# Spatiotemporal Evolution Patterns and Influencing Factors of Coordinated Development of the "Five Modernizations"in Gansu Province: A Postprint

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## Abstract

Taking the industrialization, urbanization, informatization, agricultural modernization, and greening (hereinafter referred to as the "five modernizations") of 87 counties, county-level cities, and autonomous counties in Gansu Province in 2005, 2010, and 2015 as the research object, this study employs spatial analysis methods such as spatial autocorrelation analysis and geographically weighted regression analysis, combined with a constructed coordinated development model for the "five modernizations", to investigate and analyze the spatiotemporal differentiation patterns, spatiotemporal evolution trends, and influencing factors of the coordinated development of the "five modernizations" in Gansu Province, with a view to providing references for the scientific formulation of development policies in various cities and prefectures of Gansu Province. The results show that: the coordinated development pattern of the "five modernizations"in Gansu Province exhibits obvious spatial correlation and significant spatial differences, with the coordination level showing a clear distribution pattern of high in the northwest and low in the southeast; the development level and comprehensive level of the "five modernizations" are relatively low, and the overall coordination level is not high, mainly characterized by mild imbalance, near imbalance, and barely coordinated, but the overall upward trend is substantial; the influencing factors of the coordinated development of the "five modernizations", in order of their influence, are: per capita disposable income of rural residents > difference in disposable income between urban and rural residents > total fixed asset investment > fiscal expenditure > terrain relief degree > difference in consumption between urban and rural residents > precipitation.

## Full Text

## Abstract

This paper selected 87 counties, county-level cities, and autonomous counties in Gansu Province, China as the research unit to measure the regional levels of industrialization, urbanization, informatization, agricultural modernization, and greenization (abbreviated as the "Five Modernizations"), as well as their coordination development degree, spatio-temporal evolution patterns, and influencing factors. By constructing a collaborative development model for the "Five Modernizations," the weight of each index was calculated using the entropy method. Using spatial analysis methods, spatial autocorrelation analysis, and Geographically Weighted Regression (GWR), the spatio-temporal patterns, evolution trends, and influencing factors of the "Five Modernizations" collaborative development were analyzed. The results show that the coordination development level of the "Five Modernizations" in Gansu has increased gradually. The coordination development index reached 0.5102 in 2015, suggesting a constrained synergy type, meaning the coordination was mildly disordered or on the verge of disorder. Considering socioeconomic factors, this paper selected 12 factors including GDP, total fixed asset investment, fiscal expenditure, disposable income of urban residents, consumption level of urban residents, disposable income of rural residents, consumption level of rural residents, income difference between urban and rural residents, consumption difference between urban and rural residents, total retail sales of social consumer goods, road length, topographic relief, and precipitation to explore the influencing factors on the coordination development of the "Five Modernizations." Combining with spatial autocorrelation analysis, the global Moran's I value of the "Five Modernizations" coordination development index in Gansu Province was 0.4961, indicating significant spatial correlation at the 0.05 confidence level. Using a spatial exploration analysis tool to eliminate factors with variance inflation factor (VIF) greater than 10, the remaining factors included total fixed asset investment, income difference between urban and rural residents, consumption difference between urban and rural areas, disposable income of rural residents, fiscal expenditure, precipitation, and topographic relief. Inputting these factors into the GWR model yielded an AICc value of -118.63, an $R^2$ value of 0.7280, and a Cond value less than 30. According to the AICc, $R^2$, and Cond values, the GWR model demonstrated good rationality in analyzing the influencing factors. By comparing the coefficient of each variable, the influence degree of the seven variables was listed in descending order as follows: per capita disposable income of rural residents > income difference between urban and rural residents > total fixed asset investment > fiscal expenditure > topographic relief > consumption difference between urban and rural areas > precipitation. Studying the coordination development level of the "Five Modernizations" in Gansu Province can provide reference for scientific development policy at the county level and put forward suggestions for coordination development.

**Keywords:** collaborative development of "Five Modernizations"; entropy

method; geographically weighted regression analysis; spatio-temporal evolution trend

## 1. Study Area and Data

### 1.1 Study Area

The study area comprises 87 counties, county-level cities, and autonomous counties in Gansu Province.

### 1.2 Data Sources

**1.2.1 Industrialization Index** The industrialization index was constructed based on five sub-indicators: per capita GDP, proportion of secondary industry output value, proportion of tertiary industry output value, proportion of non-agricultural employment, and per capita industrial output value. The entropy method was used to determine weights, and the index was normalized to a range of [0, 1].

**1.2.3 Urbanization Index** The urbanization index was built using four sub-indicators: proportion of urban population, urban population density, per capita urban road area, and urban gas 普及率. The entropy method calculated weights, with values normalized to [0, 1].

**1.2.4 Informatization Index** The informatization index included four sub-indicators: telephone 普及率, internet 普及率, per capita postal and telecommunications business volume, and number of mobile phones per 100 people. Weights were determined by entropy method, with normalization to [0, 1].

**1.2.5 Agricultural Modernization Index** The agricultural modernization index comprised five sub-indicators: per capita agricultural output value, proportion of agricultural machinery, effective irrigation rate, per capita grain output, and rural electricity consumption per unit area. The entropy method calculated weights, normalized to [0, 1].

## 2. Methods

### 2.1 Entropy Method

The entropy method was employed to determine objective weights for all indicators. This approach avoids subjective bias in weight assignment by calculating information entropy based on data dispersion.

### 2.2 Spatial Autocorrelation Analysis

Spatial autocorrelation analysis was conducted using GeoDa software to examine spatial clustering characteristics. Moran' s I statistic was calculated for the

coordination development index of the "Five Modernizations" in Gansu for 2005, 2010, and 2015. The global Moran' s I values were 0.4731, 0.5236, and 0.4961 respectively ($P \leq 0.05$), indicating significant positive spatial autocorrelation.

### 2.3 Geographically Weighted Regression

GWR analysis was performed using ArcGIS software to explore spatially varying relationships between the coordination development index and influencing factors. The model used an adaptive kernel with AICc bandwidth selection. Key parameters included: AICc = -118.63, $R^2 = 0.7280$, Adjusted $R^2 = 0.6926$, and condition number (Cond) $< 30$, indicating model robustness.

## 3. Spatio-Temporal Evolution of Five Modernizations

[Figure 1: see original paper] shows the spatial and temporal patterns of industrialization, urbanization, informatization, agricultural modernization, and greenization development levels in Gansu Province from 2005 to 2015.

[Figure 2: see original paper] displays the integrated development level and coupling coordination degrees of the five modernizations from 2005 to 2015.

The coordination development index increased from 0.2632 in 2005 to 0.3011 in 2010 and 0.3374 in 2015, showing steady improvement. The coefficient of variation decreased from 0.1031 to 0.1015 to 0.1073, indicating relatively stable regional disparities.

## 4. Influencing Factors Analysis

[Figure 3: see original paper] illustrates the evolution of spatial patterns in hotspot areas of coordinated development from 2010 to 2015.

[Figure 4: see original paper] shows the spatial distribution of regression coefficients and $R^2$ values for factors influencing the coordination degree of five modernizations.

The GWR results reveal spatially heterogeneous impacts:

1. **Rural residents'disposable income** showed the strongest positive effect on coordination development, particularly in central and eastern regions.
2. **Urban-rural income difference** exhibited significant positive correlation, indicating that narrowing the gap promotes coordinated development.
3. **Fixed asset investment** demonstrated strong positive impacts, especially in economically developed areas.
4. **Fiscal expenditure** positively influenced coordination, with stronger effects in western regions.

5. **Topographic relief** negatively affected coordination, with mountainous areas showing lower development levels.
6. **Urban-rural consumption difference** showed moderate positive correlation.
7. **Precipitation** had the weakest but positive effect, mainly in arid regions.

## 5. Conclusions and Policy Implications

The coordination development of the "Five Modernizations" in Gansu Province shows: 1. Overall upward trend but remains at a constrained synergy level 2. Significant spatial autocorrelation with stable clustering patterns 3. Rural income and urban-rural gaps are primary drivers 4. Investment and fiscal policies show spatially varying effectiveness

Policy recommendations include: - Prioritizing rural income growth and urban-rural integration - Implementing regionally differentiated investment strategies - Strengthening fiscal support in ecologically fragile areas - Improving infrastructure to overcome topographic constraints

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*Note: Figure translations are in progress. See original paper for figures.*