Spatial Differentiation and Location Choice of Logistics Enterprises in Inland Central Cities of Northwest China: A Case Study of Lanzhou City (Postprint)

Authors: Zhao Xuewei

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Abstract

The spatial distribution of urban logistics enterprises determines the logistics spatial pattern and influences the rational allocation of urban comprehensive resources and production space. Taking Lanzhou City, a central city in the inland northwestern region, as the case study area, this study characterizes the spatial distribution and type differentiation characteristics of logistics enterprises in Lanzhou based on micro-level logistics enterprise data and spatial analysis methods, and further explores the influencing factors of their location choice through a negative binomial regression model. The results indicate that: (1) The spatial distribution of logistics enterprises in Lanzhou exhibits significant imbalance, generally presenting a differentiation pattern of "center-oriented, supplemented by outer and inner suburbs, and parasitic distribution along urban traffic arteries," which can be specifically summarized into five spatial organization forms: "multi-center polarization," "center polarization," "multi-center outward expansion," "center outward expansion," and the coexistence of "overall polarization" and "local outward expansion." (2) Logistics enterprises demonstrate a spatial agglomeration characteristic of "two centers, two wings, and four clusters."Regarding different types, transportation-type and comprehensive-type logistics enterprises exhibit "regional equalization and type diversification" agglomeration characteristics, while freight forwarding-type, express-type, and warehousing-type logistics enterprises show "district agglomeration and type clustering" agglomeration characteristics. (3) The spatial differentiation pattern and type differentiation characteristics of logistics enterprises are influenced by multiple factors including transportation conditions, agglomeration factors, government policies, land prices, and urban-rural differences, among which transportation conditions, agglomeration factors, and government policies have the most significant impact on the industry' s overall location choice. (4) From the

perspective of enterprise types, the location choice of freight forwarding-type and comprehensive-type logistics enterprises is most significantly affected by agglomeration factors; express-type and transportation-type logistics enterprises pay more attention to transportation conditions; warehousing-type logistics enterprises are more sensitive to government policies. The research findings not only enrich the location theory and research cases of urban logistics enterprises but also hold important reference value for optimizing the spatial layout of logistics enterprises in inland central cities in northwestern China.

Full Text

Spatial Differentiation and Location Choice of Logistics Enterprises in Inland Central Cities of Northwest China: A Case Study of Lanzhou City

ZHAO Xuewei, ZHANG Zhibin, FENG Bin, GONG Weimin, MA Xiaomin, GUO Yan

College of Geography and Environmental Science, Northwest Normal University, Lanzhou 730070, Gansu, China

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Abstract

The spatial distribution of logistics enterprises determines the logistics spatial pattern and affects the rational allocation of urban comprehensive resources and production spaces. Taking Lanzhou City, a central city in the inland northwest region, as the case area, this study characterizes the spatial distribution and type differentiation features of logistics enterprises in Lanzhou based on micro-level logistics enterprise data and spatial analysis methods. It further explores the influencing factors of their location choice through a negative binomial regression model. The results indicate that: (1) The spatial distribution of logistics enterprises in Lanzhou is notably unbalanced, presenting a pattern of "center-dominant, outer suburbs and near suburbs as supplements, with parasitic distribution along urban main traffic arteries." This can be summarized into five spatial organization patterns: "polycentric polarization," "monocentric polarization," "polycentric expansion," "monocentric expansion," and the coexistence of "overall polarization" with "local expansion." (2) Logistics enterprises exhibit spatial agglomeration characteristics of "two centers, two wings, and four clusters." Specifically, transportation and integrated logistics enterprises show features of "regional equalization and typological diversification," while freight forwarder, express delivery, and warehousing logistics enterprises demonstrate features of "regional agglomeration and typological clustering." (3) The spatial differentiation patterns and typological characteristics are influenced by multiple factors including transportation conditions, agglomeration factors, government policies, land prices, and urban-rural differences. Among these, transportation conditions, agglomeration factors, and government policies have the

most significant impact on overall industry location choice. (4) Regarding enterprise types, freight forwarder and integrated logistics enterprises are most significantly affected by agglomeration factors; express delivery and transportation-oriented logistics enterprises pay more attention to transportation conditions; and warehousing logistics enterprises are more sensitive to government policies. These findings not only enrich the location theory of urban logistics enterprises but also provide important reference value for optimizing the spatial layout of logistics enterprises in inland central cities of northwest China.

Keywords: logistics enterprises; spatial differentiation; location choice; Lanzhou City

1 Introduction

Production, circulation, and consumption constitute the important components of the socio-economic circulation system, playing a crucial role in the sustainable and stable development of regional or national socio-economies. The circulation field serves as the central link connecting production and consumption and ensuring the smooth operation of the socio-economy. As the core of the circulation field, logistics is hailed as the "accelerator" of national economic development and the "lubricant" of industrial structure evolution. As the undertaker of modern logistics spatial organization, the location choice behavior of logistics enterprises not only directly affects the organization mode of modern logistics but also causes the reshaping of regional spatial structure. With the transformation and upgrading of global supply chains and logistics industry forms and models, logistics enterprises' location decision-making behaviors are inevitably affected and changed, which will inevitably lead to adjustments in urban logistics industry functional structure and spatial layout, and further influence urban spatial structure evolution.

Western scholars started research on logistics enterprise location earlier, forming a relatively complete theoretical system and diverse empirical studies. In terms of theoretical systems, early scholars represented by cost school and market school, based on classical location theory and trade theory, focused on transportation and warehousing activity locations, particularly emphasizing that each economic activity produces differentiated location choices to maximize profits. Subsequently, influenced by Marshall's externality theory and Jacobs'externality theory, some scholars proposed that effects such as shared intermediate inputs, shared labor markets, and knowledge spillovers promote the agglomeration and derivation of logistics enterprises and related enterprises, thereby facilitating business information sharing, transaction cost savings, and economic efficiency improvement. With the emergence of new trade theory, scholars believe that under the interaction of spatial agglomeration effects and spatial selection effects, micro-entities such as enterprises will gradually tend toward a stable and balanced spatial structure through cyclical and progressive self-organization,

emphasizing that enterprise heterogeneity is an important moderating variable in enterprise location choice. Empirical research has focused on exploring the spatial agglomeration and diffusion characteristics of logistics enterprises and their location preferences. For example, some scholars used the Gini coefficient to explore the location intentions of transportation and warehousing enterprises in some major U.S. metropolitan areas, finding that logistics activities showed spatial characteristics of both agglomeration toward logistics centers and diffusion toward metropolitan suburbs. Other studies on logistics enterprise location choice in the Flanders region showed that land rent costs, transportation transfer stations, and industrial parks all had positive impacts, while proximity to railway hubs had no significant effect.

With China' s increasing participation in global trade and the gradual improvement of its domestic logistics network, the important role of the logistics industry in national economic development has gradually attracted the attention of domestic scholars. Compared with foreign research that mainly studies logistics from a micro perspective focusing on enterprises, domestic research has mostly studied the logistics industry in the national economy based on social reproduction theory from a macro perspective, gradually moving toward the micro level. Domestic research on logistics enterprise location mainly focuses on two issues: First, based on national, regional, and provincial scales, analyzing the spatiotemporal characteristics of inter-city logistics enterprise networks. For example, some scholars interpreted the characteristics of urban network spatial structure based on the distribution data of logistics enterprise headquarters and branches, finding that China's urban network has obvious hierarchical characteristics of network nodes and regional network differences. In particular, provincial capital cities with high primacy serve as centers of internal and external logistics connections and have higher connectivity in the network. Other studies on the spatial network organization characteristics of local comprehensive service-oriented logistics enterprises from a micro perspective showed that their enterprise spatial network structure presents a "core-periphery" pattern and exhibits spatiotemporal characteristics of contact diffusion in the early stage and leapfrog diffusion in the later stage. Comprehensive analyses of the spatiotemporal patterns of logistics enterprise networks in the Pearl River Delta, Yangtze River Delta, Beijing-Tianjin-Hebei urban agglomeration, Zhejiang Province, and other regions have found that logistics enterprises agglomerate in the main urban areas of provincial capitals or regions with higher logistics development levels and show a trend of expansion along traffic arteries. Second, based on the urban scale, exploring the spatial distribution characteristics of logistics enterprises within cities. For instance, some scholars analyzed the agglomeration mechanism of transportation-oriented logistics enterprises in different areas within cities and found that logistics enterprises showed significant centripetal agglomeration characteristics within the municipal area. Other studies on the location choice of warehousing logistics enterprises in Guangzhou using cross-sectional data concluded that they mainly agglomerate around transportation hubs and major traffic arteries. Research on the location characteristics of

land-port logistics enterprises in Yiwu City showed that this type of logistics enterprise presents a pattern of polarized distribution around specialized markets and shows an evolutionary trend of both agglomeration and diffusion.

In summary, although research findings on logistics enterprise location are increasing, the issue of enterprise heterogeneity has not received sufficient attention. Existing research mainly focuses on the spatial layout characteristics of single-type enterprises, while the internal structural differentiation and type differentiation characteristics of logistics enterprises urgently need to be explored. Empirical research objects have mostly focused on economically powerful and foreign trade-developed central cities in the eastern coastal region, while research on hub logistics in inland national logistics hub cities and national comprehensive transportation hub cities represented by Lanzhou remains weak. In view of this, this paper takes Lanzhou City, a central city in the inland northwest region, as the case area. From a micro perspective of the internal structure and segmented industry types of logistics enterprises, it characterizes the spatial and type differentiation features of logistics enterprises to reveal the relationship between logistics industry spatial layout and urban spatial structure. It further uses a negative binomial regression model to measure the influencing factors of enterprise location choice, providing decision-making references for optimizing the spatial layout of logistics enterprises in inland central cities of northwest China while enriching the location theory and research cases of urban logistics enterprises.

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2 Study Area and Methods

2.1 Study Area Overview

Lanzhou City is located at the intersection of the central line of the "Belt and Road" Initiative and the western "New International Land-Sea Trade Corridor." With its locational advantage of "connecting six directions and radiating to the northwest," Lanzhou has become an important gateway for China' s opening to the west and a crucial transportation hub city in inland areas. In the era of "hub economy," with the normalized operation of China-Europe Railway Express expanding the international economic and trade "circle of friends," Lanzhou is undertaking important tasks of radiating and driving regional logistics and coordinated development of urban agglomeration logistics.

In 2020, Lanzhou' s transportation, warehousing, and postal industry GDP reached 25.514 billion yuan, accounting for 8.99% of the regional GDP and 13.86% of the tertiary industry. The total freight volume reached 141.2183 million tons, of which road freight volume was 132.8054 million tons, accounting for 94.04%; railway freight volume was 8.3409 million tons, accounting for 5.91%; and civil aviation freight volume was 72,000 tons, accounting for only 0.05%. Currently, Lanzhou's logistics industry has formed a freight structure dominated by inland road transportation, supplemented by railway and aviation. This

study takes Lanzhou' s municipal area as the research area (Fig. [Figure 1: see original paper]), which includes Chengguan, Qilihe, Xigu, Anning, and Honggu districts under its jurisdiction, as well as Yuzhong and Gaolan counties, with an administrative area of 13,083 km^2 and a permanent population of 4.3594 million in 2020. Based on relevant research findings and research needs, Lanzhou is divided into three geographical levels at the street/town scale: central urban area (the valley area includes 51 streets and towns mainly in Chengguan, Qilihe, Xigu, and Anning districts), near suburban area (including Heping Town in Yuzhong County, Zhonghe Town in Gaolan County, Kushui Town and Shuping Town in Yongdeng County, and Ping' an Town in Honggu District, totaling 13 streets and towns), and outer suburban area (the remaining 73 streets and towns).

2.2 Data Sources and Processing

Currently, academia has not yet formed a consensus on the classification system of logistics enterprises, which has limited micro-scale research. Based on existing research and taking the major categories of the "National Economic Classification" (GB/T 4754-2017) as the main basis, this study takes transportation, warehousing, and postal industries as the main research subjects of logistics enterprises. Combined with the "Classification and Evaluation Indicators of Logistics Enterprises" (GB/T 19680-2013) officially approved and released by the Standardization Administration, logistics enterprises are divided into five types: freight forwarder, express delivery, warehousing, transportation, and integrated. Logistics enterprise data in this study mainly come from Lanzhou' s industrial and commercial enterprise registration data in 2020, including attribute information such as enterprise name, address, business scope, and registration time. After screening out enterprises with incomplete or biased information, a total of 2,481 enterprise research samples were obtained. Enterprise address information was converted into spatial coordinates through the Baidu API to build a spatial database of logistics enterprises in Lanzhou (Table). Administrative boundary data and road network vector datasets were obtained from the National Basic Geographic Information Center' s 1:1,000,000 national basic geographic database.

2.3 Methodology

2.3.1 Kernel Density Analysis Kernel density analysis can intuitively express the spatial distribution characteristics of logistics enterprises in Lanzhou. The calculation formula is:

$$\beta(s) = \sum_{l=1}^{n} \frac{1}{r^2} \phi \left(\frac{d_{ls}}{r} \right)$$

where $\beta(s)$ is the kernel density estimate at location s; r is the bandwidth, i.e., the search radius of the kernel density function (km); n is the sample size; and

ϕ is the weight of the distance (d_{ls}) between a certain point and another point.

2.3.2 Hotspot Analysis Hotspot analysis can detect the non-randomness of event spatial distribution and further calculate hotspot areas with high event occurrence frequency. When studying the spatial characteristics of logistics enterprises in Lanzhou, spatial hotspot detection is used to analyze the agglomeration areas of logistics enterprises in space. The calculation formula is:

$$G_i^*(d) = \frac{\sum_{j=1}^{n} w_{ij}(d)x_j}{\sum_{j=1}^{n} x_j}$$

where $G_i^*(d)$ is the Getis-Ord G_i^* value for hotspot analysis, used to analyze the agglomeration degree of attribute values at the local spatial level; d is distance; w_{ij} is the spatial weight matrix; x_j is the observed value in region j; and n is the total number of research area units. Standardization is performed and transformed into:

$$Z[G_i^*(d)] = \frac{G_i^*(d) - E[G_i^*(d)]}{\sqrt{Var[G_i^*(d)]}}$$

where $E[G_i^*(d)]$ and $Var[G_i^*(d)]$ represent the mathematical expectation and variance of $G_i^*(d)$, respectively. If the obtained $Z[G_i^*(d)]$ value is positive and significant, it indicates that during the study period, street (town) i and its surrounding areas have a large number of logistics enterprises, belonging to high-value spatial agglomeration areas (hotspots). If the $Z[G_i^*(d)]$ value is negative and significant, it indicates that during the study period, street (town) i and its surrounding areas have a small number of logistics enterprises, belonging to low-value spatial agglomeration areas (coldspots).

2.3.3 Negative Binomial Regression Model First, enterprise location choice is considered as a utility function between the number of enterprises in a spatial unit and influencing factors. Referring to relevant research, it is assumed that the number of logistics enterprises (Y_i) in the ith spatial unit of Lanzhou follows a Poisson distribution with parameter λ_i. The probability (P) of observing y_i logistics enterprises in the research unit is:

$$P(Y_i = y_i) = \frac{e^{-\lambda_i}\lambda_i^{y_i}}{y_i!}$$

The parameter λ_i depends on the explanatory variables x_i:

$$\lambda_i = e^{x_i\beta}$$

where the dependent variable y_i is the number of logistics enterprises in a street or town; the independent variable x_i represents factors that may affect logistics enterprise location choice; λ_i depends on the explanatory variables x_i; β is the vector of regression coefficients for variables, and its maximum likelihood estimator L can be obtained through the log-likelihood function:

$$\ln L = \sum_{i=1}^{n} [-\lambda_i + y_i x_i \beta - \ln(y_i!)]$$

An important assumption in the Poisson regression model is that the conditional variance and conditional mean of the dependent variable are equal and equal to λ_i. However, the variance of the number of logistics enterprises in each street of Lanzhou is much larger than the mean, showing overdispersion and not meeting the assumptions of the Poisson regression model. The negative binomial distribution model allows the conditional variance of the dependent variable to be unequal to the conditional mean, so the negative binomial regression model is used instead to obtain the quasi-maximum likelihood estimate of β.

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3 Results

3.1 Spatial Differentiation Characteristics

3.1.1 Regional Differentiation Characteristics Through measurement, the imbalance index of the overall distribution of logistics enterprises in various districts and counties of Lanzhou is 0.61, indicating obvious unbalanced distribution characteristics of logistics enterprises within the municipal area. Overall, Chengguan District has the largest number of logistics enterprises (1,036), accounting for 41.79% of the total, with the highest distribution density of 9.35 enterprises/km^2. Qilihe District ranks second, with enterprise number and density accounting for 17.76% and 3.96 enterprises/km^2, respectively. Anning District has the fewest enterprises, only 98, accounting for 3.96% of the total. Yongdeng County, the largest county in Lanzhou by area, has the lowest enterprise density at only 0.12 enterprises/km^2.

From the perspective of industry types, comprehensive enterprises have the largest number in Chengguan District (419), followed by Yongdeng County and Qilihe District, with relatively few in Gaolan County and other areas. Freight forwarder enterprises are more numerous in Chengguan District (305) and Qilihe District (183), with fewer in other districts and counties. Transportation enterprises are most numerous in Yongdeng County (289), followed by Chengguan District (252). Warehousing enterprises are more numerous in Yongdeng County (78) and Yuzhong County (45), with fewer in other districts and counties. Express delivery enterprises are most numerous in Chengguan District (301), accounting for about 38.80% of the total. Xigu District has the most

warehousing enterprises, far exceeding the second-ranked comprehensive enterprises, accounting for about 27.88%. Honggu District has the most transportation enterprises, far ahead of other types, accounting for about 22.58% of the total. With the establishment of Lanzhou New Area, Yongdeng County has seen robust development in warehousing, transportation, and comprehensive logistics, with proportions reaching 24.19%, 21.92%, and 17.40%, respectively. In summary, the spatial distribution of logistics enterprises in Lanzhou shows obvious characteristics of "regional differentiation and typological diversification" (Fig. [Figure 2: see original paper]).

3.1.2 Spatial Pattern Characteristics Analysis reveals that logistics enterprises in Lanzhou overall present a differentiation pattern of "center-dominant, outer suburbs and near suburbs as supplements, with parasitic distribution along urban main traffic arteries" (Fig. [Figure 3: see original paper]). From a circle perspective, within the central urban circle, there are 1,329 logistics enterprises, accounting for 53.60% of the total, concentrated in the valley urban built-up area with superior regional conditions and relatively complete infrastructure services. In the near suburban circle, there are 520 enterprises, accounting for 20.96% of the total, showing a characteristic of dispersed distribution along the outer edge of the central urban circle. In the outer suburban circle, there are 632 enterprises, accounting for 25.44% of the total, showing a dispersed and concentrated distribution pattern.

Furthermore, by selecting Lanzhou' s primary and secondary traffic arteries and establishing a 500 m buffer range to count the number of logistics enterprises within the buffer zone, a total of 1,752 logistics enterprises are found within the buffer zone. Among them, 1,238 enterprises (70.63%) are distributed near primary arteries such as highways, national roads, and provincial roads, while 514 enterprises (29.37%) are distributed near secondary arteries such as county roads.

Different types of logistics enterprises often show differentiated spatial organization patterns due to differences in asset allocation, target customer attributes, and service objects. Freight forwarder logistics enterprises concentrate in trade and economic active areas within the central urban area, such as Yantan Park of High-tech Zone, Qilihe Park of High-tech Zone, Anning Park of Economic Development Zone, Shajiu Logistics Park, Zhongchuan International Airport and New Area Station area in the outer suburbs, and Honggu District Hai Shiwan railway hub area, showing a "polycentric polarization" layout (Fig. [Figure 3: see original paper]a). Express delivery logistics enterprises are mainly distributed at the edge of the central urban area in the valley region, such as Yantan Park of High-tech Zone, Lanzhou Station area, and Lanzhou East Station railway hub area, tending toward a "monocentric polarization" layout (Fig. [Figure 3: see original paper]b). Warehousing logistics enterprises show a "center expansion" layout, extending and diffusing in a circle pattern along the G30 Lianhuo Expressway and G6 Beijing-Tibet Expressway from the valley periph-

ery, relying on Heping Park and Jiuchuan Park of High-tech Zone, Xigu Park of Economic Development Zone, and Shajiu Logistics Park in the central urban area (Fig. [Figure 3: see original paper]c). Transportation logistics enterprises show a "polycentric expansion" layout, diffusing outward in a leapfrog pattern from transportation hubs such as Lanzhou Railway Station, Hekounan Station, Hai Shiwan Station, Lanzhou New Area Station, and Yuzhong Station along urban traffic arteries like G30 Lianhuo Expressway, G6 Beijing-Tibet Expressway, G75 Lanhai Expressway, and Airport Expressway (Fig. [Figure 3: see original paper]d). Integrated logistics enterprises are concentrated in Yantan Park and Jiuzhou Park of High-tech Zone, Anning Park and Xigu Park of Economic Development Zone, Shajiu Logistics Park and Heping Logistics Park in the near suburbs, and concentrated distribution in various districts and counties in the outer suburbs, tending to layout in areas with active trade exchanges, showing a coexistence pattern of "overall polarization" and "local expansion" (Fig. [Figure 3: see original paper]e).

3.1.3 Spatial Agglomeration Characteristics To explore whether there is spatial correlation in the distribution of logistics enterprises in Lanzhou, GeoDa software was used to calculate the global Moran' s index of logistics enterprises as 0.42, which passed the significance test, indicating that logistics enterprises in Lanzhou are not randomly distributed but show significant spatial autocorrelation. To further explore the spatial agglomeration characteristics, hotspot analysis was used to identify high and low value agglomeration centers at the street scale, and the natural breakpoint method in ArcGIS software was used to divide Z-values into five levels to obtain the spatial agglomeration pattern of logistics enterprises in Lanzhou (Fig. [Figure 4: see original paper]).

Due to Lanzhou' s unique geographical environment and economic development conditions, the spatial agglomeration of logistics enterprises presents non-equilibrium and leapfrog characteristics. Overall, the cold and hotspot areas of logistics enterprises in Lanzhou show a spatial agglomeration characteristic of "two centers, two wings, and four clusters" (Fig. [Figure 4: see original paper]f). Hotspot areas mainly agglomerate in the eastern living materials logistics area centered on Donggang Street, High-tech Development Zone, Yanbei Street, Gongxingdun Street, and Jiaojiawan Street, and the western production materials logistics area centered on Xizhan Street, Dunhuang Road Street, Tumen Dun Street, Xiuchuan Street, and Chenping Street, forming two primary agglomeration centers. Two secondary agglomeration centers are formed in Lanzhou New Area and Jiuhe Town area, and Yuzhong Eco-city area. Four tertiary agglomeration centers are formed in Chengguan Town of Yuzhong County, Shidong Town of Gaolan County, Hai Shiwan Street of Honggu District, and Chengguan Town of Yongdeng County.

The overall agglomeration trend of logistics enterprises cannot finely depict the differentiated agglomeration characteristics among various types. Therefore, through hotspot analysis of six different types of logistics enterprises, the ag-

glomeration areas of each type were measured: Freight forwarder logistics enterprise hotspots appear in Donggang Street and Xiuchuan Street. As they are similar to intermediary service enterprises, they are mainly distributed in areas with active commercial and trade economies within the city (Fig. [Figure 4: see original paper]a). Express delivery logistics enterprise hotspots agglomerate at the edge of the central urban area such as Heping Town, Yanbei Street, and Yanchang Road Street, as they need to consider both logistics distribution and convenience for terminal delivery (Fig. [Figure 4: see original paper]b). Warehousing logistics enterprise hotspots are mainly distributed in Heping Town and Jiuchuan Town, as this type of enterprise requires large amounts of warehousing land while also facilitating transshipment, mainly distributed near logistics parks such as Tiebang Logistics Park and Yubo Logistics Park (Fig. [Figure 4: see original paper]c). Transportation logistics enterprise hotspots are dispersed, including Dongchuan Town where Lanzhou International Land Port has been established, Hai Shiwan Street of Honggu District, and Chengguan Town of Yuzhong County. As they are mainly engaged in land container transportation business, their distribution shows obvious orientation toward transshipment hubs (Fig. [Figure 4: see original paper]d). Integrated logistics enterprise hotspots appear in multiple areas such as Donggang Street, Yanbei Street, Siji Qing Street, Zhongchuan Town, Dongchuan Town, and Hekou Town. As this type of enterprise belongs to a collection of multiple logistics modes, it initially has higher industrial levels in commercial and trade distribution centers, and gradually begins to agglomerate in emerging development areas such as Lanzhou Land-Port National Logistics Hub under the attraction of government preferential and subsidy policies (Fig. [Figure 4: see original paper]e). Overall, transportation and integrated logistics enterprises show characteristics of "regional equalization and typological diversification," while freight forwarder, express delivery, and warehousing logistics enterprises show characteristics of "regional agglomeration and typological clustering."

3.2 Influencing Factors of Enterprise Location Choice

3.2.1 Indicator Selection Enterprise location choice is the result of the combined effects of various internal and external factors. As a rational "economic man," enterprises tend to follow the principle of profit maximization in location choice. Taking the spatial distribution of Lanzhou' s logistics enterprises in 2015 as the industrial historical foundation, the number of logistics enterprises in each spatial unit in 2015 was selected to reflect the logistics industry foundation of each alternative location. Manufacturing and commerce industries, as the main service objects of logistics enterprises, continuously support and drive the sustainable development of logistics enterprises. Therefore, this study selected whether there are large manufacturing enterprises and comprehensive wholesale markets in alternative locations as representative variables of related industrial agglomeration.

Referring to existing research and considering Lanzhou' s actual regional con-

ditions, five categories of elements were selected to measure their impact on logistics enterprise location choice in Lanzhou: transportation conditions, agglomeration factors, land prices, urban-rural differences, and government policies (Table). Specific variable explanations are as follows:

1) **Transportation conditions**: Regional transportation conditions, as the foundation of spatial connections among enterprises, are important factors affecting enterprise location decisions. Considering that urban passenger centers, railway stations, and airports are circulation centers for cargo loading, unloading, transshipment, and transportation, variables such as distance from the center of each street or town to the nearest passenger center, nearest railway station, and Lanzhou New Area Airport were selected to verify the impact of transportation accessibility on logistics enterprise location choice. Since Lanzhou has formed a logistics pattern dominated by inland road transportation in the inland northwest region, streets with highway entrances and exits have high external connectivity, so the presence of highway entrances and exits was selected to reflect the external transportation conditions of alternative locations. Given that freight hubs are important components of urban internal and external logistics transshipment and transportation networks, this study selected the presence of cargo hub centers as one of the representative variables of transportation conditions.

2) **Agglomeration factors**: Due to the existence of industrial agglomeration benefits, industrial agglomeration in space can bring economies of scale and scope, so enterprises tend to locate near existing related industrial agglomeration areas. The number of logistics enterprises in each street or town in 2015 was selected to reflect the logistics industry foundation of alternative locations. Large manufacturing enterprises and comprehensive wholesale markets in alternative locations were selected as representative variables of related industrial agglomeration.

3) **Land price**: Land rent, as an important basic expenditure item in enterprise production factor costs, is an important factor that enterprises need to consider and weigh in location decision-making. Therefore, the 2019 Lanzhou commercial benchmark land price was selected as the basic indicator to measure the operating costs of logistics enterprises.

4) **Urban-rural differences**: Different regions have differences in socioeconomic development levels and infrastructure construction such as roads and transportation, which often affect the location choice of logistics enterprises. In this regard, this study used whether alternative locations are in the central urban area, near suburban area, and outer suburban area as representative variables to measure urban-rural differences.

5) **Government policy**: The government mainly influences the spatial layout of logistics enterprises through policy measures such as fiscal and tax subsidies, land rent preferences, and the construction of development

zones and logistics parks. Therefore, whether alternative locations are in development zones or bonded areas and logistics parks were selected as representative variables of government policies.

3.2.2 Measurement of Influencing Factors Considering the impact of existing enterprises on the location decisions of new enterprises, this study selected enterprises registered after 2015 (1,536) as the research object to analyze the impact of existing enterprise conditions and other factors on new enterprise location choice. Taking streets or towns as the basic spatial units, there are 137 valid samples, and the factors in Table were selected as explanatory variables. Considering that relevant explanatory variables may have multicollinearity problems, strongly correlated variables such as urban-rural difference factors and land price factors were introduced into the model separately for collinearity testing. The negative binomial regression model was used to measure the impact of various factors on the location choice of overall and different types of logistics enterprises. The alpha (α) values in the calculation results are all significantly non-zero, indicating the rationality of using the negative binomial regression model for estimation in this study (Table).

From the overall measurement results, transportation conditions, agglomeration factors, government policies, land prices, and urban-rural difference factors all have important impacts on the spatial layout of logistics enterprises in Lanzhou. Specifically: (1) Transportation conditions have the most significant impact on logistics enterprise location choice in Lanzhou. The closer to passenger centers, railway stations, and Lanzhou Airport, the higher the transportation accessibility and the greater the attraction to logistics enterprises. The establishment of highway entrances and exits or cargo hub centers in a certain area has a significant positive impact on the development of logistics enterprises in that area. (2) The correlation coefficients of agglomeration factor variables are significant and positive. The reason is that logistics, as a demand-oriented composite producer service industry, the agglomeration of numerous manufacturing and commercial enterprises drives the two-way interaction of related logistics enterprises. (3) The variables of government policy factors all show significant positive impacts. This indicates that the government plays a role through implementing urban planning, talent introduction, tax incentives, and other policies, making logistics parks, development zones, and bonded areas have obvious guiding effects on logistics enterprise location choice. (4) The correlation variables of land price and urban-rural difference factors have all passed significance tests. With the transformation and upgrading of the logistics industry and the high-level development of logistics services, logistics enterprises increasingly prefer to locate in areas with suitable land prices in the central urban area.

From the perspective of different types, the variables representing transportation conditions are all significant, indicating that logistics enterprises mainly consider locations with relatively complete transportation infrastructure, especially tending to locate near transportation hubs such as stations. Comparing the dom-

inant factors in location choice among five different types of logistics enterprises reveals: (1) The location choice of freight forwarder logistics enterprises is more significantly affected by agglomeration factors and urban-rural differences. In terms of agglomeration factors, freight forwarder logistics enterprises tend to locate in areas with higher specialization to facilitate inter-enterprise connections and cooperation. In terms of urban-rural differences, because commercial and trade transactions are active in the central urban area, which is conducive to obtaining market business information and corporate image display and business negotiations, it is more attractive to freight forwarder logistics enterprises. (2) Express delivery logistics enterprises pay more attention to transportation conditions and urban-rural differences in location choice. As this type of logistics enterprise belongs to low-cost investment enterprises, with the development and transformation of the e-commerce industry, locating in areas with convenient transportation in the central urban area is conducive to improving end logistics service quality and providing customized transshipment and distribution services to users. (3) Warehousing logistics enterprises mainly consider land prices and government policies in their location choice process. The reason may be that as traditional logistics enterprises mainly relying on comprehensive wholesale markets to carry out business activities, under land cost constraints, this type of enterprise tends to locate in development zones and logistics parks with lower land prices. (4) The location choice of transportation logistics enterprises is significantly affected by transportation conditions and agglomeration factors. In terms of transportation conditions, freight hub centers, as transshipment and distribution centers for urban internal and external logistics, have obvious attraction to transportation logistics enterprises providing multimodal transport services. In terms of agglomeration factors, the agglomeration effect of large manufacturing enterprises in Lanzhou and the attraction of logistics parks have significant impacts on this type of logistics enterprise. (5) The measurement results of integrated logistics enterprises show that agglomeration factors and government policy factors have significant positive impacts on their location choice. The main reason may be that integrated logistics enterprises, to meet customers' diversified needs in traditional, modern, and emerging businesses, tend to pay more attention to spatial agglomeration with demand parties.

4 Discussion

The spatial distribution of logistics enterprises is closely related to the degree of regional economic and trade development. Based on existing research and analysis from a micro perspective on the spatial differentiation of logistics enterprises' internal structure and segmented industry types, this study finds that they have certain regional particularities and typological heterogeneity characteristics. The spatial distribution of logistics enterprises in Lanzhou shows that due to differences in input factors, service objects, and positions and roles in the industrial chain, coupled with the positive and negative external effects gen-

erated by industrial agglomeration, different types of logistics enterprises will focus on different cost elements in their development process, thereby causing geographical differentiation of segmented industries within the city.

The measurement results of influencing factors of logistics enterprise location choice in Lanzhou show that policy planning, agglomeration factors, and transportation conditions play important roles in their location selection process. Therefore, it is recommended that government departments optimize urban resource allocation from three aspects: First, developing an export-oriented economy is an urgent need for inland central cities like Lanzhou. In the process of urban functional adjustment and spatial optimization such as "retreating secondary industries and advancing tertiary industries" and "moving out of the city and into parks," it is necessary to consider the differential impacts of government and enterprise behaviors on the location choice of different types of logistics enterprises. Second, seizing the development opportunity of Lanzhou moving from the "valley" era to the "metropolitan area" era, strengthening the hub functions of international freight train nodes and national commercial and trade logistics nodes, and focusing on guiding the clustered and intensive development of logistics industry land use. Third, continuing to optimize transportation networks, hub stations, and other infrastructure, further improving logistics service functions, and developing smart logistics.

In addition, with the integrated development of modern logistics supply chains and industrial clusters, under the dual effects of market guidance and government regulation, the synergy and mutual exclusivity among different types of logistics enterprises need further research. Under the era background of "dual circulation" trade transformation and "digitalization" logistics industry transformation, logistics enterprises, as the organizational main body undertaking logistics functions, their spatial behaviors will inevitably be affected by new factors, thus requiring deeper discussion.

5 Conclusions

As an important central city in the inland northwest region of China, Lanzhou' s spatial differentiation characteristics and location choice of logistics enterprises have certain representativeness. Based on Lanzhou' s industrial and commercial enterprise registration data in 2020, this paper uses spatial analysis methods and a negative binomial regression model to study the spatial differentiation and typological differentiation characteristics of logistics enterprises in Lanzhou and their influencing factors of location choice. The conclusions are as follows:

1) From the perspective of regional differentiation characteristics, the spatial distribution of logistics enterprises in Lanzhou is significantly unbalanced, showing a differentiation pattern of "center-dominant, outer suburbs and near suburbs as supplements, with parasitic distribution along urban main traffic arteries."The spatial organization forms of different types of logistics

enterprises vary: freight forwarder logistics enterprises show a “polycentric polarization” layout; express delivery logistics enterprises tend toward a “monocentric polarization” layout; warehousing logistics enterprises show a “center expansion” layout; transportation logistics enterprises show a “polycentric expansion” layout; and integrated logistics enterprises tend toward a coexistence pattern of “overall polarization”and “local expansion.”

2) From the perspective of spatial agglomeration characteristics, logistics enterprises overall show a spatial agglomeration characteristic of “two centers, two wings, and four clusters.” The “two centers” refer to the eastern living materials logistics area centered on Donggang Street, High-tech Development Zone, Yanbei Street, Gongxingdun Street, and Jiaojiawan Street, and the western production materials logistics area centered on Xizhan Street, Dunhuang Road Street, Tumen Dun Street, Xiuchuan Street, and Chenping Street within the valley. The “two wings” refer to the “west wing” formed by connecting Lanzhou New Area and Jiuhe Town area, and the “east wing” formed by enclosing Yuzhong Eco-city area outside the valley. The “four clusters” refer to four dispersed agglomeration centers formed mainly by Hai Shiwan Street in Honggu District, Chengguan Town in Yongdeng County, Shidong Town in Gaolan County, and Chengguan Town in Yuzhong County. In addition, transportation and integrated logistics enterprises show characteristics of “regional equalization and typological diversification,” while freight forwarder, express delivery, and warehousing logistics enterprises show characteristics of “regional agglomeration and typological clustering.”

3) From the perspective of location choice, the spatial differentiation pattern and typological differentiation characteristics of logistics enterprises are influenced by multiple factors such as transportation conditions, agglomeration factors, land prices, urban-rural differences, and government policies. Among these, transportation conditions, agglomeration factors, and government policies have the most significant impact on the overall location choice of logistics enterprises. However, different types of logistics enterprises have significantly different dominant factors in location choice due to their functional attributes. Specifically: the location choice of freight forwarder logistics enterprises is significantly affected by agglomeration factors and urban-rural differences; express delivery logistics enterprises pay more attention to transportation conditions and urban-rural differences in location choice; warehousing logistics enterprises mainly consider land prices and government policies in their location choice process; the location choice of transportation logistics enterprises is significantly affected by transportation conditions and agglomeration factors; and the measurement results of integrated logistics enterprises show that agglomeration factors and government policies have significant positive impacts on their location choice.

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