "Three Red Lines" policy directly constrained land market demand by restricting real estate companies' financing capabilities and expenditures on land acquisition. Concurrently, the "centralized land supply" policy further limited the scale of land transfers by reforming the pace and rules governing land distribution. From 2020 to 2023, land conveyance revenue in Liaoning Province declined sharply from 129.6 billion yuan to 31.6 billion yuan, clearly illustrating the concentrated impact of these policy shifts on shrinking cities. By 2023, most cities exhibited dependency levels below 0.15, indicating a substantial weakening of land finance as a fiscal support mechanism. This reveals the inherent vulnerability and early decline of land finance, especially in the resource-dependent and aging industrial cities of Northeast China, reflecting pronounced regional characteristics.

Spatially, land finance dependency in Liaoning Province exhibits central polarization, gradient attenuation, and overall provincial convergence. Initially characterized by high dependency concentrated in central cities, the pattern evolved towards province-wide lower dependency and diminishing spatial heterogeneity. Cities such as Shenyang, Dalian, Chaoyang, Huludao, and Yingkou formed a high-dependency cluster, consistently maintaining high values, with peaks often exceeding 0.3. Shenyang, as the provincial capital, reached a maximum value of 0.467 in 2020, the highest province-wide. Huludao maintained dependency levels above 0.3 from 2016 to 2018, reflecting persistent dependency inertia. Jinzhou, Benxi, Liaoyang, and Dandong formed a medium-dependency cluster, with values generally fluctuating between 0.12 and 0.28. Fushun, Tieling, Fuxin, and Panjin belonged to the low-dependency group, consistently maintaining lower levels. In 2023, Fushun (0.012), Panjin (0.027), and Tieling (0.049) showed dependency levels closely linked to their resource-based economies, demographic challenges, and limited land supply.

Land finance dependency data for each city from 2016 to 2023 are presented in Table 4. Trends in land finance dependency for shrinking cities are illustrated in Figure 2.

**Table 4.** Land Finance Dependency in Liaoning Province.

| | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 |
|---|---|---|---|---|---|---|---|---|
| Shenyang | 0.231 | 0.261 | 0.336 | 0.407 | 0.467 | 0.376 | 0.127 | 0.090 |
| Dalian | 0.147 | 0.187 | 0.153 | 0.315 | 0.328 | 0.277 | 0.230 | 0.138 |
| Anshan | 0.134 | 0.138 | 0.074 | 0.124 | 0.125 | 0.131 | 0.149 | 0.107 |
| Fushun | 0.088 | 0.050 | 0.251 | 0.134 | 0.212 | 0.113 | 0.118 | 0.012 |
| Benxi | 0.210 | 0.192 | 0.203 | 0.120 | 0.142 | 0.218 | 0.174 | 0.077 |
| Dandong | 0.120 | 0.099 | 0.148 | 0.269 | 0.330 | 0.289 | 0.163 | 0.164 |
| Jinzhou | 0.237 | 0.223 | 0.231 | 0.268 | 0.232 | 0.122 | 0.144 | 0.100 |
| Yingkou | 0.209 | 0.196 | 0.362 | 0.190 | 0.183 | 0.337 | 0.148 | 0.126 |
| Fuxin | 0.165 | 0.180 | 0.120 | 0.174 | 0.223 | 0.154 | 0.041 | 0.059 |

**Table 4.** *Cont.*

| | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 |
|---|---|---|---|---|---|---|---|---|
| Liaoyang | 0.268 | 0.216 | 0.123 | 0.179 | 0.117 | 0.187 | 0.115 | 0.110 |
| Panjin | 0.162 | 0.094 | 0.186 | 0.366 | 0.216 | 0.163 | 0.048 | 0.027 |
| Tieling | 0.079 | 0.155 | 0.171 | 0.137 | 0.126 | 0.090 | 0.095 | 0.049 |
| Chaoyang | 0.224 | 0.251 | 0.285 | 0.179 | 0.367 | 0.379 | 0.240 | 0.193 |
| Huludao | 0.311 | 0.306 | 0.358 | 0.284 | 0.282 | 0.283 | 0.107 | 0.109 |

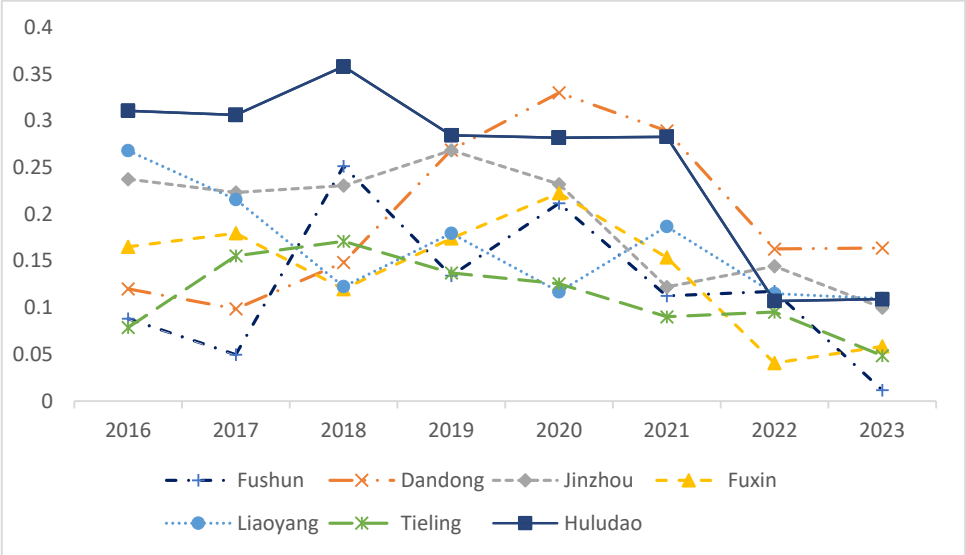



**Figure 2.** Trends in Land Finance Dependency among Shrinking Cities in Liaoning Province, 2016–2023.

### *4.3. Measurement of Coupling Coordination Degree*

We calculated the urban shrinkage degree and land finance dependency for the seven shrinking cities using Equations (7)–(9). MATLAB R2023b software was employed to numerically solve the coupling coordination degree model, producing the coupling coordination degrees (DC) and corresponding grades between urban shrinkage and land finance dependency from 2016 to 2023. Results are detailed in Tables 5 and 6.

**Table 5.** Coupling Coordination Degree (DC) between Urban Shrinkage and Land Finance Dependency in Seven Shrinking Cities of Liaoning Province, 2016–2023.

| Year | Huludao | Tieling | Liaoyang | Fuxin | Jinzhou | Dandong | Fushun |
|---|---|---|---|---|---|---|---|
| 2016 | 0.317 | 0.291 | 0.335 | 0.296 | 0.381 | 0.279 | 0.247 |
| 2017 | 0.166 | 0.341 | 0.271 | 0.259 | 0.355 | 0.223 | 0.188 |
| 2018 | 0.521 | 0.456 | 0.295 | 0.361 | 0.374 | 0.428 | 0.372 |
| 2019 | 0.436 | 0.360 | 0.471 | 0.393 | 0.485 | 0.486 | 0.438 |
| 2020 | 0.516 | 0.399 | 0.418 | 0.497 | 0.503 | 0.549 | 0.363 |
| 2021 | 0.379 | 0.123 | 0.368 | 0.271 | 0.358 | 0.455 | 0.383 |
| 2022 | 0.359 | 0.370 | 0.307 | 0.265 | 0.403 | 0.415 | 0.364 |
| 2023 | 0.338 | 0.302 | 0.235 | 0.240 | 0.224 | 0.405 | 0.191 |

Temporally, the coupling coordination grades among the seven shrinking cities displayed a pattern of fluctuating improvements initially, followed by widespread deterioration. At the beginning of the observation period, most cities exhibited poor coordination, predominantly categorized within mild-to-moderate disorder, with limited short-term improvements. Between 2018 and 2020, coordination levels improved: Huludao, Jinzhou, and Dandong achieved barely coordinated status, while Tieling, Liaoyang, Fuxin, and Fushun

advanced from moderate to near or mild disorder, reflecting temporary benefits from active land markets. However, improvements were not sustainable, and 2021 marked a collective turning point towards declining coordination. Subsequently, Huludao regressed to mild disorder, Tieling fell sharply into severe disorder, Fushun returned to severe disorder in 2023, and Liaoyang and Fuxin relapsed to moderate disorder. By the end of the study period, almost all shrinking cities in Liaoning Province were categorized as mild disorder or lower, with only Dandong and Jinzhou remaining near disorder but still below coordinated thresholds.

**Table 6.** Coupling Coordination Grades between Urban Shrinkage and Land Finance Dependency in Seven Shrinking Cities of Liaoning Province, 2016–2023.

| Year | Huludao | Tieling | Liaoyang | Fuxin | Jinzhou | Dandong | Fushun |
|---|---|---|---|---|---|---|---|
| 2016 | Mild disorder | Moderate disorder | Mild disorder | Moderate disorder | Mild disorder | Moderate disorder | Moderate disorder |
| 2017 | Severe disorder | Mild disorder | Moderate disorder | Moderate disorder | Mild disorder | Moderate disorder | Severe disorder |
| 2018 | Barely coordinated | Near disorder | Moderate disorder | Mild disorder | Mild disorder | Near disorder | Mild disorder |
| 2019 | Near disorder | Mild disorder | Near disorder | Mild disorder | Near disorder | Near disorder | Near disorder |
| 2020 | Barely coordinated | Mild disorder | Near disorder | Near disorder | Barely coordinated | Barely coordinated | Mild disorder |
| 2021 | Mild disorder | Severe disorder | Mild disorder | Moderate disorder | Mild disorder | Near disorder | Mild disorder |
| 2022 | Mild disorder | Mild disorder | Mild disorder | Moderate disorder | Near disorder | Near disorder | Mild disorder |
| 2023 | Mild disorder | Mild disorder | Moderate disorder | Moderate disorder | Moderate disorder | Near disorder | Severe disorder |

From the perspective of industrial structure, resource-depleted cities such as Fushun and Fuxin have long been constrained by reliance on a single extractive industry, particularly coal mining. Although the secondary sector still accounts for a relatively large share of the economy, the industrial chain remains short and technological spillover effects are limited. During periods of resource depletion, these cities are unable to maintain stable tax revenues or generate sufficient fiscal income through the secondary land market, resulting in coupling coordination degrees that have consistently remained below the "mildly disordered" level. In contrast, cities such as Dandong and Huludao briefly reached a "barely coordinated" state between 2018 and 2020. In addition to a booming land market, this was partly attributable to their relatively diversified industrial structures, which retained a limited capacity to attract population and capital. Nevertheless, their non-agricultural industrial bases remain weak. From the perspective of population mobility, shrinking cities in Liaoning Province generally experience sustained net outflows of the working-age population. Between 2016 and 2023, Fushun and Tieling recorded average annual population losses exceeding 0.8%, directly weakening demand for housing and commercial land and thereby undermining the demand-side foundation of land conveyance revenue. Population outflows also reduce the utilization density of public services, forcing local governments to contract fiscal expenditures and further lowering the coordination degree. Therefore, the observed pattern of "rise followed by decline" in the coordination degree essentially reflects differences in cities' capacities for industrial restructuring and population agglomeration, as manifested through the land finance cycle.

At the same time, the level of coupling coordination is systematically associated with the actual operational conditions of cities. Under severe disorder, land conveyance revenue declines sharply, public services are compressed, and infrastructure renewal stagnates. Under moderate disorder, the land market is primarily sustained by local government financing platforms (chengtou), while population outflows accelerate. Under mild disorder, basic public services can still be maintained, although operational efficiency declines. On the verge of disorder, fiscal balance depends heavily on current-year land sales; although normal urban operations can still be maintained, the fiscal position remains fragile, and continued market downturns may push cities into disorder within one to two years. A barely coordinated state reflects only short-term prosperity in the land market rather than genuine structural improvement. Once external support weakens, the coordination degree rapidly declines again.

Overall, the coupling coordination between urban shrinkage and land finance dependency in Liaoning Province demonstrates significant procyclical behavior and vulnerability. Once external market support diminishes, the system quickly deteriorates into disorder and severe imbalance.

### *4.4. Coupling Coordination Analysis Between Urban Shrinkage and Land Finance Dependency*

Based on the measured coupling coordination results, this section systematically analyzes the relationship between urban shrinkage and land finance dependency in Liaoning Province from multiple dimensions, including spatial agglomeration characteristics, differences in shrinkage types, regional heterogeneity in land market responses, and fiscal resilience constraints.

#### 4.4.1. Spatial Agglomeration Characteristics

The spatial distribution of the seven shrinking cities in Liaoning Province demonstrates a clear core–periphery structure, marked by structural decline in central areas alongside peripheral belt-like shrinkage. Cities such as Fushun, Liaoyang, Tieling, and Fuxin are clustered around the periphery of the Shenyang metropolitan region and traditional industrial hinterlands. Dandong and Huludao are located in eastern and western Liaoning respectively, while Jinzhou serves as a key node in the western corridor. This spatial pattern aligns closely with Liaoning's historical industrial layout, the life cycle of resource-dependent cities, and population migration routes. Consequently, urban shrinkage emerges as a systemic spatial phenomenon shaped by regional developmental imbalances, entrenched industrial structures, and institutional inertia.

In terms of spatial differentiation in coupling coordination, cities within the inland old-industrial regions consistently exhibited low coordination levels and significant fluctuations during the study period. Fushun, Liaoyang, and Tieling remained primarily within mild-to-moderate disorder categories. In contrast, coastal cities such as Dandong and Huludao temporarily improved to the barely coordinated level between 2018 and 2020. However, after 2021, as the land market cooled, all cities experienced declining coordination, narrowing intercity differences, and converging toward low-level equilibrium. This trend illustrates that spatial locational advantages have significantly diminished due to institutional shrinkage and structural fiscal issues, with regional disparities converging toward generalized coordination deterioration.

#### 4.4.2. Resource Depletion-Oriented Shrinkage

Resource depletion-oriented urban shrinkage primarily stems from systemic urban decline triggered by diminishing dominant resource industries. After intensive resource extraction and industrial concentration, these cities encounter structural issues including declining reserves, increased extraction costs, and delayed industrial diversification. These

issues trigger chain reactions characterized by population outflow, fiscal contraction, and spatial vacancies. Fuxin exemplifies resource depletion shrinkage in Liaoning Province. The city's urban shrinkage index declined consistently from 0.686 in 2016 to below 0.5 by 2023, accompanied by simultaneous reductions in demographic, economic, and social indicators. Concurrently, Fuxin's land finance dependency drastically decreased from a peak of 0.22 to 0.06 in 2023, highlighting the land market's loss of fiscal support capacity following industrial collapse. Similarly, Fushun's urban shrinkage was primarily driven by coal industry contraction, leading to reduced employment and consumer bases, resulting in the province's lowest urban shrinkage index in 2023.

The internal dynamics of resource depletion shrinkage represent a negative cycle of industrial rigidity, fiscal overextension, and spatial inefficiency. Industrially, prolonged dependence on resource extraction and basic processing creates structural rigidity, with limited investment in innovation and human capital, making industrial transformation costly and path-dependent. Fiscally, established infrastructure and public service commitments from resource boom periods remain unreduced despite industrial downturns. This creates severe mismatches between rigid expenditures and declining revenues, exacerbated by shrinking tax bases and stagnating land markets. Spatially, abandoned mining sites, vacant industrial areas, and empty residential space coexist. Nonetheless, local governments, incentivized by land finance, often continue to pursue land development, exacerbating spatial inefficiencies and resource misallocation. The coupling coordination results confirm these consequences, as Fuxin and Fushun consistently remained within mild-to-moderate disorder categories throughout the study period.

#### 4.4.3. Regional Heterogeneity in Land Market Responses

Land market responses to urban shrinkage exhibit clear regional differences in sensitivity. Coastal and inland shrinking cities differ in both the magnitude of fluctuations and the cyclical dynamics of land finance dependency. During the upward phase of the land market from 2016 to 2020, coastal shrinking cities such as Dandong and Huludao experienced markedly stronger rebounds in land finance dependency and more pronounced improvements in coupling coordination than inland cities. This was mainly because, during the market upswing, some private real estate enterprises were attracted by locational advantages and expectations surrounding tourism-oriented real estate development, resulting in a notable increase in dependence. Dandong's dependency increased from 0.12 to 0.33, while Huludao also reached a stage peak during 2019–2020. During this period, their coupling coordination degrees entered the barely coordinated category. However, following the market downturn after 2021, coastal cities experienced equally sharp declines. After financing policies were tightened, real estate enterprises' willingness to acquire land decreased substantially. Because local government financing platforms in these cities lacked sufficient capacity to support the land market, dependence levels declined and coordination status deteriorated. Dandong's dependency fell rapidly to approximately 0.1, and its coordination degree returned to the near-disorder category.

In contrast, inland shrinking cities continue to be affected by the decline of resource-based industries, sustained population outflows, and industrial hollowing-out, all of which weaken real estate enterprises' willingness to invest. At the same time, oversupply and high inventory levels in the existing real estate market have contributed to persistently low land market activity in resource-based cities such as Fuxin and Fushun. The dependence levels of Fuxin and Fushun have long remained within a low range of 0.02–0.22, with relatively limited fluctuations. This indicates that while coastal cities can rapidly improve fiscal conditions during periods of land market expansion, they are also highly vulnerable

to contraction. Inland shrinking cities, by comparison, face persistent stagnation, and land finance no longer functions as an effective fiscal adjustment instrument.

## 5. Conclusions and Policy Implications

### *5.1. Conclusions*

Using panel data from 2016 to 2023 for 14 prefecture-level cities in Liaoning Province, this study constructs a multidimensional urban shrinkage evaluation system encompassing population, economy, society, and space, along with a measurement model for land finance dependency. By applying a coupling coordination degree model, the study systematically examines the dynamic linkage and spatial differentiation between urban shrinkage and land finance dependency. The main conclusions are as follows:

(1) Urban shrinkage in Liaoning Province exhibits significant multidimensional characteristics and clear regional clustering. During the study period, seven cities, Fushun, Dandong, Jinzhou, Fuxin, Liaoyang, Tieling, and Huludao, were identified as shrinking cities. These are concentrated in the old industrial base of central–southern Liaoning and the resource-based regions of northwestern Liaoning, forming a typical core–periphery spatial pattern. The continued agglomeration of the two core cities, Shenyang and Dalian, contrasts with widespread shrinkage in surrounding traditional industrial cities. Urban shrinkage reflects systemic decline driven by industrial structure lock-in, sustained population outflow, and institutional inertia, rather than isolated or incidental processes.

(2) Land finance dependency follows an inverted U-shaped trajectory and is closely aligned with, yet ultimately unsustainable under, urban shrinkage. During the land market expansion phase from 2016 to 2020, dependency across cities rose to peak levels. After 2021, the land market cooled rapidly, and by 2023, dependency in most shrinking cities had fallen below 0.15. Fushun, Tieling, and Fuxin declined to 0.012, 0.049, and 0.059, respectively, indicating a substantial weakening of land finance as a source of fiscal support.

(3) The coupling coordination between urban shrinkage and land finance dependency remains generally low and exhibits strong procyclicality and fragility. The coordination degree follows an inverted U-shaped pattern, characterized by initial improvement followed by widespread decline. Around 2020, a small number of coastal cities temporarily reached the barely coordinated stage. After 2021, coordination levels across shrinking cities deteriorated significantly, with most falling into mild or severe disorder, and the overall system entering a low-level equilibrium.

### *5.2. Policy Implications*

#### 5.2.1. Build a Resilient Local Fiscal System

Local fiscal foundations should shift from reliance on incremental land expansion to leveraging existing asset values. Given the irreversible decline in land conveyance revenue amid urban shrinkage, fiscal strategies should prioritize operational taxes derived from existing urban spaces. Efforts should vigorously promote urban renewal and explore benefit-sharing mechanisms for land value appreciation resulting from repurposing idle factories and inefficient land, allowing local governments to sustain revenue from improved asset values. Additionally, diversified financing channels for urban infrastructure should be expanded. Local governments should actively utilize special-purpose bonds to support renovation projects of existing spaces, prioritizing projects with stable expected cash flows, such as affordable rental housing and industrial parks. Among the seven shrinking cities in Liaoning Province, Fushun and Fuxin are representative resource-depleted shrinking cities whose development strategies focus on the remediation and redevelopment of abandoned

industrial and mining land, as well as the introduction of emerging industries. Tieling and Liaoyang have adopted a development path characterized by "smart shrinkage and stock-quality improvement," with core objectives including the revitalization of inefficient land use, optimization of industrial structure, and the absorption of spillover effects from the Shenyang metropolitan area while avoiding disorderly expansion.

#### 5.2.2. Promote Urban Renewal to Reshape Stock Land Value

Urban renewal is critical for shifting from reliance on land finance and spatial expansion to a development model centered on existing land resources. A land supply system emphasizing renewal and reduction planning should be established. Shrinking cities should strictly control new construction land quotas and redirect land resources towards redeveloping inefficient stock land. Territorial spatial planning should allow these cities to moderately reduce urban development boundaries, giving priority to ecological restoration and public space provision instead of continued real estate development. Urban renewal projects should function as platforms for industrial restructuring and revitalization. Cities such as Fushun and Fuxin should select characteristic stock spaces, such as mining heritage sites and old industrial facilities, and integrate these spaces with cultural creativity, educational tourism, healthcare, and related services. This strategy aims to stimulate employment and expand the tax base through spatial value enhancement.

#### 5.2.3. Strengthen Institutional Supply and Regional Governance Coordination

Shrinking cities should have the flexibility to scale public service provision according to actual service populations, thereby avoiding resource misallocation associated with adhering rigidly to planned population targets. Pilot land management systems should be introduced specifically for shrinking cities. The pilot program adopts a two-tier governance structure of "provincial-level coordination and municipal-level implementation." Specifically, policy channels are established at the provincial level, while approval authority is delegated from the provincial to the municipal level. The municipal level is responsible for specific implementation, planning, and routine management of the pilot program. Within the framework of provincial-level coordination, shrinking city pilot programs in Liaoning Province should be granted substantial autonomy at the municipal level. In cities clearly experiencing shrinkage, such as Fushun and Fuxin, planning restrictions on the conversion of existing land uses should be relaxed on a trial basis. Land previously designated for industrial, mining, and warehousing uses should be permitted to transition flexibly to public services, affordable housing, innovative industries, and similar functions, provided safety and environmental standards are maintained. Additionally, streamlining approval procedures can reduce institutional transaction costs and enhance administrative efficiency.

**Author Contributions:** Conceptualization, methodology, software, validation, formal analysis, resources, data curation, writing—original draft preparation, writing—review and editing, visualization, and supervision, J.R. and J.L. Investigation, S.W. and S.L. All authors have read and agreed to the published version of the manuscript.

**Funding:** This research was funded by Liaoning Provincial Department of Education Project, grant number JYTMS20231589.

**Institutional Review Board Statement:** Not applicable.

**Informed Consent Statement:** Not applicable.

**Data Availability Statement:** The original contributions presented in this study are included in the article. Further inquiries can be directed to the corresponding author.

**Conflicts of Interest:** The authors declare no conflicts of interest.

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