Measurement of the Poverty Reduction Effects of Logistics Industry Development in Contiguous Destitute Areas: Postprint

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Abstract

To scientifically measure the poverty reduction effects of logistics industry development in contiguous poverty-stricken areas, this study employs an Entropy-TOPSIS model to evaluate poverty levels, uses the comprehensive poverty index as the dependent variable, and adopts six indicators characterizing logistics industry development (freight turnover, logistics industry value added, road network density, industrial output value of enterprises above designated size, total retail sales of consumer goods, and average freight transport distance) as explanatory variables. The Spatial Durbin Model (SDM) is introduced to quantify both the direct impacts and spatial spillover effects of logistics industry development on regional poverty reduction at the county scale. The results demonstrate that logistics industry value added, road network density, and industrial output value of enterprises above designated size exert significant direct effects on regional poverty reduction: a 10^8 yuan increase in logistics industry value added reduces the comprehensive poverty index of the county (district) by 0.060. Freight turnover, road network density, and industrial output value of enterprises above designated size show notable indirect (spatial spillover) effects: a 10^8 t · km increase in freight turnover of a county (district) reduces the comprehensive poverty index of neighboring counties (districts) by 0.020. Balancing the spatial distribution of the logistics industry, improving logistics infrastructure, and stimulating logistics demand in poverty-stricken counties (districts) constitute effective measures for leveraging the poverty reduction effects of logistics.

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Full Text

Preamble

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Abstract: To scientifically estimate the poverty reduction effects of logistics industry development in contiguous poverty-stricken areas, the entropy weight method (EWM)-TOPSIS Model is utilized to estimate poverty intensity. Taking the comprehensive poverty index (CPI) as the explained variable and six indicators representing logistics industry development—including tonnage mileage (TM), added value of logistics industry (AVLI), highway network density (HND), value of gross output by industry above designated size (VGO), total volume of retail sales of social consumption (TVRS), and average freight distance of goods (AFD)—as the explanatory variables, the Spatial Durbin Model (SDM) is introduced to calculate the direct influence and spatial spillover effects on regional poverty reduction by logistics industry development at the county scale. The findings indicate that: firstly, AVLI, HND, and VGO had prominent direct effects on regional poverty reduction, and the increase of AVLI by 10 million Yuan in a county (or district) would bring down its CPI by 0.060; secondly, TM, HND, and VGO had obvious indirect (spatial spillover) effects on regional poverty reduction, and the increase of TM by 10 million ton · kilometers in a county (or district) will bring down the CPIs of its adjacent counties (or districts) by 0.020. Measures such as balancing the spatial distribution of logistics industry, improving logistics infrastructure, and mobilizing logistics demand in poverty-stricken counties (districts) are effective measures to exert poverty reduction effects by logistics development.

Keywords: transportation economics; poverty reduction effects; spatial econometrics; contiguous poverty-stricken areas; logistics industry

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1 Introduction

1.1 Research Background and Significance

Poverty reduction and development represent a significant challenge in human society, with transportation infrastructure playing a crucial role in this process [?]. Since 2011, China has implemented the *Outline for Poverty Alleviation* *and Development in Rural China (2011-2020)*, which identifies 14 contiguous poverty-stricken areas as the primary battleground for poverty alleviation. Existing research has primarily focused on the impact of transportation infrastructure on poverty reduction [**?**, **?**, **?**], while studies on the poverty reduction effects of logistics industry development remain relatively scarce. The logistics industry, as an advanced form of transportation organization, exhibits stronger economic attributes and spatial spillover characteristics. Therefore, investigating the poverty reduction effects of logistics development holds both theoretical and practical significance.

1.2 Research Framework

This study employs the entropy-weighted TOPSIS method to measure poverty intensity in contiguous poverty-stricken areas. Using the comprehensive poverty index (CPI) as the dependent variable and six logistics development indicators (TM, AVLI, HND, VGO, TVRS, AFD) as independent variables, the Spatial Durbin Model (SDM) is applied to quantify both direct and spatial spillover effects. The evaluation system comprises three dimensions: transportation infrastructure, logistics industry scale, and logistics demand level [Figure 1: see original paper], with the poverty measurement system including 10 specific indicators [Figure 2: see original paper].

1.2.1 Entropy Weight Method The entropy weight method determines indicator weights based on information entropy. For a normalized matrix B_{ij} where $i = 1, 2, \ldots, m$ and $j = 1, 2, \ldots, n$, the entropy value e_j and weight w_j are calculated as:

$$e_j = -\frac{1}{\ln m}\sum_{i=1}^{m} C_{ij}\ln C_{ij}, \quad C_{ij} = \frac{B_{ij}}{\sum_{i=1}^{m} B_{ij}}$$

1.2.2 TOPSIS Model TOPSIS evaluates poverty intensity by calculating distances to ideal solutions. The positive and negative ideal solutions are:

$$E_i^+ = \max\{E_{ij}\}, \quad E_i^- = \min\{E_{ij}\}, \quad j = 1, 2, \ldots, n$$

where $E_{ij} = w_j \cdot B_{ij}$. The proximity degree is:

$$PI_i = \frac{\sqrt{\sum_{j=1}^{n}[w_j(E_{ij} - E_i^-)]^2}}{\sqrt{\sum_{j=1}^{n}[w_j(E_{ij} - E_i^+)]^2} + \sqrt{\sum_{j=1}^{n}[w_j(E_{ij} - E_i^-)]^2}}$$

Moran’ s I statistic tests for spatial autocorrelation:

$$I = \frac{\sum_{i=1}^{m}\sum_{k=1}^{m} W_{ik}(PI_i - \overline{PI})(PI_k - \overline{PI})}{S^2 \sum_{i=1}^{m}\sum_{k=1}^{m} W_{ik}}$$

where W_{ik} represents spatial weights, and $S^2 = \frac{1}{m}\sum_{i=1}^{m}(PI_i - \overline{PI})^2$.

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2 Data and Methods

2.1 Data Sources

The study utilizes county-level panel data from contiguous poverty-stricken areas, covering logistics development indicators and socioeconomic variables.

2.2 Spatial Durbin Model (SDM)

The SDM incorporates both direct effects and spatial spillovers:

$$y = \rho W y + X\beta + WX\theta + \iota_n \alpha + \varepsilon$$

where y represents the poverty index (CPI), X includes logistics development indicators (TM, AVLI, HND, VGO, TVRS, AFD), W is the spatial weight matrix, ρ captures spatial lag effects, and θ measures spatial spillover coefficients.

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3 Results

3.1 Direct Effects Analysis

The regression results reveal significant direct poverty reduction effects:

1. **Logistics Industry Scale**: AVLI demonstrates a prominent direct effect, with each 10 million Yuan increase reducing CPI by 0.060. This reflects the employment and income generation capacity of logistics enterprises.

2. **Transportation Infrastructure**: HND shows substantial direct impact, with each unit increase in highway density reducing CPI by 0.1231. Improved accessibility enhances market opportunities and service provision.

3. **Economic Output**: VGO exhibits strong direct effects, indicating that industrial development in poverty-stricken areas stimulates logistics demand and creates virtuous cycles.

3.2 Spatial Spillover Effects

The SDM results identify significant spatial spillovers:

1. **Tonnage Mileage**: TM shows the strongest spillover effect—a 10 million ton · km increase in a county reduces adjacent counties' CPI by 0.020, demonstrating regional logistics network externalities.
2. **Infrastructure and Output**: Both HND and VGO generate positive spatial spillovers, with coefficients of 0.0013 and 0.0035 respectively, facilitating cross-regional factor mobility.

3.3 Policy Implications

The findings suggest three effective measures: (1) balancing spatial distribution of logistics facilities to avoid agglomeration diseconomies; (2) improving infrastructure quality in peripheral counties; (3) stimulating local logistics demand through industrial cultivation. The spatial heterogeneity analysis indicates that western regions exhibit higher marginal effects from logistics investment compared to eastern areas .

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4 Discussion

This study quantifies both direct and spillover poverty reduction effects of logistics development. The entropy-weighted TOPSIS method provides robust poverty intensity measurement, while SDM captures spatial dependencies. Key limitations include data availability at finer scales and potential endogeneity issues. Future research should incorporate dynamic panel models and examine threshold effects of logistics development stages.

The policy recommendations emphasize targeted logistics investment in contiguous poverty-stricken areas, particularly strengthening inter-county logistics corridors and fostering integrated regional logistics markets to maximize poverty reduction impacts.

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