Research Article

Research on Spillover Effect of Urbanization on Rural Land Transfer Based on the SDM Model of Intelligent Computing

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In order to explore the spillover effect of urbanization on rural land transfer, this paper uses the panel data of various regions and cities in Xinjiang from 2008 to 2018. Moran's I method is used to test and analyze the spatial correlation between urbanization and farmland transfer. Intelligent computing SDM is used to analyze the spillover effect of urbanization on farmland transfer. The results show that there is spatial correlation between farmland transfers in Xinjiang. There is spatial heterogeneity in the spatial agglomeration of urbanization and farmland transfer in northern and southern Xinjiang. The content of this paper can provide some reference and ideas for follow-up research.

1. Introduction and Literature Review

The Fifth Plenary Session of the 19th CPC Central Committee pointed out to "promote the new people-centered urbanization." With the continuous agglomeration of rural population in China, the transfer of agricultural land is also accelerating. According to the statistical communique, China's urbanization rate exceeded 60% in 2020, the number of rural migrant workers reached 286 million, and the farmland transfer rate reached 37% in 2017 [1]. However, urbanization and farmland transfer still have prominent problems of regional development imbalance and insufficiency. Is there a spatial correlation between urbanization and agricultural land transfer? Does the regional urbanization have an impact on the regional circulation of agricultural land? Does other regional urbanization also have an impact on the transfer of regional agricultural land? Accordingly, this paper proposes whether urbanization has direct and spillover effects on farmland transfer?

At present, the research on urbanization and agricultural land transfer mainly focuses on four aspects. First is the internal relationship between urbanization and agricultural land transfer. Cai has found that the causal relationship between urbanization and agricultural land transfer is one

way [2]. Zhang believes in the interaction between urbanization and agricultural land transfer [3]. Second is the research on the impact of urbanization on agricultural land transfer. To sum up, although the current scholars have conducted more comprehensive and thorough research on urbanization and farmland transfer, there are still some differences and deficiencies. First, there are differences in the internal relationship between urbanization and agricultural land transfer. Second, in the process of urbanization development, we also have different views on promoting the transfer of agricultural land. Third, there are different views on the impact of urbanization in different regions on the circulation of agricultural land.

2. The Theoretical Mechanism of the Overflow Effect of Urbanization on Agricultural Land Transfer

In order to study and explore the spillover effect of urbanization on agricultural land transfer, this paper constructs a theoretical mechanism of urbanization on agricultural land transfer (Figure 1), with i and j for different regions; Y means agricultural land transfer and X means the
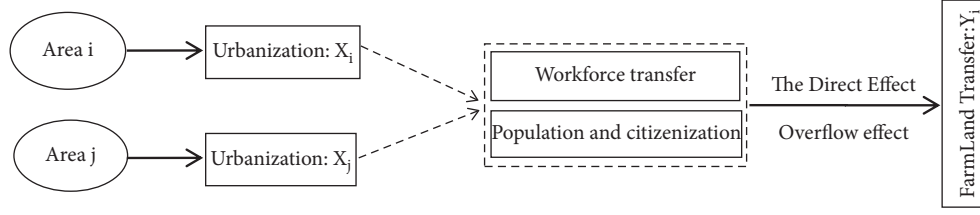
FIGURE 1: The theoretical mechanism of the overflow effect of urbanization on farmland transfer.

3. Space Measurement Model Setting and Data Description

influencing factors. The rural labor force flows between regions according to the demand for labor force according to the urbanization of different regions. Di-Clark's theorem holds that the income gap between industries promotes the transfer of agricultural labor force to secondary and tertiary industries, and the transfer of agricultural labor force will surely cause the transfer of agricultural land [4]. On the contrary, rural population transfers to towns in different areas, while rural migrant population promotes agricultural land transfer [5].

3.1. Setting of the Space Measurement Model. This paper selects the common spatial lag model (SAR), spatial error model (SEM), and spatial Dubin model (SDM) [6].

3.1.1. Space Lag Model. SAR not only reflects the impact of urbanization and other factors in the region but also reflects the impact of agricultural land in the transfer of other regions. The model is set as follows:

$$
\ln rlandtrans_{it} = \alpha_0 + \alpha_1 \ln rurbani_{it} + \alpha_2 \ln rIndustri_{it} + \alpha_3 \ln pgdp_{it} + \alpha_4 \ln capilabor_{it} + \alpha_5 \ln pagrivalue
$$
$$
+ \rho \sum_{i=1}^{n} wij \ln rlandtrans_{it} + \varepsilon_{it}. \tag{1}
$$

3.1.2. Space Error Model (SEM). SEM not only reflects the impact of the urbanization and other factors in the region but also reflects the impact of the spatial error items on the

agricultural land transfer in the region. The model is set as follows:

$$
\ln rlandtrans_{it} = \alpha_0 + \alpha_1 \ln rurbani_{it} + \alpha_2 \ln r \ln dustri_{it} + \alpha_3 \ln pgdp_{it} + \alpha_4 \ln capilabor_{it}
$$
$$
+ \alpha_5 \ln pagrivalue_{it} + \lambda \sum_{j=1}^{n} wij\mu_{jt} + \varepsilon_{it}. \tag{2}
$$

3.1.3. Space Durbin Model (SDM). SDM not only reflects the impact of urbanization and other factors in the region but

also reflects the impact of agricultural land transfer in the region of other regions. The model is set as follows:

$$
\ln rlandtrans_{it} = \alpha_0 + \alpha_1 \ln rurbani_{it} + \alpha_2 \ln rIndustri_{it} + \alpha_3 \ln pgdp_{it} + \alpha_4 \ln capilabor_{it} + \alpha_5 \ln pagrivalue_{it} +
$$
$$
\beta_1 \sum_{j=1}^{n} wij \ln rurbani_{it} + \beta_2 \sum_{j=1}^{n} wij \ln rIndustri_{it} + \beta_3 \sum_{j=1}^{n} wij \ln pgdp + \beta_4 \sum_{j=1}^{n} wij \ln capilabor_{i}
$$
$$
+ \beta_5 \sum_{j=1}^{n} wij \ln pagrivalue_{it} + \rho \sum_{j=1}^{n} wij \ln rlandtrans_{it} + \varepsilon_{it}. \tag{3}
$$

In the above formula, $lnrlandtrans_{it}$ is the natural logarithmic number of farmland transfer rates in i area in year t, $lnrurbani_{it}$ is the natural logarithm of the i regional urbanization rate in t years, $lnrIndustri_{it}$ is the natural

logarithm of the industrialization rate of the i region in t years, $\ln pgdp_{it}$ is the natural logarithms *of i regional GDP per capita in t years,* and, *lncapilabor $_{it}$ is the natural logarithm of capital labor ratios for i region, t,* $lnpagrivalue_{it}$ is the natural

logarithmic number of the total agricultural output value per capital in t years, w_{ij}, for space weights, α_0. For the intercept items, α_1-α_5 and β_1-β_5, ρ and λ are unestimated parameters, ε_{it} is for a random perturbation term, and μ_{jt} is a stochastic error vector for the normal distribution.

3.2. Space Weight Matrix.
The geographic distance weight matrix is constructed according to the actual traffic distance between the regional administrative centers and computable using the inverse of the square of the actual traffic distance.

The economic distance weight matrix is constructed from economic and distance factors between regional administrative centers and is calculated using the reciprocal of the absolute value of the GDP difference between regions multiplied by the reciprocal of the square of the actual traffic distance [7].

3.3. Spatial Effect Decomposition.
This paper seeks direct and overflow effects using LeSage and Pace and other decomposition of partial differential [8]:

$$
\begin{aligned}
Y &= \alpha L_n + \rho W Y + \beta X + \theta W X + \varepsilon, \\
(I_n - \rho W) Y &= \alpha L_n + \beta X + \theta W X + \varepsilon, \\
Y &= (I_n - \rho W)^{-1} \alpha L_n + (I_n - \rho W)^{-1} (I_n \beta + \theta W) X + (I_n - \rho W)^{-1} \varepsilon V(W) \\
&= (I_n - \rho W)^{-1} = I_n + \rho W + \rho^2 W^2 + \rho^3 W^3 + \cdots \\
S(W) &= (I_n - \rho W)^{-1} (I_n \beta + \theta W), \\
Y &= S_k \sum_{k=1}^{n} (W) X_k + V(W) \alpha L_n + V(W) \varepsilon, \\
\begin{bmatrix} Y_1 \\ \vdots \\ Y_n \end{bmatrix} &= \begin{pmatrix} S_k(W)_{11} & \cdots & S_k(W)_{1n} \\ \vdots & \ddots & \vdots \\ S_k(W)_{n1} & \cdots & S_k(W)_{nn} \end{pmatrix} \begin{bmatrix} X_{1k} \\ \vdots \\ X_{nk} \end{bmatrix} + V(W) \alpha L_n + V(W) \varepsilon, \\
S_k(W) X_{ik} &= \frac{\partial Y_i}{\partial X_{ik}}, \\
S_k(W) X_{jk} &= \frac{\partial Y_i}{\partial X_{jk}}.
\end{aligned}
\tag{4}
$$

The nonmain diagonal element of the coefficient matrix, representing the influence of the k explanatory variable of region j on the interpreted the variable of region i and the spillover effect [9].

3.4. Variable Description (Table 1).
The data in this paper are mainly derived from Xinjiang Statistical Yearbook from 2009 to 2019, Corps Statistical Yearbook, and the statistics of agricultural land transfer in Xinjiang from 2008 to 2018.

3.4.1. Interpreted Variable.
For agricultural land transfer rate (rlandtrans), agricultural land transfer area is divided by the agricultural land area to measure the agricultural land transfer level.

3.4.2. Interpretation Variable.
The urbanization rate (rurbani) is calculated by the urban population divided by the total population and used to measure the level of urbanization.

3.4.3. Control Variable.
The industrialization rate (rIndustri) is divided by the industrial added value and is made available by GDP to measure the level of industrialization. GDP per capita (pgdp) is divided by the total population to measure the level of economic development. The capital-labor ratio (capilabor) is calculated by dividing the investment in fixed assets by the total population, which is used to measure the level of economic investment. The per capita gross agricultural output value (pagrivalue) is calculated by dividing the gross agricultural output value by the total population, which is used to measure the level of agricultural production.

Table 1: Descriptive statistics of the data.

Variable	Obs	Mean	S.D.	Min	Max
rlandtrans	165	0.18180	0.17775	0.00005	0.98030
rurbani	165	0.61704	0.22837	0.21359	0.99246
rIndustri	165	0.37421	0.20907	0.04870	0.89362
pgdp	165	43689.67	38522.99	3928.00	210529.30
capilabor	165	3.44156	3.03027	0.29844	14.17515
pagrivalue	165	0.80168	0.53409	0.08789	2.59634

4. Empirical Analysis

4.1. Space Correlation Test. This paper selects the most commonly used "Moran Index I" (Moran's I) for spatial autocorrelation tests [6], based on the weight of neighbors and geographical distance and economic distance in Xinjiang.

From the perspective of the whole Xinjiang region, as shown in Tables 2 and 3, Moran's I of the urbanization rate of prefectures and cities in Xinjiang from 2008 to 2018 under the adjacent weight is positive, and some is significant, and it indicated that there is a significant spatial positive correlation between only some parts of agricultural land circulation under the adjacent weight. Besides, Moran's I of the urbanization rate of prefectures and cities in Xinjiang from 2008 to 2018 under the geographic distance weight is significant, and it indicated that there is a significant spatial positive correlation between only some parts of agricultural land circulation under the geographic distance weight. Moreover, Moran's I of the urbanization rate of prefectures and cities in Xinjiang from 2008 to 2018 under the economic distance weight is significant, and it indicated that there is a significant spatial positive correlation between only some parts of agricultural land circulation under economic distance weight.

According to the above conclusions, Moran's I distribution map of the farmland transfer rate and urbanization rate of prefectures are shown in Figure 2; cities in Xinjiang were analyzed under the weight of economic distance.

The first quadrant dispersion points all belong to northern Xinjiang, indicating that the agricultural land transfer in northern Xinjiang mainly presents the "high and high" spatial agglomeration characteristics, while the third quadrant distribution point mainly belongs to southern Xinjiang, indicating that the agricultural land transfer in southern Xinjiang mainly presents the characteristics of "low and low" spatial agglomeration. It can be seen that there is spatial heterogeneity of farmland transfer in southern and northern Xinjiang, which is consistent with the research results of Song Min and Jingui [10, 11].

From the perspective of southern and northern Xinjiang, as shown in Figure 3, Moran's I scatter of the urbanization rate of cities in Xinjiang in 2008 and 2018 was mainly distributed in the first and third quadrants. Among them, the first quadrant distribution point belongs to northern Xinjiang, indicating that the urbanization in northern Xinjiang mainly presents the characteristics of "high and high" spatial agglomeration.

According to the above research conclusions, urbanization may have direct effect and spillover effect on farmland

transfer and propose Moran's I maximum principle according to Anselin [12]. It is reasonable to select the spatial measurement model based on the weight of economic distance.

4.2. Model Inspection and Selection. Using the OLS model without spillover effect, Table 4 shows that urbanization has a significant positive impact on farmland transfer.

Considering the spillover effects, both SEM and SAR rejected the original hypothesis. It can be seen that urbanization has a spatial effect on the transfer of agricultural land. Secondly, both LR tests with SEM and SAR rejected the original hypothesis that SDM can be converted into SEM and SAR. So, choosing the SDM is better. Finally, the Hausman test shows that the random effect is better (as shown in Table 5). From the above tests, it is more reasonable to choose the SDM random effect model for empirical analysis. [13]

This paper estimates SDM random effect model from the perspective of whole Xinjiang and southern northern Xinjiang. According to the estimation results of Table 6, the R_2 values of the whole Xinjiang, northern Xinjiang, and southern Xinjiang are 0.630, 0.693, and 0.625, respectively, the model fits very well, and the coefficient estimation of the variables works very well. Furthermore, a deep analysis of the spatial effect decomposition of the model is needed.

4.3. Spatial Effect Decomposition

4.3.1. Spatial Effect Decomposition throughout Xinjiang Region. (1) The spatial effect decomposition of urbanization: it can be seen from Table 7 that the direct effect coefficient of urbanization is−0.394, which has not passed the significance test, indicates that urbanization has a negative direct effect on agricultural land transfer and is not significant, and may be due to the weakening spatial correlation of urbanization rate after 2014 and inhibit the transfer of agricultural land. However, the spillover effect and total effect of urbanization are 1.257 and 0.863, respectively, in which both passed the significance test, indicating that the spillover effect of urbanization is significantly greater than the direct effect.

(2) It can be seen from Table 7 that the direct effect coefficient of urbanization is −0.394, which has not passed the significance test. In addition, it indicates that urbanization has a negative direct effect on agricultural land transfer, which may be the weakening spatial correlation of the urbanization rate after 2014. Besides, it may inhibit the transfer of agricultural land. However, the spillover effect and total effect of urbanization are 1.257 and 0.863, respectively, in which both passed the significance test, and it indicated that the spillover effect of urbanization is significantly greater than the direct effect. Moreover, it can be seen from Table 7 that industrialization has significant negative effect on agricultural land transfer. To be specific, per GDP has significant positive and total spillover effect on agricultural land transfer. Capital and labor ratio has significant negative spillover effect on

TABLE 2: Moran 's I of agricultural land transfer rate of Xinjiang from 2008 to 2018.

Year	Adjacent weight			Geographic distance weight			Economic distance weight		
	Moran 's I	Z value	P value	Moran 's I	Z value	P value	Moran 's I	Z value	P value
2008	0.330	2.445	0.015	0.347	2.253	0.024	0.489	2.475	0.013
2009	0.404	2.905	0.004	0.374	2.406	0.016	0.501	2.538	0.011
2010	0.443	3.216	0.001	0.437	2.812	0.005	0.401	2.140	0.032
2011	0.454	3.208	0.001	0.469	2.912	0.004	0.457	2.338	0.019
2012	0.274	2.164	0.030	0.282	1.958	0.050	0.353	1.928	0.054
2013	0.433	3.055	0.002	0.436	2.715	0.007	0.519	2.594	0.009
2014	0.381	2.782	0.005	0.462	2.893	0.004	0.499	2.542	0.011
2015	0.290	2.327	0.020	0.407	2.724	0.006	0.403	2.212	0.027
2016	0.511	3.509	0.001	0.532	3.213	0.001	0.594	2.908	0.004
2017	0.466	3.221	0.001	0.443	2.723	0.006	0.546	2.685	0.007
2018	0.265	2.183	0.029	0.362	2.486	0.013	0.355	2.004	0.045

TABLE 3: Moran 's I of urbanization rate of Xinjiang in 2008–2018.

| Year	Adjacent weight			Geographic distance weight			Economic distance weight		
	Moran's I	Z value	P value	Moran's I	Z value	P value	Moran's I	Z value	P Value
2008	0.202	1.706	0.088	0.337	2.253	0.024	0.482	2.503	0.012
2009	0.201	1.699	0.089	0.336	2.248	0.025	0.484	2.510	0.012
2010	0.183	1.579	0.114	0.310	2.095	0.036	0.431	2.265	0.024
2011	0.202	1.700	0.089	0.343	2.279	0.023	0.493	2.547	0.011
2012	0.238	1.928	0.054	0.387	2.528	0.011	0.539	2.762	0.006
2013	0.223	1.830	0.067	0.388	2.530	0.011	0.549	2.799	0.005
2014	0.241	1.947	0.051	0.393	2.556	0.011	0.550	2.806	0.005
2015	0.118	1.256	0.209	0.266	1.984	0.047	0.327	1.921	0.055
2016	0.100	1.093	0.275	0.270	1.928	0.054	0.364	2.015	0.044
2017	0.091	1.033	0.302	0.248	1.797	0.072	0.347	1.925	0.054
2018	0.060	0.841	0.400	0.238	1.753	0.080	0.357	1.989	0.047
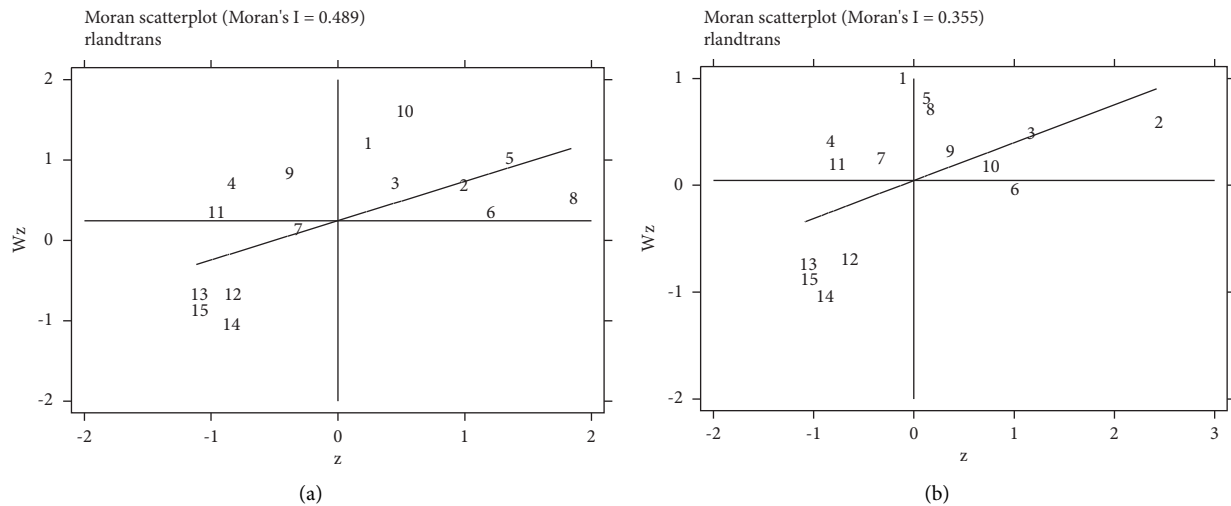
FIGURE 2: Moran 's I distribution map of agricultural land transfer rate in Xinjiang in (a) 2008 and (b) 2018.

agricultural land transfer. It can be seen that there is spatial heterogeneity in terms of the spatial effect of industrialization, GDP per capita product, and capital and labor ratio.

4.3.2. Spatial Effect Decomposition in Northern and Southern Xinjiang. (1) The decomposition of the spatial effect of urbanization: it can be seen from Table 8 that urbanization in southern Xinjiang has a significant and negative direct effect and a positive spillover effect on agricultural land transfer, while urbanization in northern Xinjiang has a significant and positive direct effect and total effect. However, the urbanization in other regions has a significant role in promoting the agricultural land transfer in the region. On the one hand, it is mainly, due to the less opportunities of
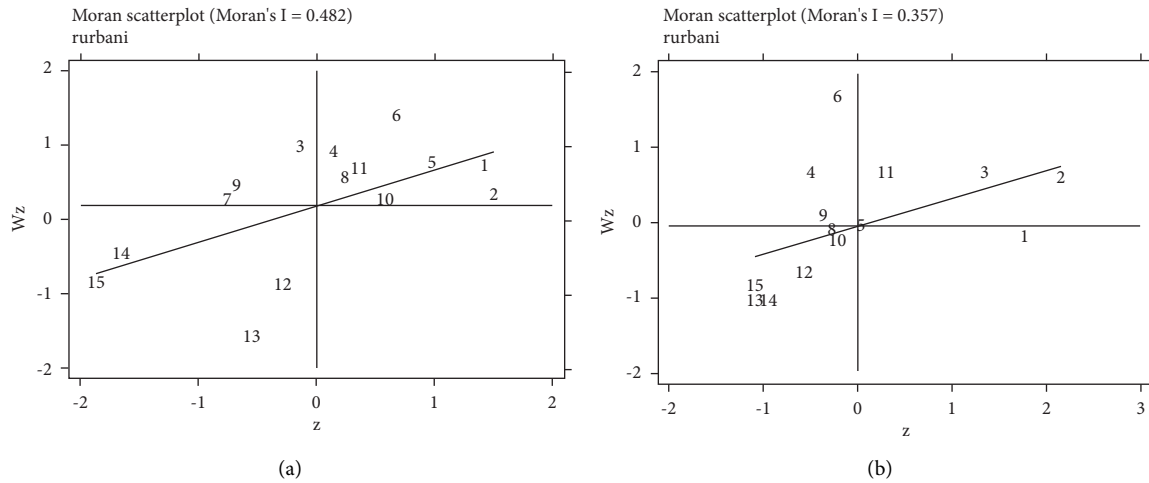
(a)

(b)

FIGURE 3: Moran 's I scatter map of the urbanization rate in cities around Xinjiang in 2008 (a) and 2018 (b).

TABLE 4: OLS model regression results.

Variables	lnrurbani	lnrIndustri	ln pgdp	lncapilabor	lnpagrivalue	_cons	R^2
Regression results	0.764** (2.44)	−0.013 (−0.04)	1.277*** (3.76)	0.070 (00).3	0.470*** (3.39)	−15.235*** (−4.17)	0.594

Note: the *, **, and *** distributions are significant at the 10%, 5%, and 1% levels.

TABLE 5: Test results of the spatial measurement model.

Index inspection method	Statistics of P value	
LM inspection and LM spatial error	10.064	0.002
Robust LM spatial error	2.035	0.154
LM spatial lag	13.282	0.000
Robust LM spatial lag	5.254	0.022
LR inspection and LR spatial error	24.40	0.0002
LR spatial lag	23.02	0.0003
Hausman inspection	5.72	

nonagricultural employment in the region, only a small number of farmers in the local towns, low and unstable wages, and high degree of agriculture, and most farmers are still stranded in rural areas and farmland transfer; on the other hand, it is mainly because some farmers are into the rural employment in other areas and agriculture is low, but conducive to the transfer of agricultural land. Urbanization and agricultural land transfer in northern Xinjiang mainly present "high" spatial agglomeration characteristics; urbanization level is higher; the regional agricultural land circulation has a significant role; mainly, because of more nonagricultural employment opportunities, farmers in local towns, with higher stable wages, compared with farming income and nonagricultural employment income, may choose to give up farming; even some conditional farmers will realize the transfer population citizenization is conducive to agricultural land transfer.

(2) The spatial effect decomposition of the control variables: as seen from Table 8, industrialization in southern Xinjiang has a significant and negative spillover effect on agricultural land transfer. The industrialization in northern Xinjiang has a significant and negative spillover effect. The per capita GDP of southern Xinjiang has a significantly

negative effect. The per capita GDP in northern Xinjiang has a significant and positive spillover effect and total effect on agricultural land transfer. The three effects of the capital-labor ratio on agricultural land transfer are not significant, and the capital-labor ratio in northern Xinjiang has a significant and positive direct effect on the farmland transfer. The per capita agricultural output value in northern Xinjiang has significant positive effect on agricultural land transfer. It can be seen that the region is spatial heterogeneity of industrialization.

4.4. Robustness Test. This paper uses long-period data, and the traffic time used changes as the interregional traffic infrastructure construction improves over time. Therefore, this paper uses the traffic time between the administrative centers to replace the actual traffic distance, calculates the new economic distance weight matrix, and conducts the robustness test from different perspectives of all Xinjiang and southern and northern Xinjiang, so as to test whether the results are stable and avoid the estimation bias due to endogenous problems. According to Table 9, the direction, size, and significance of the

Table 6: Estimation results of the SDM random effect model.

Variables	The whole region of Xinjiang	Southern Xinjiang region	Northern Xinjiang region
lnrurbani	−0.482	−1.444**	0.372*
	(−0.94)	(−2.20)	(1.89)
lnrIndustri	−0.717	0.888	−0.491
	(−1.32)	(0.90)	(−1.60)
ln pgdp	0.835	−1.592***	0.239
	(1.31)	(−3.63)	(0.72)
lncapilabor	0.246	1.038	0.290***
	(12).2	(1.30)	(2.76)
lnpagrivalue	0.311	3.064***	0.266*
	(0.76)	(3.65)	(1.65)
$W \times$ lnrurbani	1.190**	1.867**	0.076
	(2.28)	(2.25)	(05).3
$W \times$ lnrIndustri	−0.447	−30*.71	−0.985***
	(−0.72)	(−1.70)	(−3.38)
$W \times$ ln pgdp	1.377***	2.683	1.379***
	(2).76	(−)	(3.69)
$W \times$ lncapilabor	−0.600***	−1.169	−0.148
	(−2.76)	(−1.56)	(−1.02)
$W \times$ lnpagrivalue	0.361	0.329	0.266
	(0.81)	(0.27)	(1.36)
_cons	−25.499***	−17.024	−20.290***
	(−6.41)	(−)	(−5.71)
P	0.141**	0.159	−0.107
	(2.46)	(1.23)	(−0.89)
Θ	−1.591***	0.340	−1.309***
	(−6.27)	(0.19)	(−3.35)
Λ	0.327**	0.760***	0.071***
	(2.23)	(4.25)	(6.85)
R^2			
	0.630	0.693	0.625
Log L	−169.169	−73.479	−26.352

Note: the *, **, and *** distributions are significant at the 10%, 5%, and 1% levels.

Table 7: Spatial effect decomposition results in SDM: all Xinjiang region.

Variables	The direct effect	Overflow effect	Total effect
lnrurbani	−0.394 (−0.77)	1.257** (2.20)	0.863* (1.73)
lnrIndustri	−0.752 (−1.46)	−0.629 (−1.00)	−1.381** (−2.19)
lnpgdp	0.959 (1.55)	1.625*** (3.36)	2.582*** (5.76)
lncapilabor	0.202 (1.00)	−0.635** (−2.45)	−0.433 (−1.21)
lnpagrivalue	0.363 (0.80)	0.502 (0.83)	0.865 (0.85)

Note: the *, **, and *** distributions are significant at the 10%, 5%, and 1% levels.

Table 8: Spatial effect decomposition results in SDM southern and northern Xinjiang.

Variables	Southern Xinjiang region			Northern Xinjiang region		
	The direct effect	Overflow effect	Total effect	The direct effect	Overflow effect	Total effect
lnrurbani	−1.294** (−1.98)	1.896** (2.17)	0.601 (0.63)	0.379* (0.82)	0.032 (0.15)	0.411** (21).2
lnrIndustri	0.614 (03).6	−3.823* (−1.68)	−3.208(−1.47)	−0.470 (−1.59)	−0.903*** (−2.99)	−1.373*** (−3.93)
lnpgdp	−1.364*** (−2.78)	2.804*** (13.54)	1.440** (20).2	0.221 (0.66)	1.261*** (3.40)	1.481*** (5.35)
lncapilabor	0.912 (1.27)	−1.176 (−11).5	−0.263 (−0.33)	0.293*** (2.86)	−0.165 (−1.21)	0.128 (1.28)
lnpagrivalue	3.144*** (3.57)	1.017 (0.69)	4.160* (1.88)	0.260* (1.65)	0.226 (1.23)	0.486* (1.67)

Note: the *, **, and *** distributions are significant at the 10%, 5%, and 1% levels.

TABLE 9: Estimated results of the SDM random effect model.

Variables	The whole region of Xinjiang	Southern Xinjiang region	Northern Xinjiang region
lnrurbani	−0.442	−1.452**	0.375*
	(−0.84)	(−2.23)	(0.92)
lnrIndustri	−0.752	1.048	−0.493
	(−1.39)	(1.09)	(−1.50)
lnpgdp	0.821	−1.860***	0.238
	(1.21)	(−4.35)	(0.65)
lncapilabor	0.215	1.021	0.2049**
	(1.09)	(1.30)	(2.28)
lnpagrivalue	0.251	3.209***	0.194
	(0.66)	(3.85)	(1.22)
$W \times l$ nrurbani	1.158**	1.929**	0.087
	(2.20)	(2.41)	(0.42)
$W \times$ lnrIndustri	−0.446	−3.535	−1.064***
	(−0.60)	(−1.60)	(−3.02)
$W \times l$npgdp	1.493***	2.921	1.570***
	(2.84)	(−)	(3.96)
$W \times l$ncapilabor	−0.559***	−1.247*	−0.097
	(−2.62)	(−1.68)	(−0.67)
$W \times l$npagrivalue	0.242	0.401	0.101
	(0.53)	(0.35)	(0.45)
_Cons	−26.666***	−15.813	−22.508***
	(−6.48)	(−)	(−5.93)
ρ	0.136**	0.160	−0.145
	(2.32)	(1.22)	(−1.12)
θ	−1.584***	0.432	−1.355***
	(−6.12)	(0.25)	(−3.28)
λ	0.330**	0.754***	0.071***
	(2.24)	(4.39)	(6.76)
R^2	0.628	0.701	0.606
Log L	−169.659	−73.076	−26.813

Note: the *, **, and *** distributions are significant at the 10%, 5%, and 1% levels.

variables are substantially consistent with the results in Table 4.

4.5. Conclusion and Suggestions

4.5.1. Conclusion. This paper analyzes the spillover effect of urbanization under the economic distance weight and draws the following main conclusions:

(1) has a spatial correlation between urbanization and agricultural land circulation throughout Xinjiang. There is spatial heterogeneity between urbanization and farmland transfer in southern and northern Xinjiang, among which the urbanization and agricultural land transfer in southern Xinjiang mainly show the characteristics of "low and low" spatial agglomeration, while the urbanization and agricultural land transfer in northern Xinjiang mainly show the characteristics of "high and high" spatial agglomeration.

(2) Urbanization in Xinjiang has a significant and positive spillover effect and total effect on agricultural land transfer. There is spatial heterogeneity of urbanization

in southern and northern Xinjiang on agricultural land transfer, among which urbanization in southern Xinjiang has significant negative direct effect and positive spillover effect on agricultural land transfer, while urbanization in northern Xinjiang has significant positive direct effect and total effect on agricultural land transfer. Compared with SDM, the OLS model estimation ignores the spillover effect of urbanization on agricultural land transfer, overestimates the direct effect of urbanization on agricultural land transfer, and underestimates the total effect of urbanization on agricultural land transfer.

(3) There is a spatial heterogeneity of the spatial effect of industrialization, GDP per capita product, capital and labor ratio, and per capita gross agricultural output value on the transfer of agricultural land. There is spatial heterogeneity between industrialization, per capita GDP, and capital and labor ratio on the transfer of agricultural land, while there is spatial homogeneity in the spatial effect of per capita agricultural output value on agricultural land transfer in northern and southern Xinjiang.

4.5.2. Suggestions. The following suggestions are proposed through the above research and analysis:

(1) The low urbanization development level in Xinjiang has a great impact on agricultural land transfer. On the one hand, Xinjiang should take industrial agglomeration as the carrier to actively and orderly guide rural population to urban agglomeration; on the other hand, according to the Key Tasks of New Urbanization and Urban-Rural Integration Development in 2021, "the permanent population of urban residents of less than 3 million will implement the comprehensive cancellation of Hukou restrictions." In addition to Urumqi, whose permanent population is higher than 3 million, the population of other towns is far lower than 3 million, which is a favorable policy for Xinjiang. Xinjiang should accelerate the transfer of agricultural labor force and the citizenization of the migrant population and promote the transfer of agricultural land.

(2) There are prominent problems of unbalanced and inadequate regional urbanization in Xinjiang that seriously affect the circulation of agricultural land. Southern Xinjiang should speed up the building of a city cluster in southern Xinjiang and play a radiating and driving role. On the one hand, it pays attention to promoting the integrated development of primary, secondary, and tertiary industries in the region, creates more nonagricultural employment opportunities, promotes the transfer of a large number of surplus rural labor to nearby towns in the region, effectively alleviates the prominent problems of rural human and local conflicts, and is conducive to the transfer of agricultural land; on the other hand, actively guide the conditional rural flow and have spillover effect on farmland transfer. Northern Xinjiang should speed up the cultivation of Urumqi metropolitan circle and build northern Xinjiang city belt, pay attention to promote the integration development of industry in the region, and realize farmers nearby employment; conditional farmers can orderly realize citizens. It not only has a radiation driving effect on the surrounding areas, but also has a radiation driving effect on the southern Xinjiang, so as to promote the healthy and orderly circulation of agricultural land resources in the northern and southern Xinjiang.

(3) Xinjiang will accelerate the coordinated development of a new-type of industrialization, urbanization, and agricultural and rural modernization, accelerate the construction of a new relationship between agriculture, peasants, and urban and rural areas, promote the efficient transfer of agricultural land and develop appropriately scale operations, and boost rural revitalization.

Data Availability

The data underlying the results presented in the study are available within the manuscript.

Disclosure

The authors confirm that the content of the manuscript has not been published or submitted for publication elsewhere.

Conflicts of Interest

The authors declare that there are no potential conflicts of interest.

Authors' Contributions

All authors have seen the manuscript and approved to submit to the journal.

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References

[1] D. Zhu, "Farmers and land — land transfer and "separation of three rights" system," *Chinese Social Sciences*, no. 7, pp. 123–207, 2020.

[2] W. Cai, Y. Wu, and L. Yao, "Interaction and coordination of agricultural land transfer and urbanization —— based on China time series data from 2000–2014," *Drought zone resources and environment*, vol. 31, no. 5, pp. 34–38, 2017.

[3] P. Zhang, "Interaction between urbanization and land transfer: mechanism, problems and regulation," *Social Science Front*, no. 6, pp. 38–45, 2014.

[4] Y. Xia and F. Zeng, "Economic effect of agricultural land transfer and its spatial overflow —— based on the development of "three modernizations"," *Technical economy*, vol. 31, no. 11, pp. 56–62, 2012.

[5] X. Yi, W. Gong, and Y. Zhao, "Impact of "explicit citizenization" and "hidden citizenization" on peasant land transfer," *Resources Science*, vol. 42, no. 5, pp. 894–906, 2020.

[6] Q. Chen, *Advanced Econometric Economics and Stata Applications*, Advanced Education Press, Alberta, Canada, Second Edition, 2014.

[7] B. Cai, W. Zhao, Z. Li, and H. Yang, "Spatial spillover effects of export-oriented economic development in the Yangtze River Economic Belt," *Resource Science*, vol. 41, no. 10, pp. 1871–1885, 2019.

[8] P. Le Sage and R. K. Pace, *Introduction to Spatial Econometrics*, CRC Press, Boca Raton, FL, USA, 2009.

[9] B. Zhang and Z. Yang, "Rural Poverty Reduction in China and its space spillover effect —— space measurement analysis based on provincial panel data," *Geographic Studies*, vol. 39, no. 7, pp. 1592–1608, 2020.

[10] M. Song and D. Wang, "Spatial heterogeneity of urban circulation scale and influencing factors," *China Population, Resources and Environment*, vol. 28, no. 1, pp. 54–62, 2018.

[11] D. X. Jingui and D. Chen, "Space distribution and structure characteristics of farmland transfer in huang-huaihai plain," *Resources Science*, vol. 38, no. 8, pp. 1515–1524, 2016.

[12] L. Anselin, *Spatial Econometrics: A Companion to the Oretical Econometrics*, Blackwell Publishing Ltd, Hoboken, NJ, USA, 2001.

[13] J. P. Elhorst, "Applied spatial econometrics: raising the bar," *Spatial Economic Analysis*, vol. 5, no. 1, pp. 9–28, 2010.