

Post-Print: Spatiotemporal Differentiation Patterns of Openness to the Outside World in Chinese Prefecture-Level and Above Cities

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Abstract

Opening-up is an important mechanism and driving force for China's economic reform and development, and the inevitable path to national prosperity. This paper takes 343 prefecture-level and above administrative units in China as the research object, measures the degree of opening-up from three dimensions by constructing an entropy-catastrophe system model, and analyzes the spatiotemporal differentiation pattern and internal evolution mechanism of the degree of opening-up at the prefecture level in China using methods such as exploratory spatial data analysis, three-dimensional interpolation fitting analysis, gravity center migration, and spatial variogram. The results show that: (1) The degree of opening-up of prefecture-level units in China exhibits multiple differentiation characteristics, including obvious administrative orientation, spatial zonality, and regional openness. The overall degree of opening-up presents the pattern of East > Central > Northeast > West, and South > North. Municipalities directly under the central government, sub-provincial cities, provincial capitals, special economic zones, and coastal open cities have relatively high levels of opening-up, with significant differences among prefecture-level cities. Over the 10-year period, the overall difference in the degree of opening-up gradually decreased. (2) The degree of opening-up shows obvious spatial dependence, manifested as the spatial club convergence characteristic of "small dispersion and large aggregation." Over the 10-year period, the dispersion degree of open-type textures tended to increase, the aggregation degree of closed-type textures tended to converge, and the plateau type showed an overall fragmented distribution. (3) The random component of the variation in China's opening-up pattern gradually decreased, with significant spatial self-organization and continuity. The homogeneity was best in the northeast-southwest direction, while spatial differences were obvious in the southeast-northwest direction. Scientifically analyzing the spatiotemporal pattern differentiation and evolution mechanism of the degree

of opening-up at the prefecture-level units is of great significance for formulating rational opening-up strategies and promoting the dual-track integrated development of export-oriented economy and regional economy.

Full Text

Abstract

Opening to the outside world is one of China's fundamental national policies. Since the enactment of the reform and opening-up policy, China has gradually formed a comprehensive, multi-level, and wide-ranging opening structure to the outside world, which has brought tremendous and impressive achievements. Since 1978, China has attracted more than 1.7 trillion US dollars of foreign investment and has reached cumulative direct foreign investment of more than 1.2 trillion US dollars, contributing greatly to the development of global economies. In this paper, by analyzing economic data from 343 Chinese administrative region cities at the prefecture level and above, the entropy-mutation model was established based on the dependence level of economic opening degree on foreign trade, investment, tourism, and other indicators, leading to a comprehensive assessment of the opening degree of these cities. Through the methods of ESDA, three-dimensional interpolation fitting analyses, barycenter shifting, and space transform function, this paper discussed the overall trends of economic opening degree of the aforementioned cities and the evolutionary characteristics and mechanism of its spatial pattern during 2005-2015 from the perspective of space-time coupling. The results showed as follows: (1) The Chinese economic opening degree obviously showed multiple characteristics directed by administration, spatial zone, and regional opening. Municipalities, sub-provincial cities, and capital cities had high economic opening degree to the outside world. Marginal differences were observed among these prefecture-level cities. The economic opening degree decreased from East to Central, Northeast, and West China respectively. South China had a higher opening degree than the North. Special economic zones and coastal opening cities showed a high level of opening. Meanwhile, river-along and inland opening cities steadily increased their opening degree but have significant difference. (2) The opening degree was significantly related to spatial zones and showed the club characteristics of small cities scattering and large cities gathering. From 2005 to 2015, the economic opening maintained a relatively overall stable status with the opening degree improving, closing degree declining, and the overall degree of plateau-type distributing sparsely. (3) The random change of China's economic opening degree structure is gradually vanishing. The spatial self-organization and continuity of opening degree's structure were more significant. Better homogeneous structure of the opening degree was observed in the Northeast over the Southwest. Clear spatial differences between the Southeast and Northwest were shown. As representatives of regional economic development, prefecture-level cities are organizers, directors, and controllers. Through the research of economic opening degree of these cities, this paper could provide scientific advice for the govern-

ment to make reasonable opening strategies to the outside world and promote regional harmony development in the new economic situation.

2. Data and Methods

This study analyzed 343 prefecture-level cities in China using panel data from 2005–2015. The entropy method was employed to construct a comprehensive evaluation index system for economic opening degree based on indicators including foreign trade, foreign investment, and tourism. Spatial analysis was conducted using ESDA-GIS methods, three-dimensional interpolation fitting, barycenter shift analysis, and spatial transformation functions to examine spatiotemporal evolution patterns.

2.1 Data Sources

The dataset encompassed 343 prefecture-level administrative units, with economic opening degree values ranging from 0.043 to 0.178. The coefficient of variation was 31.7%, indicating significant regional disparities. The data were extracted from statistical yearbooks and urban statistical bulletins, with missing values interpolated using temporal trend methods.

2.2 Methodology

Entropy-Mutation Model: An entropy-weighted model was established to calculate the comprehensive opening degree index, incorporating foreign trade dependency, investment openness, and tourism development metrics.

ESDA-GIS Analysis: Exploratory spatial data analysis was integrated with GIS to identify spatial clustering patterns and heterogeneity characteristics. Global and local spatial autocorrelation analyses were performed using Moran's I and LISA statistics.

Three-Dimensional Interpolation: A 3D surface fitting model was constructed with spatial coordinates (x, y) and opening degree values (z) to visualize spatial differentiation patterns.

Barycenter Shift Analysis: The geometric center of opening degree was calculated annually to track spatial displacement trajectories and directional trends.

[Figure 1: see original paper] Distribution of prefecture-level cities with economic opening rate during 2005–2015

[Figure 2: see original paper] 3D fitting figure of economic opening rate during 2005–2015

[Figure 3: see original paper] Spatial interaction clustering and texture of economic opening rate during 2005–2015

Economic opening rate by administrative levels in China

Economic opening rate by region in China

Component of economic opening rate in the structure of the level of opening up

Results

The analysis revealed distinct spatial patterns in China's economic opening degree. Coastal regions and special economic zones exhibited significantly higher opening levels than inland areas. The spatial distribution demonstrated clear administrative hierarchy effects, with municipalities and sub-provincial cities showing the highest opening degrees. From 2005 to 2015, the overall opening degree increased while maintaining relative stability, with the spatial pattern evolving from random distribution to organized clustering. The barycenter of opening degree shifted gradually eastward, reflecting the concentration of opening-up policies in coastal regions. Spatial autocorrelation analysis identified significant high-high clusters in the Pearl River Delta, Yangtze River Delta, and Bohai Rim regions, while low-low clusters were concentrated in western and northeastern provinces. The study demonstrates that prefecture-level cities serve as critical nodes for implementing opening strategies and coordinating regional development.

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

Source: ChinaXiv – Machine translation. Verify with original.