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Spatio-Temporal Evolution and Influencing Factors of Integrated Urban–Rural Development in Northeast China under the Background of Population Shrinkage

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Abstract: Population shrinkage has had a certain negative impact on urban and rural development in many aspects. The impact of population shrinkage on urban–rural integration has become one of the core scientific issues that needs to be addressed in the current research on promoting the goal of common prosperity in China. Northeast China is a typical region in China that is experiencing a decrease in population and economic activity. Investigating the integrated development of urban and rural areas in this region is highly important for revitalizing Northeast China. This research paper focuses on 32 prefecture-level cities in Northeast China and utilizes spatial correlation analysis and the Geographical Weighted Regression model to uncover the evolving spatial patterns and influential factors affecting integrated urban–rural development in the context of population decline. The findings revealed the following: (1) The level of integrated urban–rural development in Northeast China continues to rise despite the shrinking population. During the comprehensive population decline stage, the growth rate of the urban–rural coupling coordination degree surpasses that of the initial stage. The areas with high values of urban–rural coupling coordination degree shift from northeastern Heilongjiang to four sub-provincial cities. The spatial correlation between urban–rural coupling and coordinated development weakens, with the main type being low–low agglomeration. (2) Factors such as economic development level, labor force size, urbanization level, level of openness, urban–rural accessibility, and proportion of built-up areas significantly correlate with urban–rural coupling and coordination. The influence of each factor varies in magnitude and direction across different locations. Labor force size and urban–rural accessibility have the most-significant impact on integrated urban–rural development, with labor force size having a positive effect and urban–rural accessibility having a negative effect. The impact of the economic development level follows a pattern of initial increase and subsequent decrease as the population shrinks. (3) Although population decline does not hinder integrated urban–rural development in Northeast China, it is closely connected to changes in the factors influencing such development. To capitalize on the development opportunities presented by national policies, Northeast China should adopt a model of urban–rural development that promotes rural growth through cities. This entails attracting talented individuals to return, enhancing the flow of urban–rural development elements in both directions, and creating a spatial development pattern characterized by "big city, big agriculture, and big ecosystem". By doing so, the revitalization of Northeast China can be achieved.

Keywords: integrated urban–rural development; influencing factors; northeast China; population shrinkage; spatial heterogeneity

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1. Introduction

The interdependence of cities and rural areas involves constant changes and interactions. Rural regions give rise to cities, while cities foster the development of rural areas. These two entities differ significantly in terms of production, lifestyle, ecology, and other

aspects. Achieving integrated urban–rural development in China requires finding ways to complement and allocate resources between urban and rural functions effectively. Due to China's reform and opening-up policy, along with rapid growth in industrialization, urbanization, and informatization, productive factors such as population, land, capital, and technology have shifted from rural regions to cities. This has led to cities advancing much further in comprehensive development compared to rural areas [1]. The disparities in income, consumption, public services, and infrastructure between urban and rural populations have widened due to insufficient rural development and a lack of coordination between urban and rural communities [2]. China's unique household registration and land tenure systems have perpetuated the urban–rural divide, exacerbating the contradiction between the two. Addressing the urban–rural divide is crucial for developing countries, as it is a visible sign of regional disparities during the intermediate stage of development. China recognizes that the principal contradiction in its current society lies between people's increasing demand for a better life and the imbalanced and inadequate development, including the imbalanced and inadequate urban–rural development. Therefore, China has put forth strategies such as new urbanization [3], rural revitalization [4], common prosperity, and its distinctive modernization approach to narrow the urban–rural gap and promote integration between urban and rural areas [5].

Globalization, deindustrialization, resource depletion, and other factors have contributed to the emergence and increase of shrinking regions in China and globally. A number of shrinking cities have emerged around the world, with nearly 180 shrinking cities in China [6]. Urbanization is closely tied to changes in the urban and rural populations. China's rapid urbanization has attracted a large number of people to cities, benefiting urban development. However, it has also resulted in various negative effects in rural areas, such as population decline, vacant houses, and abandoned land. Scholars around the world refer to this as rural shrinkage or rural decline [7]. China is currently experiencing a deepening stage of industrialization. The urban population will continue to grow, leading to a more-pronounced reduction in the rural population, which in turn will cause economic and social decline and other shrinking phenomena in rural areas [8,9]. Some scholars view shrinkage as a natural phase in the development process and consider it a neutral term. However, it has been demonstrated that population and economic shrinkage in regions can have adverse effects on various aspects of regional development. Given the context of both regional and rural shrinkage, it is crucial to study the evolving characteristics of urban–rural development, how to promote a healthy urban–rural relationship, and whether coordinated development in shrinking regions can be achieved. China has reached a stable phase of urbanization in its development. Given the current state of the economy and society, China sees integrated urban–rural development as a way to address the contradiction between urban and rural areas and overcome the middle-income trap.

Northeast China is a typical region in China that is experiencing a decline [10], and its progress in urban–rural development has undergone four distinct stages: the coexistence of urban and rural areas, a division between urban and rural areas, the integration of urban and rural areas, and finally, the achievement of integrated urban–rural development. In the early years of the People's Republic of China, the development model known as the urban–rural dichotomy was implemented, where agriculture supported industry and rural areas supported cities, in order to gather the necessary elements and funds for constructing the industrial system [11]. Through a national strategic plan, Northeast China was able to bypass the establishment of a light industrial system and directly transition to a heavy industrial system, benefiting from approximately 30% of the heavy industrial construction projects that were originally supported by the former Soviet Union and located in the region. This accelerated the process of urbanization in Northeast China, resulting in a higher level of urbanization compared to the rest of the country. Northeast China possesses favorable natural surroundings and a solid agricultural foundation. Its rural areas have consistently aimed at increasing agricultural production and improving farmers' income, although the pace of development has been slow. Since the implementation of

economic reforms and opening up, the economy of Northeastern China has declined, and after entering the new century, the population of Northeastern China has been shrinking seriously, with great resistance to urban–rural development and a widening gap between urban and rural areas [12]. Following the 18th National Congress of the Communist Party of China, the focus of urban–rural development shifted from integration to a more-comprehensive approach, aiming at achieving integrated urban–rural development. In this context, studying the integrated urban–rural development in the Northeast region during the period of population contraction is of great significance in narrowing the urban–rural gap, realizing common prosperity, and promoting the transformation of the Northeast region and high-quality urban–rural development [13].

2. Research Review and Framework

2.1. Research Review

Thomas More's "Utopia" introduced the idea of integrated urban–rural development [14], which entails planning both urban and rural areas as a cohesive whole. This concept was put into practice by More's followers through the establishment of communities such as New Harmony and the Fourierist communities. Another influential figure, Howard, presented the Garden City theory [15], which examined the relationship between urban and rural settings to address planning challenges in the modern industrial era. This theory explored crucial aspects such as population density, urban economy, and urban landscaping. Later, theories such as satellite cities and organic decentralization further emphasized the integration of urban and rural areas. Adam Smith, known as the father of classical economics, developed the concept of natural order, recognizing that cities emerge from rural regions and that the urban–rural development gap varies depending on a country's history, culture, and political system. Von Thunen, a German economic geographer, proposed the concept of an isolated state in his book, analyzing the spatial distribution of different sectors in urban and rural locations. T.G. McGee, a Canadian scholar, introduced the Desakota model to address urban–rural development challenges in certain developing countries and Asian regions. This model examines the interconnectedness and interaction between urban and rural spatial structures, portraying the Desakota area as a hybrid with characteristics of both urban and rural environments. It is considered a transitional zone where urban and rural life strongly intersect. Takuro Kishine, a Japanese researcher, proposed the concept and paradigm of urban–rural integration design based on systems theory. His work analyzed the development and transformation of urban and rural regions in Japan aiming to create a human-operated space that transcends traditional urban–rural boundaries and harmonizes with nature.

Western researchers have primarily conducted micro-level studies on the integration of urban and rural areas. These studies focus on the social tensions that arise between cities and rural regions due to urbanization and examine issues of fairness and justice in regional spatial structure. These scholars advocate for high-quality regional development by bringing together urban and rural areas within a region. They propose concepts such as urban–rural spatial production and dynamic suburban development. Their research methodology combines qualitative and quantitative analysis and aims to explore various aspects of the urban–rural relationship [16], such as industrial development [17], spatial layout [18], interactions [19], integration [20], social cohesion [21], governance networks [22], and political coordination [23]. On the other hand, Chinese scholars approach the topic of urban–rural integration differently [24]. They mainly utilize a comprehensive evaluation index system and employ methods such as the comprehensive index approach and coupling coordination degree model to analyze the level of integration between urban and rural areas [25,26]. There are three main types of index systems used by Chinese scholars. The first type takes a holistic view of the urban–rural territorial system [27] and uses the urban–rural ratio index as a fundamental component [28]. The second type utilizes the coupling coordination model to assess comprehensive indicators from both urban and rural subsystems [29]. The third type combines elements from the first two types by integrating

indicators of the urban–rural ratio with comprehensive indicators [30]. In the construction of the evaluation indicator system, the selection of indicators is similar and universal, but there is a lack of characteristic indicators that can reflect typical regions.

In studies examining the factors that impact integrated urban–rural development, both macro and micro analyses are commonly employed. The influencing factors encompass three main components. First, the systemic factors affecting urban–rural coordinated development, which consist of the natural environment system, economic system, social system, cultural system, and policy system, are examined using a combination of quantitative and qualitative analysis methods [31]. Second, the specific elements of urban–rural development, such as population, capital, transportation, infrastructure, and technology, display spatial heterogeneity and nonequilibrium, influencing urban–rural integration [32–34]. Third, various micro-level entities such as governments, businesses, and migratory labor engage in behavioral interactions during the process of urban–rural coupling and coordinated development [35,36]. Furthermore, scholars have primarily focused on the factors influencing urban–rural coordinated development due to the complex internal mechanisms involved in urban–rural development. However, research into the influencing mechanisms has been relatively limited. Nevertheless, there is a general consensus that urban–rural coordinated development is an ongoing process influenced by multiple factors, including endogenous factors, external assistance, market forces, and government actions [37]. In analyses of the impact mechanisms of urban–rural integration, qualitative and quantitative analyses are often independent parts, lacking a deep connection between quantitative and qualitative research methods.

Currently, scholars generally agree that achieving integrated urban–rural development requires close coordination and cooperation between urban and rural areas. The goal of integrated urban–rural development can be accomplished through positive interactions, such as complementing each other's roles, facilitating the movement of resources, and ensuring equal rights. However, the specific routes and strategies employed to achieve urban–rural coupling and coordinated development may vary across countries and regions due to differing circumstances. Several examples of urban–rural coordination and coupling can be observed, including the equalization model in Germany, the legislative-driven model in the United States, the transfer payment model in Canada, and the contemporary rural model in France [38]. Chinese scholars have devised a three-fold approach to integrated urban–rural development. Firstly, they rely on national policies such as new urbanization and rural revitalization strategies to establish a comprehensive framework for urban–rural integration, requiring collaborative efforts from both urban and rural regions [39,40]. Secondly, institutional reforms are emphasized to overcome the urban–rural divide and establish mechanisms that integrate urban and rural elements, thereby promoting positive interactions [41]. Lastly, a spatial planning system is constructed that takes into account land usage and promotes complementary urban–rural functions. This system recognizes the distinctive characteristics of urban–rural spatial development patterns, encompassing aspects such as production, lifestyle, and ecological spaces [42,43].

2.2. Research Framework

Based on the rules and policies regarding urban–rural development in China [44], the current state of urban–rural development in Northeast China is undergoing a transition from integrating urban and rural areas to achieving integrated urban–rural development [45]. The crucial foundation and requirement for this integrated development is the coordinated progress of urban and rural regions through their interaction and mutual influence. This principle aligns with the concept of the coupling coordination model [46]. Consequently, the degree of urban–rural coupling coordination is utilized to indicate the level of integration between urban and rural areas. The urban and rural regions together form a complex regional system that encompasses both human and environmental aspects. This urban–rural coupling and coordination system is an interconnected entity that relies on economic growth, signifies social progress, and depends on a healthy ecosystem in

which humans play a central role (see Figure 1). Its objective is to achieve a dynamic equilibrium between urban and rural regions and promote equalization between them. The urban–rural coupling and coordination system consists of two main territorial systems—the urban system and the rural system—each characterized by distinct development strategies, foundations, and paths. While acknowledging the disparities in the meanings and manifestations of urban and rural regions, we can employ the orderly, rational, and efficient allocation of urban–rural elements to create a similar economic and social environment, as well as a comparable quality of life, in both urban and rural areas. When examining the development of the urban–rural relationship in Northeast China, it is important to consider the specific characteristics of this region, as well as the unique development and evolutionary traits of urban and rural areas. By doing so, we can effectively work towards the goal of achieving integrated urban–rural development.

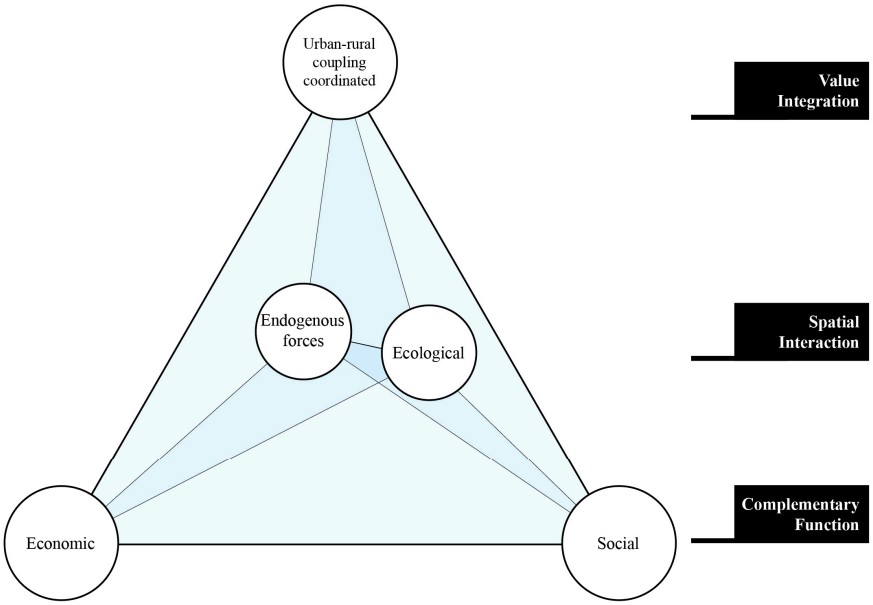

Figure 1. Urban–rural coupling and coordinated development goals.

The global economy is currently experiencing significant transformations and adjustments. The recovery of the world economy is slow, and the COVID-19 pandemic has worsened the global economic downturn. Northeast China's economy and society are confronted with numerous challenges, including the immense pressure of population decline and the widening gap between urban and rural areas. The reduction in population is a prominent feature of regions experiencing shrinkage. As a city goes through the process of shrinking, its development potential within the regional urban system declines either absolutely or relatively. This decline is evident in the outflow of development elements such as human capital, investment, factories, and businesses. Consequently, the city's central role in development weakens, making it difficult to drive rural development and diminishing the interaction between urban and rural areas [47]. This exacerbates the deprivation of rural regions by urban areas. In response, rural regions must utilize their agricultural and ecological advantages to achieve complementary urban–rural functions and gradually narrow the urban–rural gap. This approach may foster a higher level of integration between urban and rural areas. The research framework presented in Figure 2 of this paper aims to address the following questions: (1) How does population decline impact the coupling and coordinated development between urban and rural areas in Northeast China? (2) What changes occur in the spatial correlation characteristics of the coupling and coordinated development between urban and rural areas in Northeast China? (3) What factors influence the coupling and coordinated development between urban and rural areas in Northeast China, and to what extent do they contribute under the context of population shrinkage? To answer these questions, we analyzed the growth of urban and rural regions in Northeast

China, considering the impact of population decline, using a standard framework for geographical research that encompasses processes, patterns, and mechanisms.

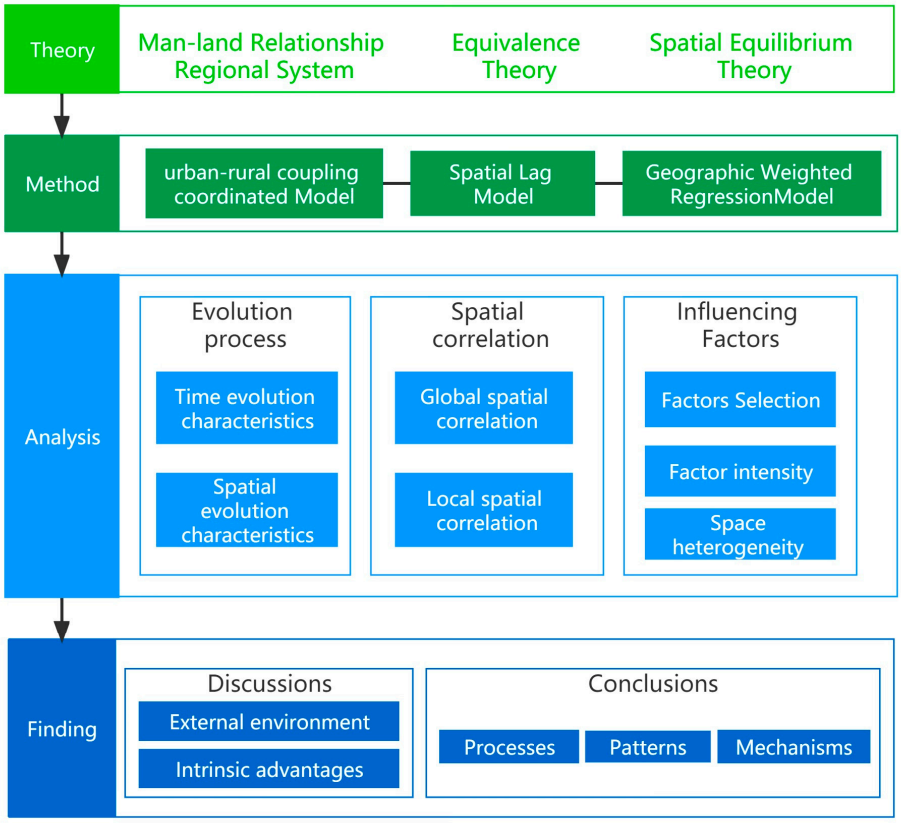

Figure 2. Theoretical framework diagram.

3. Study Area, Data Sources, and Research Methods

3.1. Study Area and Data Sources

3.1.1. Overview of the Study Area

Northeast China, situated in the northeastern part of China, possesses fertile land and abundant forest and mineral resources (Figure 3). It serves as a significant heavy industry and agricultural hub in China, playing a crucial role in ensuring national defense security, food security, ecological preservation, and industrial stability. As a distinct economic and geographical entity, Northeast China has undergone its own distinctive historical development. Following the establishment of the People's Republic of China, it emerged as a vital center for heavy industries, commodity grain production, energy production, and forestry, making substantial contributions to the country's economic progress. However, since the advent of economic reforms and opening up, the region has experienced a significant deceleration in economic growth, becoming one of the pressing challenges in China's regional economic development. The changes in population within Northeast China have closely paralleled its economic growth. Between 2000 and 2020, the total population of the region witnessed two distinct phases: A period of slow growth, followed by a period of rapid decline. From 2000 to 2010, the population increased from 106.55 million to 109.51 million, exhibiting a growth rate of approximately 2.7% and an average annual increase of 296,000 individuals. However, during this period, the population of 11 cities in the region experienced a decline. Subsequently, from 2010 to 2020, a period of swift population decrease occurred, resulting in the region's population dropping from 109.51 million to 98.51 million, reflecting a decrease rate of around 10% and an average annual decline of 1.1 million people. Only Shenyang, Dalian, and Changchun observed growth in their overall population. The population dynamics in Northeast China from 2000 to 2020 can be categorized as the initial stage of population shrinkage from 2000 to 2010, followed by

a phase of comprehensive population decline from 2010 to 2020, based on the distinctive characteristics observed.

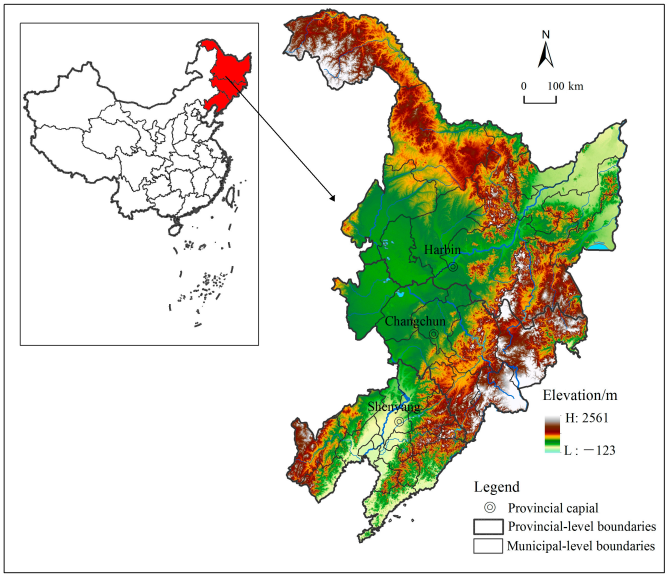

Figure 3. Overview of the research region.

3.1.2. Data Sources

The population data utilized in this research paper were obtained from the fifth, sixth, and seventh China Census Yearbooks. Economic and social data primarily originated from the China City Statistical Yearbook, Jilin Statistical Yearbook, Heilongjiang Statistical Yearbook, and Liaoning Statistical Yearbook. In instances where needed, we supplemented our analysis with data from the corresponding years' editions of the national economic and social development bulletins for the prefecture-level cities in Northeast China. The fundamental geographic data were derived from the 1:4 million database of the National Geomatics Center of China, while data on arable land, forests, grasslands, and water areas were gathered from the Resource and Environmental Science and Data Center of the Chinese Academy of Sciences (http://www.resdc.cn/ (accessed on 20 May 2023)). This analysis exclusively covers 34 prefecture-level cities in Heilongjiang, Jilin, and Liaoning provinces, as specific economic and social statistics for the Greater Khingan Mountains area and Yanbian Autonomous Prefecture are unavailable. Within this study, the term "urban" refers to the central urban regions of the prefecture-level cities, while "rural" pertains to the surrounding counties and county-level cities.

3.2. Study Methods

3.2.1. Evaluation of Integrated Urban–Rural Development Level

The meaning of integrated urban–rural development, which involves the positive relationship between urban and rural areas, can be understood through a logical analysis of the evolution process. To measure the level of integrated urban–rural development, a coupling coordination model was employed. Considering the strategic significance and distinct regional characteristics of Northeast China, a comprehensive indicator system was created to assess the coupling and coordination between urban and rural areas. This multi-dimensional system encompassed the dimensions of economy, society, and ecology [48] and was developed based on existing research findings [29,49–52], adhering to the principles of comprehensiveness, scientific rigor, comparability, and practicality (Table 1).

Table 1. Evaluation index system for the development level of urban–rural coupling and coordination.

System	Dimension	Indicators	Unit	+/−	System	Dimension	Indicators	Unit	+/−
Urban	Economy	Output value of secondary and tertiary industries	CNY	+	Rural	Economy	Output value of primary and secondary industries	CNY	+
		Proportion of the output value of secondary and tertiary industries	%	+			Proportion of the output value of primary and secondary industries	%	+
		Labor productivity of secondary and tertiary industries	CNY/person	+			Labor productivity of primary and secondary industries	CNY/person	+
		Total social fixed asset investment	CNY	+			Total social fixed asset investment	CNY	+
		Local fiscal revenue	CNY	+			Grain output	Ton	+
		Average wage	CNY	+			Average wage	CNY	+
	Society	Per capita disposable income	CNY	+		Society	Per capita disposable income	CNY	+
		Per capita consumption expenditure	CNY	+			Per capita consumption expenditure	CNY	+
		Public budget expenditure per capita	CNY	+			Public budget expenditure per capita	CNY	+
		Total number of teachers and students in primary and secondary schools per 1000 people	Person	+			Total number of teachers and students in primary and secondary schools per 1000 people	Person	+
		Number of beds in hospitals and health centers per 1000 people	Bed	+			Number of beds in hospitals and health centers per 1000 people	Bed	+
		Books collected in public libraries per 1000 people	Book	+			Books collected in public libraries per 1000 people	Book	+
	Ecology	Green area per capita	m^2	+		Ecology	Average fertilizer consumption per hectare	Ton/ha	−
		Green coverage rate of built-up area	%	+			Forest coverage rate	%	+
		PM2.5	um	−			Proportion of grassland area	%	+
		Proportion of built-up area	%	−			Proportion of water area	%	+

In this paper, we employed the entropy method to establish indicator weights, computed the urban development index and rural development index through a comprehensive index approach, and subsequently, employed the coupling coordination model to assess the level of coupling and coordination between urban and rural areas [53].

3.2.2. Analysis of the Spatial Pattern Characteristics of Integrated Urban–Rural Development

Spatial analysis techniques, encompassing global and local spatial correlation analysis, were utilized to investigate the spatial correlation and variance of the interconnectedness and coordination between urban and rural areas. To assess the overall spatial autocorrelation of the coordinated development between urban and rural areas in Northeast China, the global Moran's I index was employed. The calculation formula for this index is as follows:

$$I = n\sum_{i=1}^{n}\sum_{j\neq i}^{n} W_{ij}(x_i - \overline{x})(x_j - \overline{x}) / \sum_{i=1}^{n}\sum_{j\neq i}^{n} W_{ij}\sum_{i=1}^{n}(x_i - \overline{x})^2 \quad (1)$$

where n represents the number of observations, x_i and x_j represent the coordinates of x, $\overline{x}$ represents the mean value, and W_{ij} represents the spatial weight matrix adjusted according to adjacent standards.

The Z-test was used to determine the significance of the global Moran's I. The calculation formula is as follows:

$$Z(I) = [I - E(I)] / \sqrt{Var(I)} \quad (2)$$

where $E(I)$ is the mathematical expectation of Moran's I and $Var(I)$ is the variance of Moran's I.

The local Moran's I was used to explore specific clusters within spatial regions; even if the global Moran's I was 0, there may still be local spatial clustering phenomena. The calculation formula is as follows:

$$I_i = \frac{Z_i}{S^2} \sum_{j \neq i}^{n} w_{ij} Z_j, \quad (3)$$

where $Z_{i=} y_i - \overline{y}$, $Z_j = y_j - \overline{y}$, $S^2 = 1/n \sum (y_i - y_j)^2$, w_{ij} represents the spatial weight, n represents the total number of regions in the study area, and I_i represents the local Moran's index of the i-th region.

3.2.3. Analysis of Influencing Factors of Integrated Urban–Rural Development

The synchronized progress of urban and rural areas relies on both internal factors within these regions and external factors related to the overall urban–rural environment. These factors play a crucial role in promoting the harmonious development of urban and rural regions, as well as influencing their outward features. Urban–Rural factors such as population, economy, space, and natural environment [54] significantly influence the interconnection and coordinated growth of urban and rural areas [55] (Table 2).

Table 2. Selection and explanation of factors influencing urban–rural coupling and coordination.

Type	Variable	Variable Meaning
Population	Scale of urban and rural population	Total population of urban and rural regions (persons)
	Level of urbanization	Proportion of urban population to the total population of urban and rural regions (%)
	Labor force scale in urban and rural regions	Total employed population (persons)
	Urban and rural labor structure	Proportion of employed population in secondary and tertiary industries to the total population (%)
Economy	Regional economic development level	Per capital GDP (CNY)
	Level of opening up	Import and export trade volume (CNY)
Space	Proportion of built-up area	Proportion of built-up area to administrative area (%)
	Urban–rural connectivity	Proportion of road area to administrative area (%)
Natural conditions	Climatic conditions	Average temperature (°C)
	Topographic conditions	Mean elevation (m)

This paper introduces the Spatial Lag Model (SLM) and Spatial Error Model (SEM) in Geoda to analyze the global spatial correlation effects of the factors affecting urban–rural coupling and coordination, based on Ordinary Least Squares (OLS) in spss. In addition, the Geographic Weighted Regression (GWR) method is introduced to analyze spatial heterogeneity in arcgis.

In this paper, in the process of exploring the factors influencing the spatio-temporal evolution of urban–rural integration in the Northeast, ordinary least-squares regression (OLS) was first performed on the independent and dependent variables, and the independent variables with covariance can be accurately screened by excluding them through stepwise regression. The analysis of the spatial process of the evolution of urban–rural integration in Northeast China shows that there is a significant spatial correlation, so the Spatial Lag Model (SLM) and Spatial Error Model (SEM) are introduced to analyze the

influencing factors of the changes in the level of urban–rural integration. Compared with Ordinary Least Squares (OLS), the Spatial Econometric Model fully considers the unit space and effectively avoids biased or invalid regression results, which weaken the explanatory ability of the model. The Geographic Weighted Regression (GWR) method is used to study spatial heterogeneity because changes in geographic location usually lead to changes in the relationship between the dependent variable and the independent variable, which in turn causes changes in the relationship or structure between the variables.

The expression of the spatial lag model is:

$$Y = \rho W_y + \beta X + \varepsilon \tag{4}$$

where Y is the dependent variable, X is the independent variable, W is the spatial weight matrix, W_y is the spatial lag term, and ρ is the spatial lag coefficient. β is the parameter vector of X. ε represents the random disturbance term, which follows a normal distribution, that is $\varepsilon \backsim \mathrm{N}\left(0, \delta^2\mathrm{I}\right)$, where I is the identity matrix.

The expression for the spatial error model is as follows:

$$Y = \rho W_y + \beta X + \varepsilon \tag{5}$$

$$\varepsilon = \lambda W\varepsilon + \mu$$

where Y is the dependent variable, X is the independent variable, W is the spatial weight matrix, β is the regression residual vector, and λ is the spatial error term coefficient. μ is a normally distributed random error vector, that is $\mu \backsim N(0, \delta^2 I)$.

We employed Geographical Weighted Regression (GWR) to identify the spatial diversity in the impacts of different independent factors on the interconnection and coordination between urban and rural areas in Northeast China. We also examined the magnitude and direction of these independent variables. The model expression is provided below.

$$y_j = \beta_0(\mu_j, v_j) + \sum_k \beta_k(\mu_j, v_j) x_{jk} + \varepsilon_j \quad j = 1, 2, \ldots, n \tag{6}$$

In the above equation, y_j and x_{jk} are the observed values of the dependent variable y and the independent variable x_{jk} at coordinates μ_j and v_j of the j-th sampling point, respectively. $\beta_k(\mu_j, v_j)$ is the k-th regression parameter at the j-th sampling point; point j is called the regression point, and $\varepsilon \backsim N(0, \delta^2 I)$.

4. Results and Analysis

4.1. Temporal Evolution Characteristics of Integrated Urban–Rural Development Level

The level of coordination between urban and rural areas in Northeast China experienced a significant upward trend (Table 3). The degree of urban–rural coupling and coordination increased from 0.429 in 2000 to 0.624 in 2019, resulting in a net increase of 0.195 and an annual growth rate of 2%. The city that exhibited the highest growth rate was Dalian, while Qitaihe showed the lowest growth rate. During the initial phase of population decline, the urban–rural coupling coordination degree rose from 0.429 to 0.527, with a growth rate of 22.84% and an average annual increase of 0.01. Dalian showed the highest growth rate, whereas Suihua had the lowest growth rate during this period. In the comprehensive population decline stage, the urban–rural coupling coordination degree increased from 0.527 to 0.624, with a growth rate of 18.41% and an average annual increase of 0.011. Changchun had the highest growth rate, whereas Tieling had the lowest growth rate in this stage. When comparing the urban–rural coupling coordination degree during the initial phase of population decline to that during the comprehensive population decline, it was observed that the average annual growth rate in the latter was higher than in the former. This indicates that population decline did not impede the process of integrated urban–rural development; instead, it accelerated it.

Table 3. Results of urban–rural coupling coordination degree of prefecture-level cities in Northeast China in 2000, 2005, 2010, 2015, and 2019.

Coupling Coordination Degree	2000	2005	2010	2015	2019
Shenyang	0.427	0.460	0.575	0.660	0.685
Dalian	0.441	0.501	0.630	0.701	0.755
Anshan	0.399	0.445	0.529	0.576	0.604
Fushun	0.425	0.457	0.528	0.586	0.626
Benxi	0.452	0.473	0.547	0.612	0.647
Dandong	0.434	0.458	0.521	0.555	0.595
Jinzhou	0.395	0.429	0.491	0.557	0.622
Yingkou	0.373	0.408	0.499	0.563	0.628
Fuxin	0.394	0.431	0.469	0.518	0.564
Liaoyang	0.380	0.403	0.483	0.548	0.601
Panjin	0.412	0.444	0.507	0.570	0.598
Tieling	0.399	0.426	0.504	0.527	0.565
Chaoyang	0.436	0.469	0.519	0.565	0.601
Huludao	0.426	0.449	0.512	0.538	0.592
Changchun	0.426	0.459	0.550	0.632	0.695
Jilin	0.444	0.480	0.565	0.631	0.647
Siping	0.397	0.429	0.495	0.560	0.585
Liaoyuan	0.390	0.424	0.496	0.546	0.569
Tonghua	0.433	0.457	0.523	0.579	0.600
Baishan	0.420	0.481	0.547	0.606	0.650
Songyuan	0.417	0.463	0.530	0.591	0.617
Baicheng	0.424	0.447	0.484	0.546	0.586
Harbin	0.470	0.516	0.606	0.709	0.733
Qiqihar	0.442	0.431	0.519	0.595	0.620
Jixi	0.459	0.480	0.527	0.586	0.629
Hegang	0.462	0.485	0.538	0.569	0.619
Shuangyashan	0.445	0.475	0.527	0.599	0.601
Daqing	0.510	0.549	0.621	0.667	0.688
Yichun	0.458	0.482	0.517	0.568	0.613
Jiamusi	0.446	0.476	0.536	0.622	0.633
Qitaihe	0.419	0.436	0.482	0.512	0.569
Mudanjiang	0.450	0.471	0.541	0.622	0.639
Heihe	0.462	0.478	0.537	0.602	0.643
Suihua	0.425	0.419	0.469	0.558	0.612
Mean	0.429	0.459	0.527	0.588	0.624

4.2. Analysis of the Spatial Correlation of Integrated Urban–Rural Development Level

4.2.1. Global Spatial Correlation

According to the analysis of the global Moran's I index for urban–rural coupling and coordination (Table 4), the level of urban–rural coupling and coordination in 2000 demonstrated that cities with high values of this degree were located close to each other, while cities with low values were also spatially adjacent. However, from 2005 to 2019, Moran's I index did not show any significant results ($p > 0.1$), suggesting the absence of a notable spatial correlation in urban–rural coupling and coordination in Northeast China. Moreover, Moran's I index displayed a fluctuating downward pattern, indicating a gradual weakening of the integration and development of urban–rural areas in Northeast China due to a decline in population.

Table 4. Global spatial correlation test of urban–rural coupling and coordination in Northeast China.

Measurement Result	2000	2005	2010	2015	2019
Moran's *I*	0.34	0.08	−0.12	−0.07	−0.06
p	0.00	0.22	0.29	0.62	0.72
Significance	***				

Note: significance levels: ***: $p < 0.01$.

4.2.2. Local Spatial Correlation

The urban–rural coupling and coordinated development of Northeast China between 2000 and 2019 can be categorized into four types based on local spatial correlation: high–high agglomeration, high–low agglomeration, low–high agglomeration, and low–low agglomeration (Figure 4). In 2000, the overall level of urban–rural coordinated development exhibited predominantly low–low agglomeration, with a total of nine agglomerations mainly located in the central and northern parts of Liaoning Province. Qiqihar belonged to the high–high agglomeration type. By 2005, the overall level of urban–rural coordinated development continued to exhibit low–low agglomeration, but with four fewer cities in this category compared to 2000. Shenyang transitioned from high–high agglomeration to high–low agglomeration. In 2010 and 2015, the overall level of urban–rural coordinated development showed three types of spatial correlation: high–low agglomeration, low–high agglomeration, and low–low agglomeration, with one agglomeration representing each type. In 2019, the overall level of urban–rural coordinated development was divided into high–low agglomeration and low–high agglomeration, with the same spatial distribution as in 2015. It is evident that the spatial agglomeration of integrated urban–rural development in Northeast China has significantly decreased during a period of comprehensive population shrinkage.

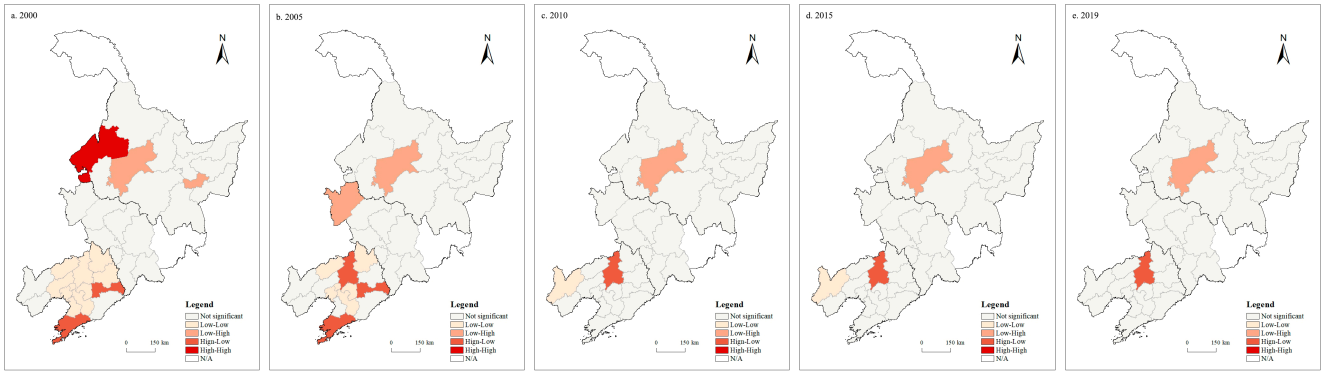

Figure 4. LISA clustering map of urban–rural coupling and coordination in Northeast China.

4.3. Analysis of Influencing Factors of Integrated Urban–Rural Development Level

4.3.1. Preliminary Study on Influencing Factors

Initially, we conducted an initial assessment of the independent variable related to the degree of urban–rural coupling and coordination. The assessment findings indicated a significant correlation between the degree of urban–rural coupling and coordination and six indicators: economic development level, labor force size, urbanization level, level of opening up, urban–rural accessibility, and proportion of built-up areas. It is worth noting that there was no multicollinearity observed among these variables.

To begin with, the GeoDa software was employed to conduct a regression analysis on the six factors mentioned earlier. After subjecting the model residuals to a spatial autocorrelation test, it was found that the Moran's I (error) values for the years 2000, 2005, 2015, and 2019 did not exhibit statistical significance. Additionally, both the Lagrange multiplier (lag) and Lagrange multiplier (error) were found to be insignificant. These results indicate that the ordinary least squares (OLS) model's regression outcomes are reliable, and there is no necessity to establish a spatial econometric model. However, in the case of the year 2010, the Moran's I (error) value amounted to 0.13 and demonstrated significance at a confidence level of 10.00%. This indicates the presence of significant spatial dependence in the regression error of the OLS model. Consequently, we decided to utilize the Spatial Lag Model (SLM) to estimate the influencing factors affecting the degree of coordination between urban and rural regions in 2010.

4.3.2. Factor Impact Analysis

Table 5 reveals the order of impact of various factors on urban–rural coupling and coordination in the year 2000. These factors, listed in descending order of influence, were urban–rural accessibility, economic development level, proportion of built-up areas, labor force size, and urbanization level. A negative correlation was found between urban–rural accessibility and the level of coordination between urban and rural regions. This means that improved accessibility of urban–rural roads resulted in a stronger "pull" effect from cities, leading to urban development at the expense of rural areas. A higher proportion of built-up areas within cities was found to have a detrimental effect on agricultural and rural development, as well as causing harm to the ecological environment. In 2005, the influencing factors ranked in descending order of impact were economic development level, urban–rural accessibility, proportion of built-up areas, urbanization level, and labor force size. The direction of impact remained consistent with that of the factors in 2000. The overall economic development level of prefecture-level cities emerged as the most-significant driver of urban–rural coordinated development. This suggests that higher economic development levels in prefecture-level cities corresponded to more-synchronized development between urban and rural regions.

Table 5. Analysis of factors affecting the degree of urban–rural coupling and coordination in Northeast China in 2000, 2005, 2010, 2015, and 2019.

Variable	2000	2005	2015	2019
Economic development level	0.63 ***	0.80 ***	0.73 ***	0.26
Labor force size	0.37 ***	0.27 **	0.77 ***	0.79 ***
Urbanization level	0.36 ***	0.28 **	0.03	0.16
Level of opening up	0.01	0.10	0.05	0.24 *
Urban–rural accessibility	−0.72 ***	−0.64 ***	−0.53 ***	−0.51 **
Proportion of built-up areas	−0.54 ***	−0.49 ***	−0.39 ***	−0.05
R^2	0.77	0.75	0.84	0.81
Adjusted R^2	0.72	0.69	0.81	0.76
LogL	−22.44	−24.20	−16.44	−19.90
AIC	58.88	62.40	46.88	53.81
SC	69.57	73.08	57.56	64.50

Note: significance levels: *: $p < 0.1$, **: $p < 0.05$, ***: $p < 0.01$.

The estimation was conducted to determine the factors influencing the degree of coordination between urban and rural areas in 2010. By employing the Spatial Lag Model (SLM) and examining Table 6, the fitting results of the model were enhanced and refined. The coefficient of determination (R2) improved to 0.89, while the spatial regression coefficient reached 0.23, indicating a close relationship between the coordination degree and the surrounding prefecture-level cities. When considering the spatial relationships of the units, it was found that the economic development level, labor force size, urbanization level, and the level of openness were positively associated with the coordination degree. Conversely, urban–rural accessibility and the proportion of built-up areas showed negative correlations with the coordination degree. In terms of impact, the influencing factors ranked as follows: the economic development level had the highest impact, followed by labor force size, urban–rural accessibility, proportion of built-up areas, level of openness, and urbanization level.

The order of influential factors on urban–rural coupling and coordination in 2015 was as follows: the size of the labor force had the greatest impact, followed by the level of economic development, urban–rural accessibility, and the proportion of built-up areas. The size of the labor force in cities at the prefecture level was the most-crucial factor in fostering coordinated development between urban and rural areas. In Northeast China, where labor-intensive industries were prominent, a larger labor force resulted in higher output value, thereby playing a significant role in the coordinated development of urban and rural regions. In 2019, the order of influential factors shifted, with the size of the labor force remaining

the most-influential, followed by the level of opening up and urban–rural accessibility. The level of opening up had a positive correlation with coordinated development between urban and rural areas. The increase in total imports and exports contributed to economic and social development, providing support for urban–rural development.

Table 6. Analysis results of factors affecting the coordination degree of urban–rural coupling and coordination in Northeast China in 2010.

Variable	OLS		SLM	
	Weight	Standard Error	Weight	Standard Error
Economic development level	0.74 ***	0.1	0.74 ***	0.08
Labor force size	0.60 ***	0.09	0.58 ***	0.08
Urbanization level	0.14 *	0.08	0.15 **	0.07
Level of opening up	0.25 ***	0.07	0.23 ***	0.06
Urban–rural accessibility	−0.50 ***	0.12	−0.49 ***	0.11
Proportion of built-up areas	−0.26 ***	0.09	−0.28 ***	0.08
W-Y	-		−0.23	0.12
R^2	0.88		0.89	
Adjusted R^2	0.85		-	
LogL	−11.94		−10.29	
AIC	37.88		36.59	
SC	48.57		48.8	

Note: significance levels: *: $p < 0.1$, **: $p < 0.05$, ***: $p < 0.01$.

In conclusion, when the population decreases, several factors that influence the situation undergo intricate transformations in their effects. The influence of economic development level, urbanization level, urban–rural accessibility, and the proportion of built-up areas diminishes, while the influence of labor force size and the level of openness increases. When comparing the early stage of population decline with the later stage encompassing multiple aspects, the impact of the economic development level on the overall development of both urban and rural areas in Northeast China initially rises and subsequently declines.

4.3.3. Factor Spatial Heterogeneity Analysis

Spatial Heterogeneity Modeling Results

In ArcGIS 10.7, we compared and analyzed the factors that significantly impact the relationship between urban and rural areas in Northeast China, as identified in the previous section. We employed two regression methods, namely Ordinary Least Squares (OLS) and Geographically Weighted Regression (GWR). Table 7 presents the results, showing that the GWR model had a higher fitting coefficient and a lower AICc value compared to the OLS model. This suggests that the GWR model provides a better fit. After applying the GWR model, we examined the standardized residuals of the prefecture-level city units for the years 2000, 2005, 2010, 2015, and 2019. The analysis revealed that all of these years had standardized residuals falling within the range of [−2.5Std.Dev., 2.5Std.Dev.], with percentages of 100%, 100%, 100%, 97%, and 100%, respectively. This indicates that the GWR model produced residuals that are well-behaved and within the expected range. Furthermore, we conducted a spatial autocorrelation test on the standardized residuals based on the GWR model. The test resulted in Moran's I values of −0.01, −0.09, 0.07, −0.07, and −0.11 for the respective years, accompanied by corresponding Z-values of 0.12, −0.70, 1.08, −0.47, and −0.94. These values indicate that the regression residuals of the GWR model are randomly distributed across space and the model parameters have successfully passed the test.

Table 7. Comparison of parameter estimation between OLS and GWR models for factors influencing urban–rural coupling and coordination development.

Year	Model	R^2	Adjusted R^2	AICc
2000	OLS	0.774	0.733	63.290
	GWR	0.775	0.734	63.269
2005	OLS	0.740	0.694	67.931
	GWR	0.741	0.695	67.929
2010	OLS	0.878	0.851	45.643
	GWR	0.879	0.852	45.642
2015	OLS	0.839	0.817	48.367
	GWR	0.931	0.893	39.912
2019	OLS	0.758	0.734	59.320
	GWR	0.770	0.739	59.105

Spatial Heterogeneity Analysis

Figure 5 displays the GWR model fitting outcomes regarding the diverse factors influencing the coordination between urban and rural areas in Northeast China during the year 2000. The regression coefficients related to the level of economic development exhibit an increasing trend from the southern to the northern regions. This suggests that the integrated urban–rural development in Heilongjiang Province was significantly influenced by the economic development level. Conversely, the regression coefficients for the size of the labor force show a decreasing pattern from the southwest to the northeast. The large population and abundant labor resources in Liaoning Province, located in Northeast China, exert a substantial impact on the integrated urban–rural development. Regarding the urbanization level, the regression coefficients demonstrate a gradual weakening trend from the south to the north, with the most-notable influence observed in Dalian and its surrounding cities. In terms of urban–rural accessibility, the regression coefficients exhibit a gradual decline from the west to the east, indicating significant polarization. This suggests that inland cities are heavily affected by urban–rural accessibility. Lastly, the regression coefficients associated with the proportion of built-up areas reveal a gradual weakening pattern from the southeast to the northwest, highlighting the strong influence of this factor on the eastern border cities.

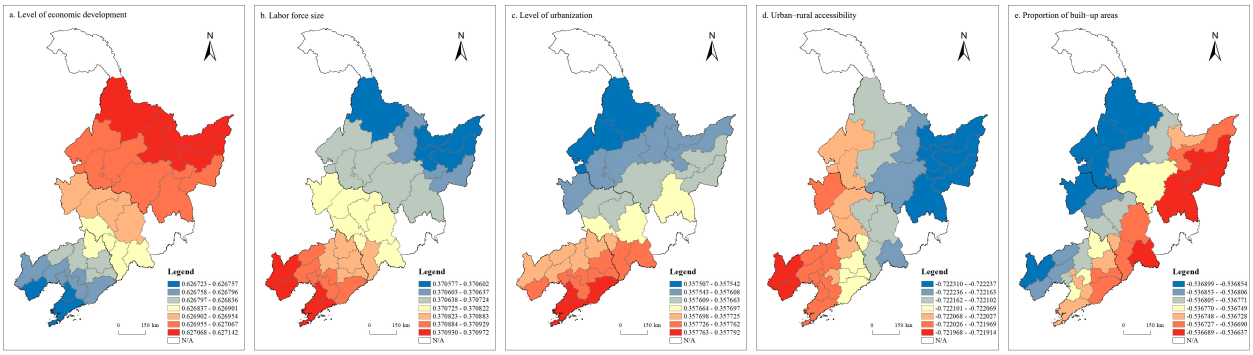

Figure 5. Spatial distribution maps of the changing impact of the influencing factors on the urban–rural coupling and coordination in 2000.

Figure 6 illustrates the outcomes of the GWR model fitting, which examines the factors influencing urban–rural coordination in different prefecture-level cities in Northeast China during 2005. The results indicate certain trends based on the regression coefficients of various variables. Specifically, the coefficients for economic development level, urbanization level, and the proportion of built-up areas exhibit an increasing pattern from the southwest to the northeast. The areas with higher coefficient values are predominantly located in Heilongjiang Province. Conversely, the coefficients for labor force size progressively decrease from the south to the north, suggesting a diminishing impact. However, eastern border

cities exhibit a strong influence in this regard. Moreover, the coefficients for urban–rural accessibility gradually decline from the southwest to the northeast, with regions of higher coefficient values concentrated in Liaoning Province.

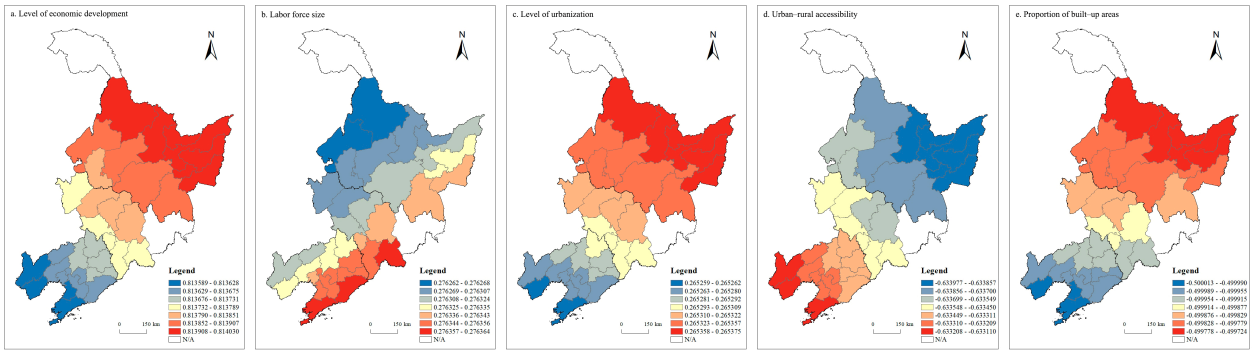

Figure 6. Spatial distribution maps of the changing impact of the influencing factors on the urban–rural coupling and coordination in 2005.

Figure 7 illustrates the outcomes of fitting the GWR model to examine the different factors affecting urban–rural coordination in Northeast China in 2010. The regression coefficients for the economic development level exhibit an upward trend from the northern to the southern regions, with areas of high value concentrated around Dalian and its neighboring cities. The coefficients for labor force size and the proportion of built-up areas display a progressive increase from the southwest to the northeast. As for the urbanization level, the regression coefficients gradually rise from the southern to the northern areas, particularly impacting Heilongjiang Province. In terms of the level of opening up, the coefficients follows a pattern of higher values in the western regions and lower values in the eastern regions, exerting a significant influence on cities in the west. Lastly, the regression coefficients for urban–rural accessibility show a gradual decrease from the southwest to the northeast, with southwestern cities in Liaoning Province having a strong influence.

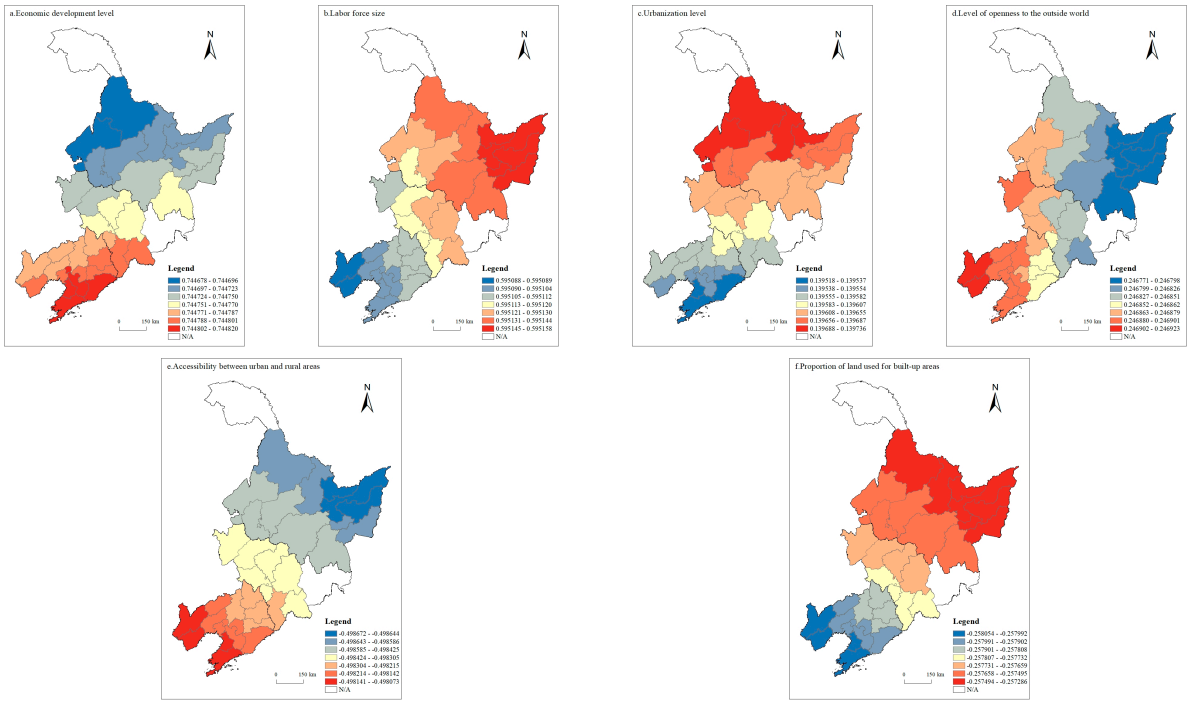

Figure 7. Spatial distribution maps of the changing impact of the influencing factors on the urban–rural coupling and coordination in 2010.

Figure 8 displays the GWR model fitting outcomes regarding the influencing factors of urban–rural coordination in different prefecture-level cities in Northeast China during the year 2015. The results reveal several trends. Firstly, the regression coefficients for the economic development level exhibit a progressive decline as one moved from the southeast to the northwest. These coefficients have a significant impact, particularly in the cities located on the border between Jilin Province and Liaoning Province. Secondly, the regression coefficients for the labor force size and proportion of built-up areas demonstrate higher values in the northern regions and lower values in the southern regions. In particular, the areas with high coefficients are concentrated in Heilongjiang Province. Lastly, the regression coefficients for urban–rural accessibility show a decreasing gradient from the southwest to the northeast. The cities in Liaoning Province experienced a substantial impact in terms of these coefficients.

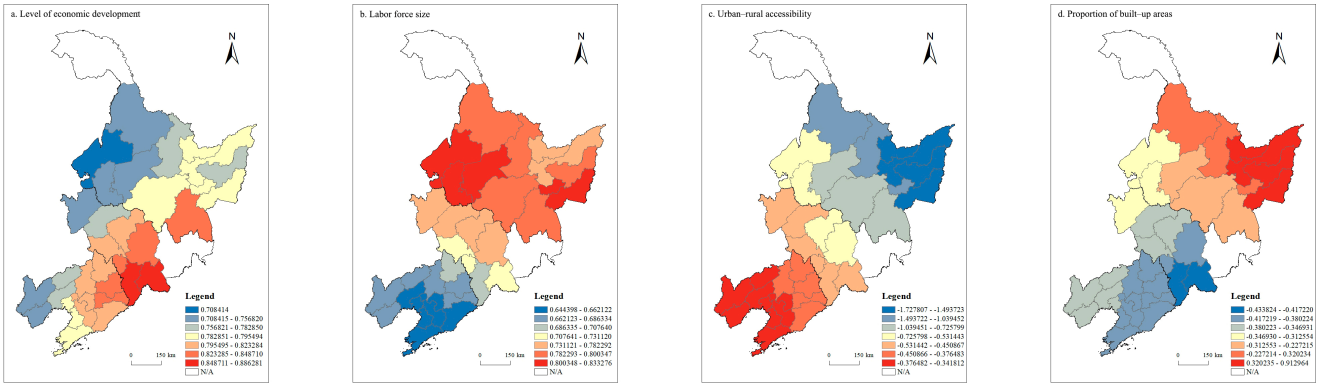

Figure 8. Spatial distribution maps of the changing impact of the influencing factors on the urban–rural coupling and coordination in 2015.

Figure 9 presents the outcomes of GWR model fitting, which examines the impact of different factors on urban–rural coordination in Northeast China during 2019. The findings indicate that the regression coefficients for labor force size demonstrate a declining trend from the northeast to the southwest. Similarly, the regression coefficients for the level of opening up exhibit a gradual weakening pattern from west to east. Furthermore, the regression coefficients for urban–rural accessibility indicate a progressive increase in gradients from the northeast to the southwest.

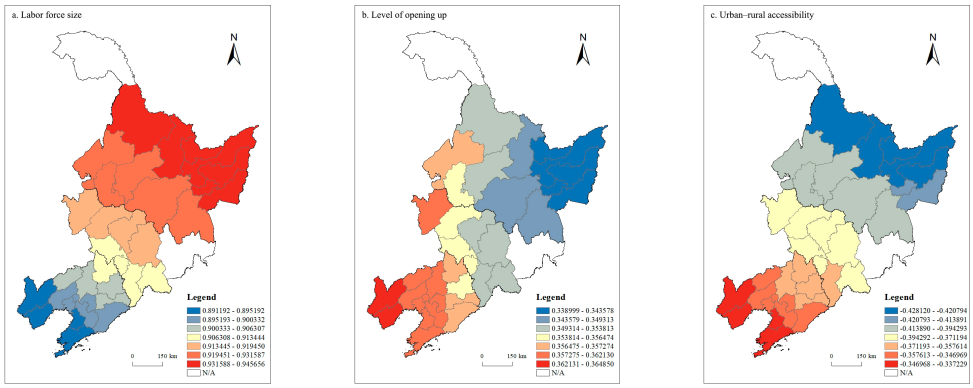

Figure 9. Spatial distribution maps of the changing impact of the influencing factors on the urbanrural coupling and coordination in 2019.

Empirical analysis demonstrates that the size of the workforce and the accessibility between urban and rural areas have the most-notable influence on the connection and coordination between these regions. Initially, when population shrinkage began, the impact of workforce size was low in the northeast and high in the southwest, but later shifted

to high in the north and low in the south during comprehensive population shrinkage. Between 2010 and 2019, the total population of all cities in Heilongjiang Province decreased by 6.25 million, indicating a severe decline. Consequently, the influence of workforce size gradually increased, playing a more-significant role in the development of integrated urban–rural areas. The impact of urban–rural accessibility changed from being high in the west and low in the east to low in the northeast and high in the southwest. This suggests a stronger demand for urban–rural accessibility in the southwestern part of the region and a lack of access in rural areas caused by cities in the western part of Northeast China. Regarding the impact of the economic development level, it initially showed high values in the northeast and low values in the southwest during the population shrinkage phase. However, during comprehensive population shrinkage, the situation reversed, with low values in the north and high values in the south. The areas with high economic development shifted from Heilongjiang Province to Liaoning Province. Similarly, during comprehensive population shrinkage, the impact of the economic development level was low in the northwest and high in the southeast, with high-value areas shifting from Dalian and its surroundings to the border cities between Jilin Province and Liaoning Province. The influence of the proportion of built-up areas also changed throughout the population shrinkage process. Initially, it was low in the west and high in the east, but during comprehensive population shrinkage, it became high in the northeast and low in the southwest, with a greater impact in the northeast. A higher proportion of built-up areas corresponded to a higher level of rural development driven by cities and enhanced integrated urban–rural development. The impact of the urbanization level varied as well, initially being low in the north and high in the south during population shrinkage. The increasing urbanization level of cities in Heilongjiang Province played a role in improving integrated urban–rural development. On the other hand, the impact of the level of opening-up remained unchanged during the population shrinkage process, with the west showing high levels of openness and the east showing low levels of openness.

5. Discussion

5.1. Choosing to Follow the Suitable Path of Integrated Urban–Rural Development in Northeast China

There are two types of coordinated development models for urban and rural regions. The first type is when urban regions drive the development of rural regions. In this case, the progress of urban development has a positive effect on rural areas, leading to coordinated development. The second type is when rural regions promote the development of urban regions. In this scenario, rural areas contribute to urban development based on their own unique characteristics and advantages. In the case of Northeast China, the urban–rural relationship has traditionally followed the model where urban regions drive rural development. However, currently, Northeast China is facing a severe economic downturn, and there is increasing pressure on rural development driven by urban areas. Based on an analysis of the spatial development pattern, during the initial stage of population shrinkage, the areas with high-value integrated urban–rural development were primarily located in the northeastern part of Northeast China [56]. However, as the population shrinkage progressed, these high-value areas shifted towards sub-provincial cities and their surrounding regions [13]. This indicates that Northeast China still prioritizes the development of large cities, as they possess significant resources for high-quality development [57]. Particularly in the context of population shrinkage, the migration of people to large cities has provided them with a significant advantage in terms of labor force. These cities drive the development of the surrounding rural areas through positive ripple effects, facilitating urban–rural integration. Therefore, it is essential to optimize the spatial structure of large, medium, and small cities and towns in Northeast China. Upgrading the functional levels of cities such as Harbin, Changchun, Shenyang, and Dalian is necessary, along with promoting the construction and development of the Harbin–Changchun Megalopolis and the Central–Southern Liaoning Megalopolis [29]. Small- and medium-sized cities and towns are experiencing more-severe

population shrinkage, so it is crucial to strengthen agricultural and ecological industries to guide transformation and facilitate rural revitalization.

5.2. History and Culture Work Together in Northeast China; Policies and the Economy Should Be Increased to Promote Urban–Rural Integration

The research findings suggest that the labor force size and accessibility between urban and rural areas are significant factors influencing integrated urban–rural development. These factors are closely linked to the actual circumstances of population decline and the historical urban–rural relationship in Northeast China [58]. The labor force serves as a regulating and dominant factor in the development of urban and rural areas, reflecting the level of knowledge, technology, and management. Population decline is an undeniable reality in Northeast China, particularly in small- and medium-sized cities and rural regions [59]. This is especially evident in the decreasing number of young and middle-aged workers, the growing aging population, and the significant outflow of highly skilled individuals. Consequently, there is a severe shortage of producers, implementers, and organizers of development in Northeast China, exacerbating the urban–rural gap [60]. The historical urban–rural divide in Northeast China, combined with ingrained thinking patterns and the lack of appeal in rural areas results in a one-way flow of population from rural to urban regions. This hinders the optimization of talent factors and impedes urban–rural integration. Urban–rural accessibility has a notably negative impact on the integrated development of urban and rural areas, highlighting the urban deprivation experienced by rural regions in Northeast China. This is due to a longstanding history of urban areas drawing resources from rural areas through attraction and, subsequently, driving rural development through radiating effects. As a result, urban development progresses at a faster pace than rural development. Following the reform and opening up, Northeast China struggled to adapt to a market-oriented development model, leading to slow development in major cities and a decline in rural areas. In the context of population decline, the influence of urban–rural accessibility on integrated urban–rural development has diminished. Therefore, it is crucial to address the one-way flow of urban and rural development elements in Northeast China [61]. Allowing the free movement of these elements is an essential requirement and a significant manifestation of urban–rural linkage and coordinated development. The government should implement policies that promote the unrestricted two-way flow of urban and rural development elements, ensuring that urban development elements also contribute to rural regions. This will foster a development model that supports rural progress through urban collaboration [62]. Since the founding of China, the Chinese Government has convened four Central Urban Work Conferences and 28 Central Rural Work Conferences, and since the 16th National Congress of the Party, it has issued 11 documents on Northeast China's revitalization and a number of policies on urban–rural integration and development, which have pointed out the direction of urban–rural development in the Northeast region. In the future, policies for the integrated development of urban and rural areas in Northeast China should be proposed in light of the characteristics of Northeast China and in accordance with local conditions.

5.3. The Shrinking Population Is an Opportunity to Create a New Model of Urban–Rural Development, Taking into Account the Characteristics of Northeast China

In the broader context of both domestic and international conditions, factors such as the global economic slowdown, slow economic recovery, decline in globalization, and power struggles among major nations have resulted in a reduced contribution of the export-oriented economy to China's economic growth. This situation presents significant challenges to China's economic development. In response, China has introduced the dual-circulation strategy, emphasizing domestic economic circulation as the primary focus [63]. The domestic economic circulation is closely linked to both urban and rural areas [64], with the rural regions holding considerable potential. As China undergoes rapid urbanization, the disparities between urban and rural areas have become increasingly evident. The relationship between urban and rural areas has shifted from rural areas supporting cities

to cities driving rural development. Consequently, agricultural and rural development have gained significant attention [65]. Looking ahead, Northeast China is expected to continue experiencing a decline in population for a certain period. The urban population will mainly concentrate in large cities, while the rural population will further decrease. To address this situation, it is crucial to pursue integrated urban–rural development through a coordinated approach, fostering a mutually beneficial relationship between urban and rural areas. This approach is essential for promoting the transformation of Northeast China. Considering the current regional conditions and key development areas in China, Northeast China possesses a strong agricultural and ecological foundation [66], providing a favorable late-mover advantage. This advantage aligns with national policies and strategies. It is feasible to address the gaps in rural development in Northeast China, achieve industrial optimization, and undergo spatial reconstruction through transformative measures [67]. By attracting the return of the population, fostering positive interactions between urban and rural areas [68], and creating a development pattern characterized by significant urban centers, thriving agriculture, and a well-preserved ecosystem, a high-quality development of both urban and rural regions can ultimately be achieved [69].

Based on the study of spatial and temporal evolution characteristics and influencing factors of urban–rural integration development in Northeast China under the background of population shrinking, this paper empirically analyzed the stage, spatial correlation, and heterogeneity characteristics of urban–rural integration development in Northeast China and obtained some basic conclusions of practical significance, which can provide references for the revitalization of Northeast China and the high-quality urban–rural development. The planning response to urban–rural integration in Northeast China in response to population shrinkage and the paths and measures of response are also worthy of in-depth study in the future. Meanwhile, there are still some shortcomings in this paper, such as the indicators need to be further updated and some data are unavailable due to the impact of the New Crown Pneumonia epidemic, and the research will be carried out in the future by using a multisource data approach.

6. Conclusions

In relation to the decline in population, we focused on investigating the spatial and temporal changes and factors influencing the integrated development of urban and rural areas in Northeast China. We examined how urban and rural areas evolved and developed in coordination with each other in Northeast China. We identified the factors that impact the coordination and development between urban and rural areas in Northeast China and employed spatial econometric models to assess the extent and direction of influence of each factor. The key findings are summarized as follows:

The level of urban–rural coupling and coordination in Northeast China has shown a gradual increase from 2000 to 2019. During the comprehensive population shrinkage phase, the growth rate of the urban–rural coupling coordination degree was higher compared to the initial stage of population shrinkage. As the population decreases in Northeast China, the distribution of areas with a high urban–rural coupling coordination degree has become more concentrated in four sub-provincial cities, moving away from northeastern Heilongjiang. In 2000, there was a significant spatial correlation in the urban–rural coupling and coordination level of Northeast China on a global scale. When considering local spatial correlation, the urban–rural coupling and coordinated development in Northeast China can be classified into four types: high agglomeration, high–low agglomeration, low–high agglomeration, and low–low agglomeration, with the low–low agglomeration being the dominant type. As the population decreases, the spatial correlation of urban–rural coupling and coordinated development in Northeast China gradually diminishes.

The examination of the factors that affect the connection and cooperation between urban and rural areas in Northeast China revealed that there were significant correlations between urban–rural coupling and coordination and several variables, namely the level of economic development, size of the labor force, degree of urbanization, level of openness,

urban–rural accessibility, and proportion of built-up areas. The impact of these various factors on urban–rural coupling and coordination displayed noticeable spatial variations, with differences in both the magnitude and direction of influence. Among these factors, the size of the labor force and urban–rural accessibility had the most-substantial effects on urban–rural coupling and coordination. The labor force size had a positive role, whereas urban–rural accessibility had a negative role. Furthermore, the impact of the economic development level demonstrated specific characteristics as the population decreased. Initially, it increased, but it later decreased during the stage of comprehensive population shrinkage.

Despite the population decline in Northeast China, it has not impeded the progress of integrated urban–rural development. However, this decline is closely linked to the influencing factors of integrated urban–rural development. In the future, Northeast China should capitalize on the development opportunities presented by national policies. By leveraging its strengths in industrial and agricultural foundations, as well as the ecological environment, Northeast China should elevate the development level of central cities and densely populated areas, strengthen the basis for rural development, and achieve industrial optimization and spatial reconstruction through a model of urban–rural development that promotes rural advancement through cities. Furthermore, it should encourage the return of talented individuals, facilitate the two-way flow of urban–rural development elements, establish a spatial development pattern characterized by significant cities, substantial agriculture, and a thriving ecosystem, foster high-quality urban and rural development, and ultimately, achieve the revitalization of Northeast China.

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