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# SPATIAL ECONOMETRIC ANALYSIS OF COMMERCIAL LOGISTICS AND REGIONAL ECONOMIC GROWTH – RESEARCH ON HANDAN AND SIX SURROUNDING CITIES

Huipo Wang* and Limei Wang

School of Management Engineering and Business
Hebei University of Engineering
No. 19, Taiji Road, Handan 056038, P. R. China
872573818@qq.com
*Corresponding author: wanghuipo@hebeu.edu.cn

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Abstract. *This paper uses the data from 2010 to 2021 to construct a spatial econometric model. This paper studies the spatial influence of commercial logistics and economic development in seven cities in China (Handan, Changzhi, Jinzhong, Xingtai, Liaocheng, Anyang, Puyang). The result shows that the development of urban commercial logistics and economic growth in border area of four provinces has a significant spatial correlation effect. TWPE (transportation, warehousing and postal employees) and NIIU (number of international Internet users) promote the economic growth of the region significantly. DFI (deposits in financial institutions) and RSCG (retail sales of consumer goods) can promote the local economic growth. However, the spatial impact of DFI and RSCG is not obvious. VTI (value-added of tertiary industry) has no significant impact on the local economy, and has a negative impact on the economic growth of adjacent areas. This research provides decision supports for the governments of the seven cities in the region to coordinate regional economic development.*

**Keywords:** Commercial logistics, Regional economy, Spatial econometric analysis, Spatial effect

1. **Introduction.** The commercial logistics industry is a new type of modern service industry that realizes the organic integration of commerce and logistics, and also plays an obvious role in driving economic growth. In recent years, commercial logistics has gained the attention of scholars, especially the interactive relationship between commercial logistics and economic growth [1,2]. However, the current study of commercial logistics and regional economy is mostly based on the national, provincial and special strategic economic zones [3-9]. Few of works have studied the background of different provinces or cross-strategic economic zones. Handan is located in the southern of Hebei province, which is the joint part of "The coordinated development strategy of Beijing-Tianjin-Hebei Region" and "Central Rise Strategy Region". See Figure 1. As far as we know, this paper is the first research on the relationship between commercial logistics and regional economic growth in China's cross-strategic development zone. This area includes seven cities, including Handan, Changzhi, Xingtai, Liaocheng, Jinzhong, Anyang and Puyang. The purpose of this article is to explore the spatial interaction between commercial logistics and economic growth in seven regions centered on Handan. Based on the analysis results, the article proposes policies and recommendations to promote economic growth in the region.

The innovations of this paper focus on the following two points. First, this paper is the first to propose the problem of studying the mechanism of economic growth across

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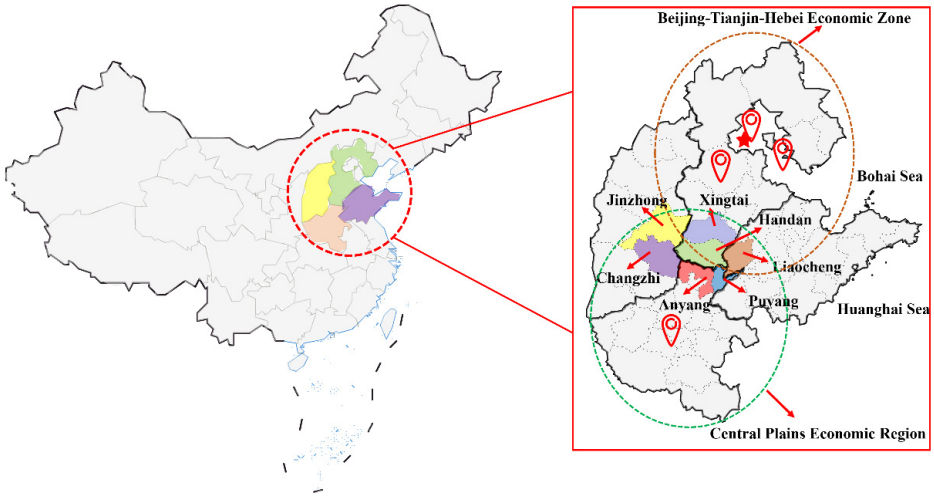


FIGURE 1. Geographical location map of Handan and its six surrounding cities

strategic development zones in China. Most of the previous papers have studied economic growth within provinces or strategic development region. Second, this paper studies the spatial effect of commercial logistics on regional economic growth, and considers control variables such as freight capacity, and human capital. This study is of great significance to promote the economic growth of the joint regions of cross-strategic development zone.

2. **Literature Review.** With rapid development of economy, logistics industry has become one of the pillar industries. The relationship between logistics and economy has attracted a lot of attention. The current study focuses on four aspects. Firstly, research on the causal relationship between economic development and logistics. Lan et al. [10] believed that the relationship between logistics and economy is mutually reinforcing and interacting. Logistics development is the fundamental driving force of economic development, while economic growth also brings ample investment to logistics industry. Fang [11], Hooi Lean et al. [12], Zhang et al. [13], Yuan and Kuang [14] used different models based on different examples to verify that the regional economic development leads to the increase of demand for logistics services, which leads to the development of the logistics industry. It is found that the increasing of regional economy brings higher requirements for regional logistics and results higher development level of logistics. Secondly, some scholars regard trade as an intermediate variable between logistics and economic growth. Burda [15] considered that logistics is the main source of trade and business growth in economy, and its development helps economic development. Xiao et al. [19] believed that the development of international trade promoted the prosperity of shipping logistics, which in turn promoted the growth of trade. Layachi and Mouhamed [22] investigated that the logistics industry is an important interface for the growth of international trade in the process of globalization. Thirdly, some scholars have studied the positive impact of logistics infrastructure on economic development. Ding et al. [16], Wan et al. [17], Wang et al. [18] reported that port logistics as an important link in logistics transportation can be a positive effect on regional economic development. According to Gafurov et al. [20] the development of large commercial logistics centers will be a growth point for regional economic development. Fourthly, some scholars focus on the empirical research that logistics promotes economic growth. Mccann [21] demonstrated that the development of regional logistics in Finland has provided a good help to regional economic competitiveness. Logistics play an important role in economic growth and development of various countries, and the development of logistics and economic development are mutually reinforcing.

Through the literature review, it can be found that there is no research on the spatial effect of commercial logistics and economic growth from the perspective of spatial interaction.

## 3. Methodologies.

### 3.1. Global spatial autocorrelation analysis.

Global spatial autocorrelation describes the spatial characteristics of attribute values in the whole region. In this paper, the index of autocorrelation is represented by the global moran index (Moran'I) [23]. The degree of similarity of spatial adjacency or spatial adjacent area is explained by Moran'I.

The expression is given as follows:

$$\text{Moran'I} = \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}\left(Y_i - \overline{Y}\right)\left(Y_j - \overline{Y}\right)}{S^2 \sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}} \tag{1}$$

where $S^2 = \frac{1}{n}\sum_{i=1}^{n}\left(Y_i - \overline{Y}\right)$, $\overline{Y} = \frac{1}{n}\sum_{i=1}^{n} Y_i$, $Y_i$ represents the observed value in the $i$ region, $n$ is the total number of regions, and $w_{ij}$ is the spatial weight matrix.

The value range of Moran'I is between $[-1, 1]$. Moran'I $\in [-1, 0)$ indicates negative correlation, Moran'I $\in (0, 1]$ means positive correlation, and Moran'I $= 0$ stands for no correlation. The closer value to 1 shows the greater spatial correlation, and the closer value to $-1$ represents the greater spatial difference.

### 3.2. Space weight setting.

The correlation of variables in regional space is represented by spatial weight, and the first law of geography points out the influence of weight increases with the closer distance. The distance in spatial correlation analysis can not only be the straight-line distance between two points, but also be the virtual distance such as economic and time distance. Therefore, this work chooses the weight matrix of economic distance under the consideration of each city's economic space factors. The economic distance's weight is calculated by absolute difference value of gross domestic production (GDP) of two areas.

### 3.3. Theoretical analysis and hypothesis.

Due to the agglomeration effect, the economic development of a region is always influenced by neighboring regions, and also affects the economic growth of neighboring regions, which has been formalized in many studies [24]. So we get hypothesis 1:

H1: The economic development of one region is influenced by the economic development of neighboring regions.

Wang et al. believed that logistics infrastructure has a strong impact on economic development. The development of logistics can shorten the transportation distance between regions, reduce the cost of cargo transportation, improve the efficiency of economic operation and promote economic development [25]. Commercial logistics is an important part of logistics. Therefore, this paper puts forward hypothesis 2:

H2: Commercial logistics in the region promote the economic development of that region.

In addition to the above factors, there are other factors that affect regional economic growth, including human capital, physical capital, market activity level, Internet development level and tertiary industry development level. These factors have also been confirmed in the existing literature [26]. So we get hypothesis 3:

H3: The human capital, physical capital, market activity level, Internet development level and tertiary industry development level of a region affect the economic development of the regions.

3.4. **Spatial econometrics model.** The inclusion of SDM is better than that of spatial autoregressive model (SAR) and spatial error model (SEM). Therefore, we first establish the spatial Durbin model (SDM), and then judge whether it is the best model through relevant tests [27]. The basic setting of the model is as follows:

$$lngdp_{it} = \rho \sum_{j=1}^{N} w_{ij} lngdp_{jt} + \beta ln f_{it} + \theta \sum_{j=1}^{N} w_{ij} lnX_{Zjt} + \mu_i + \eta_t + \varepsilon_{it} \tag{2}$$

where $lngdp_{it}$ is regarded as explained variable and corresponded to economic growth. $w_{ij}$ is spatial weight matrix. $\sum_{j=1}^{N} w_{ij} lngdp_{jt}$ represents the influence of adjacent region's explained variable to current region. $\rho$ is spatial autocorrelation coefficient of explained variable. $lnf_{it}$ stands for explanatory variable, which is the regional commercial logistics. $\beta$ is coefficient to be estimated of the explanatory variable. $lnX_{Zjt}$ are control variables including human capital ($i$), physical capital ($k$), market activity level ($m$), Internet development level ($net$) and the development of the tertiary industry ($n$), that is, $z \in \{i, k, m, net, n\}$. $\theta \sum_{j=1}^{N} w_{ij} lnX_{Zjt}$ illustrates the influence of adjacent region's explanatory variable to current region. $\theta$ is control variables' coefficient of spatial lag term. $\mu_i$ is spatial effect term, $\eta_t$ is time effect term, and $\varepsilon_{it}$ is random error term.

3.5. **Spatial effect decomposition.** The spatial effect decomposition is a reasonable interpretation of regression coefficients to SDM model. Lesage and Pace [28] reported the spatial effect of SDM model can be decomposed into direct effect and indirect effect. The direct effect represents the influence of current region's explanatory variables on the explained variables, and the indirect effect accounts for the influence of current region's explanatory variables on adjacent region's explained variables, namely the spillover effect.

4. **Variable Selection and Data Sources.** According to the hypothesis, this paper needs some variables to measure economic growth, freight capacity, human capital, physical capital, market activity level, Internet level, tertiary industry developing level, etc. In [29-31], they use gross domestic product (GDP), volume of road freight (VRF), transportation, warehousing and postal employees (TWPE), deposits in financial institutions (DFI), retail sales of consumer goods (RSCG), number of international Internet users (NIIU), and value-added of tertiary industry (VTI) to represent those variables. So in this paper we also use those indexes. The variables are described in Table 1.

Table 1. Description of variables

| Variables | Index | Code of variables | Definition of variables |
|---|---|---|---|
| Explained variable | Economic growth | $gdp$ | Gross domestic product (GDP) |
| Explanatory variable1 | Freight capacity | $f$ | Volume of road freight (VRF) |
| Explanatory variable2 | Human capital | $i$ | Transportation, warehousing and postal employees (TWPE) |
| Explanatory variable3 | Physical capital | $k$ | Deposits in financial institutions (DFI) |
| Explanatory variable4 | Market activity | $m$ | Retail sales of consumer goods (RSCG) |
| Explanatory variable5 | Internet level | $net$ | Number of international Internet users (NIIU) |
| Explanatory variable6 | Tertiary industry | $n$ | Value-added of tertiary industry (VTI) |

The data come from the China City Statistical Yearbook (2011-2022) and the Statistical Bulletin of National Economic and Social Development of each city (2011-2022). Readers may contact the corresponding author for data requests.

## 5. Empirical Analysis.

### 5.1. Spatial autocorrelation analysis.

Based on the GDP and freight capacity data of seven cities from 2010 to 2021, this work conducts Global Moran'I analysis on their spatial autocorrelation, as shown in Table 2.

TABLE 2. Regional economy and logistics Moran'I index

| Index | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *gdp* | 0.263 | 0.197 | 0.198 | 0.250 | 0.275 | 0.304 | 0.311 | 0.316 | 0.319 | 0.213 | 0.119 | 0.069 |
| *f* | 0.287 | 0.323 | 0.295 | 0.271 | 0.148 | 0.167 | 0.164 | 0.180 | 0.178 | 0.134 | 0.135 | 0.064 |

It can be seen at Table 2 that Moran'I in each year is significant and positive at the level of 5% from 2010 to 2021, and shows an increasing trend year by year. Moran'I of freight volume ($f$) is significant and positive, so it can be considered that there is certain agglomeration in the development of commercial logistics in the border area of the four provinces.

Figure 2 shows the trend of the Moran'I of GDP and road freight volume during 2010-2021. It can be found that Moran'I of commercial logistics and economic development showed a trade-off relationship before 2014. This may be attributed to cities basically fought on their own in terms of economic and logistics development. More attention was paid on logistics infrastructure construction, and less attention to the coordinated development of regional logistics and regional economy. After 2014, with the proposed concept of "Beijing-Tianjin-Hebei coordinated development", industrial coordination between cities gradually began to be implemented, and spatial correlation started to be emphasized. This makes the change of the Moran'I of logistics and economy gradually converge, which also conforms to the law of economic and logistics development, that is, they complement and promote each other.

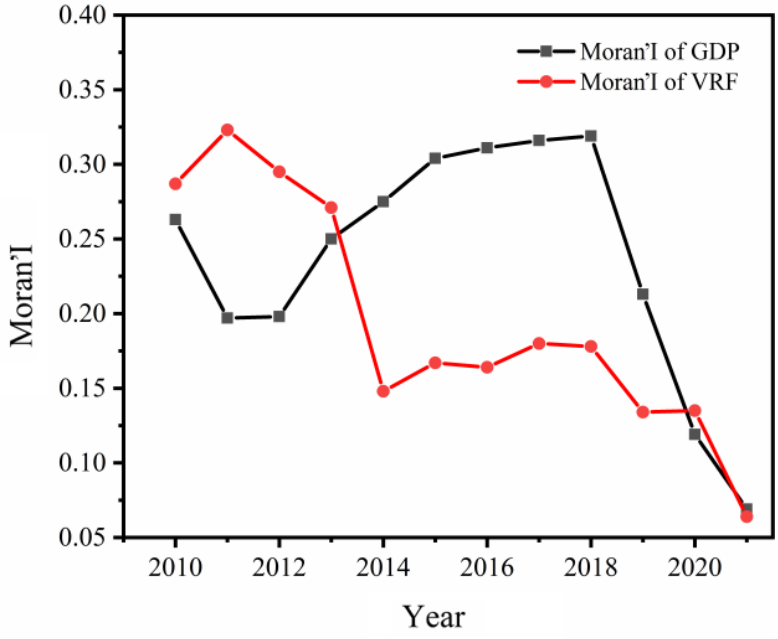


FIGURE 2. Trends chart of the Moran index of GDP and highway cargo volume from 2010 to 2021

## 5.2. **Spatial econometric model estimation.**

5.2.1. *Choice of spatial econometrics model.* In the selection of spatial econometric model, the influence of spatial factors is removed firstly and conducts ordinary least squares (OLS) regression estimation, Lagrange mutiplicator (LM) test and Hausman test [32] (see Table 3 for the test results). Considering the limitation of length, OLS regression results are omitted from the statistical results.

Table 3. LM and Hausman test

| Test | Statistic | p-value |
|---|---|---|
| LMerr | 8.286 | 0.004 |
| R-LMerr | 6.330 | 0.012 |
| LMlag | 9.188 | 0.001 |
| R-LMlag | 5.032 | 0.015 |
| Hausman | 26.49 | 0.000 |

The purpose of LM test is to judge whether each variable has property of spatial distribution and whether it is necessary to introduce spatial econometric into the model. According to the p-value of LMerr and LMlag, LMlag passes the significance test at the significance level of 5%, so the original hypothesis is rejected and the spatial econometric model should be used to explain the spatial relationship of the lag term. Through Hausman test, it can be judged whether the model adopts fixed effect or random effect. According to the test results, the hypothesis of using the random effect model should be rejected, which means there are significant differences between individual coefficients, so the space panel model with fixed effect is used for subsequent operations. The results are summarized at Table 3 and calculated by STATA16.0.

As shown in Table 3, it can be determined that the spatial hysteresis model with fixed effects should be adopted. However, LM test is only based on statistical inference and ignores Anselin's theory about model setting, that is, the model permutation order should be set by Log-likelihood statistics > LM statistics. If the model is set correctly without considering the applicability of SDM, may lead to the selection error. Therefore, whether SDM can be degenerated to SAR or SEM needs to be verified by likelihood ratio (LR) test [33]. Table 4 shows that LR test has passed the significance level test, and SDM cannot degenerate to SAR or SEM. Wald test and LM test results are consistent, both of which indicate that SDM will not degenerate. Therefore, the SDM with fixed effects is selected in this work.

Table 4. LR and Wald test

| Test | Statistic | p-value |
|---|---|---|
| LR test space lag | 34.71 | 0.0000 |
| LR test space error | 33.79 | 0.0000 |
| Wald test space lag | 261.09 | 0.0000 |
| Wald test space error | 64.97 | 0.0000 |

5.2.2. *Regression analysis of SDM.* According to the comparison results of three kinds of fixed effects in Table 5, only the spatial coefficient of individual fixed effects is positive and passes the significance test at the level of 10%, which indicates that the development of urban commercial logistics and economic growth in border area of four provinces has a significant spatial correlation in spatial distribution. Results of R-squared show that

TABLE 5. The results of the three fixed effect models are compared.

| Index | Time fixed effect | Individual fixation effect | Double fixed effect |
|---|---|---|---|
| R-squared | 0.846 | 0.900 | 0.887 |
| Log-likelihood | 103.2 | 111.0 | 143.4 |
| WSptaial-rho | $-0.264(-1.49)$ | $0.280^{*}(2.35)$ | $-0.659^{***}(-4.58)$ |
| Sigma2_e | $0.00441^{***}(6.81)$ | $0.00407^{***}(6.41)$ | $0.00173^{***}(5.97)$ |
| AIC | $-178.4$ | $-193.9$ | $-258.7$ |
| BIC | $-144.4$ | $-159.9$ | $-224.7$ |

Note: ***, ** and * indicate significance at 1%, 5% and 10%.

TABLE 6. The SDM regression of the individual fixed effect

| Main | p-value | Wx | p-value |
|---|---|---|---|
| $lnf$ | $0.057^{*}(0.07)$ | $lnf$ | $-0.058(0.32)$ |
| $lni$ | $0.163^{***}(0.00)$ | $lni$ | $-0.150^{**}(0.04)$ |
| $lnk$ | $0.083(0.36)$ | $lnk$ | $0.196(0.28)$ |
| $lnm$ | $0.219^{*}(0.09)$ | $lnm$ | $-0.286(0.14)$ |
| $lnnet$ | $0.115(0.16)$ | $lnnet$ | $0.368^{***}(0.01)$ |
| $lnn$ | $0.078^{**}(0.24)$ | $lnn$ | $-0.337^{***}(0.00)$ |
| Spatial-rho | $0.280^{**}(0.02)$ | sigma2_e | $0.004^{***}(0.00)$ |

Note: ***, ** and * indicate significance at 1%, 5% and 10%.

the fit degree under the individual fixed effect is higher than the other two models. Log-likelihood statistic explains that the value of individual fixed effect is less than the other two models, indicating a better fitting effect. The regression results of SDM with individual fixed effects are shown in Table 6.

5.2.3. *Spatial effect decomposition of SDM.* According to the spatial effect decomposition theory, the total effect decomposition is direct effect and indirect effect. This explains the impact of the changes in the variables expressed in the regression results to the economic growth. The specific decomposition results are shown in Table 7.

TABLE 7. SDM effect decomposition of individual fixed effect

| | LR_Direct | LR_Indirect | LR_Total |
|---|---|---|---|
| $lnf$ | $0.053(0.11)$ | $-0.061(0.45)$ | $-0.008(0.94)$ |
| $lni$ | $0.152^{***}(0.00)$ | $-0.136(0.45)$ | $0.016(0.88)$ |
| $lnk$ | $0.114^{**}(0.02)$ | $0.298(0.21)$ | $0.412^{**}(0.01)$ |
| $lnm$ | $0.197^{*}(0.09)$ | $-0.298(0.17)$ | $-0.101(0.59)$ |
| $lnnet$ | $0.156^{*}(0.06)$ | $0.519^{**}(0.02)$ | $0.675^{**}(0.01)$ |
| $lnn$ | $0.045(0.53)$ | $-0.421^{**}(0.02)$ | $-0.376(0.11)$ |

Note: ***, ** and * indicate significance at 1%, 5% and 10%.

The coefficient of the direct effect of VRF is 0.053, and does not pass the significance test, indicating that VRF does not have significant effect on boosting the economic growth of Handan and neighboring cities. The coefficients of the indirect and total effects are both negative and insignificant explaining that the road freight transport volume cannot explain the economic development of the junction region of four provinces which centered on Handan. This also shows that the degree of economic cooperation in this region is not high.

The direct effect coefficient of TWPE is 0.152, and it is significant at 1% level, indicating that the number of related workers will play a positive role in promoting local economic development, that is, for every 1% increase in related workers, the local economy will grow by 0.152%. The coefficient of indirect effect is −0.136, but it is not significant, indicating that the number of relevant employees in one region may have negative effect on the economic development of other cities, but it is not significant. This situation may be due to the fact that the collaboration between the logistics industries of the cities in current economic collaboration region is not very obvious, and the logistics development of each city is basically "individual".

The direct effect coefficient of DFI is 0.114, and it is significant at the 5% level, indicating that the increase in deposits of financial institutions has a significant effect on the economic growth of local area. Every 1% increase in DFI will lead to 0.114% local economic growth. The indirect effect coefficient of DFI is 0.298, but it is not significant, indicating that increasing DFI has little effect on economic growth of surrounding cities.

The direct effect coefficient of RSCG is 0.197 and it is significant at 10% level, which indicates that the increase of RSCG will boost local economy. Specifically, each 1% increase in RSCG will boost the local economy by 0.197%. The coefficient of the indirect effect is −0.298, but insignificant, which indicates that the effect of RSCG does not have a significant effect on the economy of neighboring cities, perhaps that stimulating internal consumption in the context of building a dual internal and external cycle should become the main task at the moment.

The direct effect coefficient of NIIU is 0.156, and it is significant at 10% level, indicating that NIIU will promote local economic growth. The indirect effect is 0.519 and significant at 5% level, indicating that the increase of NIIU will promote the economic development of neighboring cities. For every 1% increase in NIIU, GDP of neighboring cities will rise by 0.519%. It shows that the new things such as big data, Internet of Things and digital economy spawned by the development of the Internet will have an increasing impact on the economy.

The direct effect coefficient of VTI is 0.045, and it is not significant, which indicates that the promotion effect of the development of VTI is not very obvious. The indirect effect coefficient of VTI is −0.421, and it is significant at 5% level, which indicates that the increase of VTI will play an inhibiting effect on economic development for other cities, that is, for every 1% increase in VTI, GDP of the surrounding cities will drop by 0.421%.

5.3. **Robustness test.** In order to ensure the solidity and reliability in the empirical part of the article, the paper adopts the variable substitution method and the qualified sample to test the economic growth. Transportation facilities are a prerequisite for logistics infrastructure, so this paper will replace the road area of the city at the end of the year as a measure of logistics development to replace the original road traffic volume. The finite sample was used for a random selection of six years, and the regression test was carried out as a subsample. Table 8 shows the result of robust testing.

Results show that the spatial correlation is significant and positive at the 5% level after variable replacement. It is basically consistent with original regression results, which demonstrates that the research results of this work are robust and reliable.

## 6. Conclusions and Suggestions.

6.1. **Conclusions.** This work adopts GDP, VRF, TWPE, etc., as indicators to study the relationship between economic development and commercial logistics development. Handan and surrounding cities are selected as research object because of its unique geographic position, located in the border area of four provinces. The agglomeration effect

Table 8. Robustness test regression results

| | **Variable substitution** | | Random 6 years sample |
|---|---|---|---|
| Index | (1) | (2) | (3) |
| | $lnf$ | $lnt$ | $lnf$ |
| R-squared | 0.900 | 0.833 | 0.964 |
| Log-likelihood | 110.96 | 110.12 | – |
| Sptaial-rho | 0.280**(0.02) | 0.257**(0.03) | 0.069*(0.07) |
| Sigma2_e | 0.004***(0.00) | 0.004***(0.00) | – |
| Prob > F | – | – | 0.0000 |
| N | 84 | 84 | 42 |

Comment: ***, ** and * indicate significance at 1%, 5% and 10%. The regression results include control variables and individual fixed effects, not shown in the table.

or spillover effect on surrounding cities is investigated through SDM. It can be concluded as below. 1) The economic development of six cities shows obvious correlation from the perspective of space. 2) At present, the development of regional and local commercial logistics is not very good, and the economic promotion of the region and the surrounding area is not obvious. 3) From other related variables, the number of TWPE will significantly promote the economic growth of the region. DFI will promote the local economic growth, but the spillover effect on the neighboring cities is not obvious. RSCG will drive the local economic growth, and the inhibitory effect on the neighboring cities is not obvious. NIIU will have a significant economic promotion effect. The increase of VTI has an insignificant promotion effect on the local; however, it has a significant negative effect on economic development of neighboring cities.

6.2. **Management implications.** According to the conclusion, the following implications are obtained.

First of all, due to the strong spatial interaction effect of economic development among the seven regions with Handan as the center, the governments of these seven cities should strengthen cooperation to promote the sustainable economic development of the region. Handan has the elements to become the trade and logistics center city among the seven cities in the border area of the four provinces. The other cities should combine its own characteristics to give full play to its own advantages.

Secondly, TWPE (transportation, warehousing and postal employees) and NIIU (number of international Internet users) can significantly promote regional economic growth. And it has a strong spatial effect. Therefore, it is suggested that local governments cooperate to strengthen investment in transportation industry and Internet industry.

Thirdly, although deposits in financial institutions (DFI) and retail sales of consumer goods (RSCG) can promote the growth of local economy, the spatial effect is not obvious. Therefore, it is suggested that local governments strengthen the development of related fields respectively.

Fourthly, VTI (value-added of tertiary industry) has a reverse effect on the economic growth of neighboring regions, indicating that each region is in a state of fierce competition in the tertiary industry. Therefore, it is suggested that the governments of the seven cities avoid direct competition through negotiation and promote coordinated development.

Shortcomings and future research: although this paper explores the spatial interaction between commercial logistics and regional economic development across the boundaries of strategic development zones in China based on spatial econometrics, and examines the control effect of some variables, it does not consider the influence of variable time lag

on regional economic growth. In the future, the authors will consider the time lag effect of variables to study the dynamic spatial interaction between commercial logistics and regional economic growth.

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## Author Biography

**Huipo Wang** received the B.Ec. degree in International Finance from Harbin Engineering University, China, 2002; the M.Se. degree in Industrial Economics from Harbin Engineering University, China, 2006; the Ph.D. degree in Management Science and Engineering, from Harbin Engineering University, China, 2007.

Dr. Wang is currently a full-time associate professor at the School of Management Engineering and Business, Hebei University of Engineering, China. His research interests include logistics management, port logistics, and supply chain finance. He has published over 40 papers in journals and conferences.

**Limei Wang** majored in Logistics Engineering and Management at Hebei University of Engineering. She obtained the master's degree in 2024. She systematically studied courses such as Intelligent Logistics, Advanced Logistics and Supply Chain Management. She achieved excellent grades through continuous effort.

She has a keen insight into the development trends of intelligent logistics, and her research works are primarily focused on studying the relationship between development of the digital economy, regional economy, and intelligent logistics. She has achieved some scholarly accomplishments in this field. Her academic pursuit is to integrate theory with practice, contributing wisdom and strength to the development of logistics industry.