Measuring the Development Level of China's Logistics Industry and Its Impact on Economic Growth: Evidence from Provincial Panel Data

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Abstract. Using provincial panel data from 2011 to 2022, this study employs the entropy method and a fixed-effects model to examine the impact of logistics development on economic growth. Results show that China's logistics industry has improved overall, with the eastern region ahead of the central and western regions. Logistics development significantly and robustly promotes economic growth, with a stronger effect in the eastern region. Urbanization supports growth, while financial development shows a slight negative effect. The findings highlight the need for region-specific logistics policies and stronger coordination with local industries.

Keywords: Logistics Industry Development, Economic Growth, Entropy Method, Fixed Effect Regression

1 Introduction

The logistics industry is key in linking production, circulation, and consumption, directly influencing resource allocation and regional economic performance. In recent years, with China's industrial restructuring and unified market development, logistics has become increasingly important for reducing costs, enhancing regional connectivity, and supporting economic growth. However, significant regional differences remain due to variations in infrastructure, market size, and industrial conditions, which affect the industry's impact on growth.

Existing research mainly examines the relationship between logistics and economic growth, but measurement methods and regional comparisons remain limited. The logistics industry is complex, and single indicators cannot fully capture its development. Regional differences in economic base, urbanization, and financial resource allocation further influence its role. Therefore, this study constructs a composite index from the dimensions of supply, demand, and scale, so as to better reflect the overall development of the logistics industry.

This study uses panel data from 31 Chinese provinces from 2011 to 2022, applying the entropy method to measure logistics development and a fixed-effects model to examine its impact on economic growth. Robustness checks and regional heterogeneity

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analyses are also conducted to validate the findings and provide guidance for logistics policy formulation.

2 Literature Review

There have been many studies on the relationship between logistics industry and economic growth.Wen[1], ect. used provincial panel data to verify the positive effect of logistics industry on economic growth. Taking Shanxi as an example, Qi[2] analyzed the relationship between logistics efficiency and regional economy, and discussed its significance to the transformation of resource-based regions. Ming[3] pointed out that digital means such as entropy method can provide method support for quantitative research of logistics industry. The World Bank notes that logistics performance, driven by infrastructure, customs, service quality, and reliability, is vital to trade efficiency and economic development. [4]. Zhang[5] found that the logistics industry continues to promote economic growth in the structural adjustment stage. Ren[6] proposed that the logistics industry has the dual role of “the third profit source” and “economic accelerator”. Zhao[7] verified the mediating effect of fixed asset investment in the impact of logistics industry on economic growth. Wang[8] et al. show that improvements in logistics infrastructure significantly support China’s economic development, with maritime transport playing a particularly important role.

On the basis of the above research, this paper uses provincial panel data, uses entropy method to construct the comprehensive index of logistics industry development, and empirically analyzes the impact of logistics industry on economic growth through fixed effect model and robustness test.

3 Comprehensive Measurement and Analysis of The Development Level of China 's Logistics Industry

3.1 Data Source

The research sample of this paper is the panel data of 31 provinces, autonomous regions and municipalities directly under the central government from 2011 to 2022. The relevant data come from the National Bureau of Statistics, the ' China Statistical Yearbook ', and the statistical yearbooks of provinces and cities.

3.2 Variable Declaration

Explanatory Quantity: Level of Economic Development. Economic development is measured by regional gross domestic product (GDP). As one of the most widely used indicators of regional economic performance, GDP can effectively reflect differences in the level of economic development across provinces. To reduce heteroscedasticity and improve the comparability of the data, the logarithm of regional GDP is used in the empirical analysis.

Core Variable : The Development Level of Logistics Industry. The development of the logistics industry is multidimensional and cannot be captured by a single indicator. Therefore, this study constructs a composite logistics development index (LPI) from three dimensions: supply, demand, and scale. Supply is measured by highway and railway mileage, demand by express delivery volume and total postal business volume, and scale by cargo turnover and the added value of transportation, warehousing, and postal services. The entropy method is then used to calculate the composite index, which better reflects the overall development level of the logistics industry. A higher value of LPI indicates a higher level of logistics industry development.

Control variables. In order to more accurately identify the impact of the logistics industry on economic growth, this paper introduces the following three control variables : Financial development is measured by the ratio of the total deposits and loans of financial institutions at year-end to regional GDP. This variable reflects the scale of regional financial development and the intensity of financial intermediation. Urbanization is measured by the proportion of urban population in the total regional population. This variable reflects the degree of population concentration and urban development. Industrial structure is measured by the ratio of the added value of the tertiary industry to that of the secondary industry. This variable is used to capture the degree of structural upgrading and the relative importance of the service sector in regional economic development.

These variables are included because they may affect regional economic growth through resource allocation, population agglomeration, and industrial transformation.

3.3 Measurement Results of Entropy Method

The entropy method results show that the indicators contribute differently to evaluating logistics development. Cargo turnover has the highest weight (0.2298), showing it strongly reflects logistics development. Total postal volume (0.2172) and the value added of transportation, warehousing, and postal services (0.2159) are also important, reflecting industry scale and economic contribution. Highway and railway mileage have similar weights, highlighting the role of infrastructure. Express business volume has the lowest weight (0.1350), likely due to smaller regional differences. Overall, cargo turnover, postal volume, and industry value added play the most significant roles in the composite evaluation.

4 Empirical Test on the Impact of Logistics Industry on Economic Growth

4.1 Model Setting

The fixed effect model is used to analyze the impact of the logistics industry on economic growth. The calculation model is as follows:

$$\ln(GDP_{it}) = \beta_0 + \beta_1 LPI_{it} + \beta_2 Finance_{it} + \beta_3 Urban_{it} + \beta_4 Industry_{it} + \mu_i + \lambda_t + \varepsilon_{it} \tag{1}$$

where i denotes province and t denotes year. Among them, μ_i denotes province fixed effects, which control for time-invariant provincial characteristics such as geographical conditions, historical development patterns, and cultural background. λ_t denotes year fixed effects, which are included to control for common time shocks and macroeconomic trends. $\boldsymbol{\varepsilon}_{it}$ random error term. $Finance_{it}$ represents the level of financial development. $Urban_{it}$ indicates the urbanization rate. $Industry_{it}$ represents the industrial structure.

LPI_{it} is the logistics development index of the i province in the t year, which is the core explanatory variable of this study(Calculated by the entropy method). The calculation formula is as follows:

$$LPI_{it} = \sum_{j=1}^{n} (w_j \times z_{it}^{j}) \tag{2}$$

j indicates index, z represents the standardized value, w_j means to calculate the weight of each index.

4.2 Empirical Results and Analysis

Descriptive statistics of variables. STATA17 was used to make descriptive statistics on the explanatory variables, explained variables and control variables selected in the text.

Table 1. Descriptive Statistics of Main Variables

Variable	Observations	Mean	Standard Deviation	Minimum Value	Maximum Value
$\ln(GDP_{it})$	372	10.856	0.462	9.682	12.155
LPI_{it}	372	8.459	1.927	3.649	13.069
$Finance_{it}$	372	3.496	1.127	1.688	7.618
$Urban_{it}$	372	.592	0.13	0.228	0.896
$Industry_{it}$	372	1.362	0.735	0.527	5.283

Table 1 reports the descriptive statistics of the main variables used in the empirical analysis. The descriptive statistics show that the mean value of the logistics development index is 8.459, ranging from 3.649 to 13.069, while the mean value of the economic development variable is 10.856, ranging from 9.682 to 12.155. The relatively large dispersion of logistics development, financial development, and industrial structure suggests substantial regional differences across provinces, which provides a meaningful basis for empirical analysis.

Hausman Test. To determine the appropriate panel specification, both the F test and the Hausman test are conducted. The F test rejects the pooled OLS model, (F(4,367)= 419.28, Prob > F = 0.0000),indicating that individual effects should be taken into account. The Hausman test compares the fixed-effects model with the random-effects model, (P=0.0000(<0.1)) and the result rejects the null hypothesis that the random-effects estimator is consistent. Therefore, the fixed-effects model is adopted for the subsequent analysis.

Benchmark Regression Analysis

Table 2. Baseline Regression

Variable	Fixed Effects	Random Effects	Pooled OLS
LPI	0.112***	0.121***	0.097***
	(8.200)	(11.886)	(13.329)
Finance	-0.037**	-0.021	0.048***
	(-2.476)	(-1.445)	(3.212)
Urban	3.253***	2.832***	1.836***
	(11.914)	(13.317)	(15.058)
Industry	0.048*	0.047*	0.044**
	(1.747)	(1.900)	(2.054)
_cons	8.044***	8.163***	8.727***
	(104.090)	(113.987)	(151.609)
N	372	372	372
R^2	0.919		0.820
Adj. R^2	0.911		0.819
F	958.769		419.281

***p<0.01", "**p<0.05", "*p<.10

Table 2 presents the baseline regression results under the fixed-effects, random-effects, and pooled OLS models. The benchmark results show that logistics development has a significant positive effect on economic growth, suggesting that improved logistics supports growth by enhancing circulation efficiency, regional connectivity, and industrial activities. Urbanization is also significantly positive across all models, indicating that population agglomeration and economic concentration create favorable conditions for growth. By contrast, the coefficient of financial development is significantly negative in the fixed-effects model. This does not necessarily imply that finance itself constrains growth; rather, it may reflect inefficient financial resource allocation in some regions. In particular, financial expansion may not always translate into effective support for productive sectors such as logistics and manufacturing, and in some cases resources may be diverted to speculative or low-efficiency activities. Therefore, the negative coefficient may indicate regional differences in financial efficiency and the need to improve the allocation of financial resources to the real economy.

Robustness Test. To test the robustness of the benchmark results, this study first excludes the year 2020 to reduce the potential influence of pandemic-related shocks. After this adjustment, the coefficient of the core explanatory variable remains positive and significant at the 1% level (0.109), with no substantive change in sign or significance, indicating that the main finding is stable. As an additional robustness check, lagged values of the LPI (LPI(t-1), LPI(t-2), and LPI(t-3) are introduced into the fixed-effects model. The results show that the short-term effect of logistics development is not significant, whereas the longer-lagged effect remains positive and significant, suggesting that the contribution of logistics development to economic growth may materialize with a time lag. At the same time, using lagged LPI helps alleviate potential simultaneity bias to some extent. Overall, the benchmark conclusion that logistics development significantly promotes economic growth remains robust.

Heterogeneity Test

Table 3. Heterogeneity Regression

	General Regression	East	Midwest
LPI	0.109***	0.192***	0.094***
	(7.557)	(5.449)	(7.840)
Finance	-0.035**	-0.135***	-0.023*
	(-2.309)	(-3.224)	(-1.881)
Urban	3.391***	1.236	4.215***
	(11.700)	(1.431)	(17.494)
Industry	0.055*	0.147**	-0.110***
	(1.858)	(2.453)	(-3.779)
_cons	7.981***	8.817***	7.903***
	(96.981)	(23.771)	(155.293)
N	341	110	231
R2	0.921	0.830	0.969
Adj. R2	0.912	0.807	0.965
F	887.365	117.476	1605.512

***p<0.01", "**p<0.05", "*p<.10

Table 3 reports the heterogeneity regression results for the full sample, eastern region, and central-western region. Heterogeneous regression results indicate that logistics development positively influences economic growth in both the eastern and central-western regions, with a stronger effect in the east (0.192 vs. 0.094), likely due to better infrastructure, higher marketization, and more mature industrial support. In the central and western regions, the effect is weaker, reflecting some development constraints. Urbanization significantly promotes growth in the overall sample and central-western regions, but not in the east, likely because urbanization there is already advanced. Financial development shows a negative effect across regions, suggesting that financial resource allocation could be improved.

5 Research Conclusions and Policy Recommendations

Using provincial panel data for China from 2011 to 2022, this study constructs a composite logistics development index by the entropy method and examines its impact on economic growth with a two-way fixed-effects model. The results show that logistics development significantly promotes economic growth, and this conclusion remains robust after excluding the year 2020 and using lagged logistics indices. At the same time, clear regional disparities are observed: the eastern region has a higher logistics development level and a stronger growth effect than the central and western regions. In addition, urbanization contributes positively to economic growth, whereas financial development shows a negative coefficient in the fixed-effects estimations, suggesting that the allocation of financial resources to the real economy may still be inefficient in some regions.

6 Limitations and Future Research

This study still has several limitations. Although lagged logistics indices are introduced to alleviate endogeneity concerns, potential reverse causality cannot be fully ruled out. Moreover, the heterogeneity analysis is relatively broad, and future research could further distinguish between central and western regions or adopt alternative measures of logistics development and economic growth. Finally, the negative coefficient of financial development suggests that the relationship among finance, logistics, and growth warrants further investigation.

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