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Analysis of Spatial-Temporal Evolution Pattern and Its Influencing Factors of Warehouse Supermarkets in Liaoning Province

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Abstract: Based on the data of existing warehouse supermarkets in Liaoning Province, China, spatial autocorrelation analysis, kernel density analysis, composite correlation coefficient analysis and other methods have been adopted to analyze their spatial-temporal evolution pattern to reflect the general law of the development of China's existing warehouse supermarkets and fill the gap in this research field. The results show that the spatial distribution of warehouse supermarkets in Liaoning Province is extremely uneven, and areas with high nuclear density are distributed along the "Shenyang-Dalian" line belonging to the aggregation distribution. The Lorentz curve shows a downward trend with a large degree of spatial imbalance, that is, the regional concentration of warehouse supermarkets is high. Through global and local autocorrelation analysis, the regions with similar development levels of warehouse supermarkets in Liaoning Province tend to gather together, and the spatial distribution has a strong correlation. The distribution of warehousing supermarkets in Liaoning Province is affected by traffic location conditions, economic conditions, population quantity and population density, the number of urban functional areas, policy conditions and the role of the government, especially by economic conditions.

Keywords: post epidemic era; Liaoning Province; warehouse supermarket; spatial-temporal evolution pattern; influencing factors

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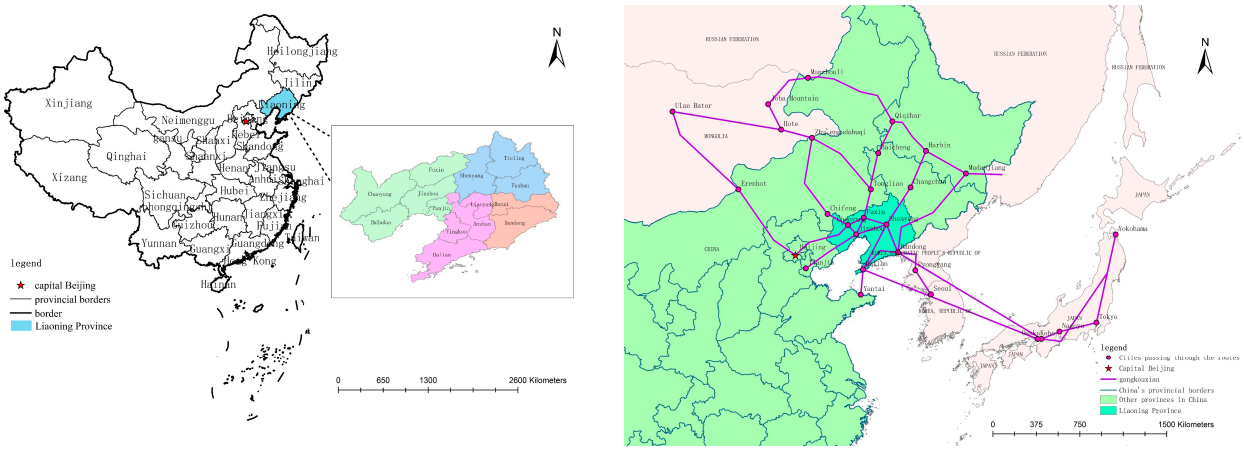
1. Introduction

As an introduced business form, warehouse-style supermarket refers to a variety of supermarket industry in which the shopping environment is mostly located in the warehouse and goods are sold in large packages and at low prices [1]. Because of its unique wholesale sales mode and shopping environment, it is widely welcomed by consumers, and has become a new supermarket development model in China [2,3]. Its development process has also aroused widespread concern in the academic community.

Through the collation of the relevant literature in recent years, we find that, while the industry is developing rapidly, there is a gap in the relevant theoretical research, lacking the corresponding theoretical support. In order to promote the optimal development of the warehouse supermarket industry, this paper studies the space-time evolution pattern of the warehouse supermarket industry and presents a comprehensive study of its influencing factors so as to adapt to the rapid development of the warehouse supermarket industry and reflect the general rules of its development.

In terms of the selection of research areas, this paper takes Liaoning Province of China as the research area and the warehousing supermarket industry in this province in recent years as the research object. The reason is as follows:

Liaoning Province is the only coastal province in Northeast China (Figure 1a). With its unique advantages of being located in the golden latitude zone of economic development and the core zone of the Northeast Asian Economic Circle, in recent years, the development focus of the city has shifted from industry to the tertiary industry dominated by the service industry. Based on the advantages of its geographical location, it provides convenient, fast and efficient services for goods from China, Japan and South Korea and other countries and regions to reach Europe and other countries and regions through the Liaoning port (Figure 1b) [4]. The document of the State Council pointed out that the current development of the retail industry presents many highlights and hotspots, including the exploration of warehouse stores [5]. With the support of policy conditions, the warehousing and logistics industry in the region has developed rapidly. By 2022, the warehousing supermarket industry in Liaoning Province has achieved full coverage of regional cities. In recent years, the warehouse supermarket industry has developed rapidly, and the systematic study of its development process is urgent. Studying the spatial-temporal evolution pattern of warehouse supermarkets and its influencing factors is of great significance for optimizing the urban shopping system [6], rational use of land resources [7] and rational development of the urban economy [8].



(**a**) (**b**)

Figure 1. (**a**) Position of Liaoning Province in China. (**b**) Main external routes of ports in Liaoning Province.

Liaoning Province has certain advantages in terms of geographical environmental conditions, and under the support of relevant policies, the development of the warehousing supermarket industry has made certain progress in recent years. At the same time of industrial development, there is a gap in the corresponding academic research. After evaluating the previous studies, we found that, in terms of the selection of the research scope, there are few studies taking Northeast China as the research area and for Liaoning Province, the relevant research in this field is almost blank. Therefore, this study will select Liaoning Province, China, as the research scope, in order to supplement the relevant research in this field.

Based on the above, this study takes the existing warehouse supermarket industry in Liaoning Province of China as the main research object and analyzes its spatial-temporal evolution pattern and influencing factors from multiple perspectives in order to enrich the research results in relevant fields and provide a decision-making basis for the development of the future and existing warehouse supermarket industry.

The choice of supermarket location is an important attribute of its attractiveness to consumers [9–11]. The existing research shows that the emergence of new retail forms such as warehouse supermarkets has changed the shortcomings of traditional supermarkets that lack vitality and have a single model [12]. Although there are many factors affecting the business status of the supermarket industry, most of them can be improved by scientific management [13]. Once the location of the supermarket is determined, it will not change

and will have a far-reaching impact on the subsequent operation [14]. Therefore, the location selection of warehouse supermarkets is particularly important.

When studying the spatial-temporal evolution pattern of the warehouse supermarket industry, we also take its location information as the research base point and carry out in-depth research on the basis of location research.

The location research method was first mentioned in the central location theory [15]. In recent years, scholars have studied the development of supermarkets through a variety of mathematical models and methods to refine the operation types of supermarkets, among which there is little research on warehousing supermarkets. In the selection of research objects, there are few regional spatial-temporal evolution pattern analyses based on warehouse supermarkets. The existing research is limited to the location selection of food stores and food service sites [16], the space-time characteristics and influencing factors of large commercial outlets [17], the location analysis of retail stores [18], the study of supermarket location evolution based on consumer convenience [19] and the spatial evolution process and mechanism of large supermarkets [20].

In terms of time scale, the number of research articles on the warehouse supermarket industry has been small in recent years. Liu et al. [21,22] studied the spatial design and architectural design of large warehouse supermarkets and mentioned the orientation of the location selection of warehouse supermarkets, but lacked a systematic analysis of the space-time evolution pattern. Chen, Yu [23,24] and others discussed the countermeasures for the development of warehouse supermarkets in China and their implications for the retail industry and mentioned the importance of studying its spatial-temporal evolution pattern, but its publication date is the beginning of the twenty-first century. Compared with the current industry development trend, the information and other data need to be further updated. There has been a certain gap in the research in this field, while the number of physical stores in Chinese warehouse supermarkets has been increasing during this period, and there is a certain decoupling between industrial development and academic research.

In terms of the selection of influencing factors, Li [25] defined the index system of influencing factors of large-scale supermarkets as consisting of four parts: population, terrain, region and transportation. Lu [26] proposed market factors, business circles, economic factors, etc., in the evaluation system of the evolution pattern of large-scale comprehensive supermarkets. Qin [27] believes that the relevant indicators for the location of large chain supermarkets include terrain, population, urban facilities, traffic environment, etc. Based on the predecessors' selection of the influencing factors of the spatial and temporal evolution pattern of large supermarkets, this paper synthesizes the previous indicator system and selects the impact of traffic conditions, economic conditions, population conditions, urban functional areas, and policy conditions and the government's leading role in the selection of the influencing factors of the spatial and temporal evolution pattern of warehouse supermarkets in Liaoning Province.

On the scale of research, scholars mostly focus on the regional development of a city, and there is less systematic research on a province. Shi, Lu [28–30] and others studied the location of large-scale supermarkets in Shanghai; Xie [31] studied the location of large supermarkets in Xi'an. This study expanded the selection of research objects and comprehensively investigated the space-time evolution of warehouse supermarkets in provinces. In terms of the choice of regions, there are few studies taking Northeast China as the research area. For Liaoning Province, the relevant research in this field is almost blank.

Based on the above, this study takes Liaoning Province of China as the research area and the existing warehouse supermarket as the research object and uses spatial autocorrelation analysis, nuclear density analysis, composite correlation coefficient analysis and other methods to study its space-time evolution pattern and influencing factors. The innovation of the article lies in filling the gap in this research field; the research object is defined as all warehousing supermarkets in Liaoning Province, and its general rules are studied in order to provide local theoretical support for the "warehousing" of Chinese supermarkets and fill the gap between theoretical research and industrial development.

To sum up, the structure of the article is as follows: It is divided into five parts. The first part emphasizes the advantages of the selected research area and summarizes the existing literature in this field, thus leading to the main research content and purpose of this paper; it points out the current gaps in this field, expounds the selection principles of the influencing factors on this basis and summarizes the innovation of this paper. In the second part, the research methods and data sources of this paper are described in detail. The third part studies and analyzes the spatial-temporal evolution pattern and its influencing factors of the existing warehouse supermarkets in Liaoning Province, China. The fourth part discusses the research content of this paper. The fifth part summarizes the research results.

2. Research Methods and Data Sources

2.1. Overview of the Study Area

Liaoning Province is located in the south of Northeast China, between 38°43′ and 43°26′ north latitude and 118°53′ and 125°46′ east longitude. It borders the Yellow Sea and the Bohai Sea in the south, Hebei in the southwest, Inner Mongolia in the northwest, Jilin in the northeast, and Korea across the river by using the Yalu River inside the southeast. It covers a total area of 1.48×10^5 square kilometers and governs 14 prefecture level cities.

2.2. Data Sources

Taking Liaoning Province as the research scope, we selected "warehouse supermarket" as the key word through Baidu Map API platform to obtain the coordinated position of relevant supermarkets.

The location of the warehouse supermarket is recognized through multi-dimensional information such as the province (city, county, etc.), zip code, administrative division code and name where the warehouse supermarket is located. The longitude and latitude coordinates of the warehouse supermarket are obtained with the assist of the Baidu Map API interface coordinate picking system, and then the regional vector map of Liaoning Province is used to match it. Then, Arcgis10.6 and GeoDa are used for visual display. The regional attribute data involved in this paper are from the Liaoning Statistical Yearbook, China Urban Statistical Yearbook, China County Statistical Yearbook, China Urban Construction Statistical Yearbook, China Regional Economic Statistical Yearbook, relevant regional statistical yearbooks and county national economic and social development statistical bulletins in 2017–2022, and the map data are from the National Geographic Information Center.

2.3. Framework and Use of Research Methods

The research technology roadmap adopted in this paper is as follows (Figure 2).

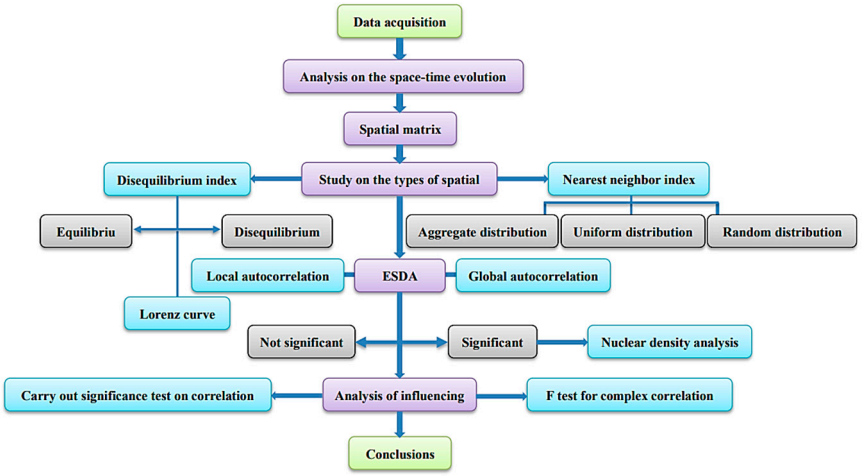


Figure 2. The framework diagram of research methods using spatial econometric model in this paper.

2.3.1. Nearest Neighbor Index

The nearest neighbor index method is used to measure the spatial distribution pattern of warehousing supermarkets in Liaoning Province [32]. The nearest neighbor index is the ratio of the actual the nearest neighbor average distance (D_N) of the point elements in the study area to the theoretical average distance (D_R) under the random distribution mode, which is used to measure the spatial distribution mode of point things. The calculation formula is as follows:

$$NNI = D_N / D_R = \left(\frac{1}{n} \sum_{i=1}^{n} d_i \right) / \left(\frac{1}{2} \sqrt{A/N} \right) \quad (1)$$

In the formula, *NNI* is the nearest neighbor index; d_i is the distance between the *i*-th warehouse supermarket and its nearest warehouse supermarket; *A* is the area of the study area; *N* is the number of warehouse supermarkets in the study area. The statistical significance of the calculation results is checked by the *Z*-test method. If *NNI = 1*, it means that warehousing supermarkets in Liaoning Province are randomly distributed; If *NNI < 1*, it means that warehousing supermarkets in Liaoning Province are clustered; If *NNI > 1*, it means that warehousing supermarkets in Liaoning Province are evenly distributed.

2.3.2. Disequilibrium Index

The disequilibrium index, as an indicator reflecting the distribution of warehousing supermarkets in cities in Liaoning Province [33], ranges from 0 to 1. The larger the index value, the more unbalanced the distribution of warehousing supermarkets in Liaoning Province. The calculation formula is as follows:

$$G = \frac{\sum_{i=1}^{n} Y_i - 50(n+1)}{100 \times n - 50(n+1)} \quad (2)$$

In the formula, *G* is the imbalance index; *N* is the number of cities in Liaoning Province; Y_i is the cumulative percentage of the *i*-th place in the order of the ratio of the number of warehouse supermarkets to the total number in each city from the largest to the smallest.

2.3.3. Exploratory Spatial Data Analysis

Exploratory spatial data analysis method includes global and local autocorrelation analysis. Global autocorrelation analysis is used to study the spatial distribution correlation of warehousing supermarkets in Liaoning Province [34,35], that is, the spatial dependence and heterogeneity of warehousing supermarkets in urban areas. The formula is as follows:

$$Moran's\ I = \frac{\sum_{i=1}^{n} \sum_{j=1}^{n} W_{ij} (Y_i - \overline{Y}) (Y_j - \overline{Y})}{S^2 \sum_{i=1}^{n} \sum_{j=1}^{n} W_{ij}} \quad (3)$$

In the following formula:

$$S^2 = \frac{1}{n} \sum_{i=1}^{n} (Y_i - \overline{Y}) \overline{Y} = \frac{1}{n} \sum_{i=1}^{n} Y_i, \quad (4)$$

n is the total number of warehouse supermarkets in the study area, Y_i is the observation value of the *i*-th city, W_{ij} is the spatial weight matrix and *i*, *j* are cities *i* and *j*. The value range of *Moran's I* is [−1,1]. The larger the value is, the stronger the correlation of the spatial distribution of elements will be.

In this paper, when *Moran's I* > 0, it means that the regions with similar development levels of warehouse supermarkets in Liaoning Province tend to gather together. If *Moran's*

$I < 0$, it means that the regions with high and low development levels of warehouse supermarkets in Liaoning Province exist in the same region, with large spatial differences. If *Moran's I* = 0, it means that there is no spatial dependence between regions.

Local autocorrelation analysis is used to investigate the refined characteristics of the spatial distribution of warehousing supermarkets in Liaoning Province, that is, to refine the local characteristics and changes of the evaluation space. This paper uses Moran scatter plot. The scatter plot is split into four quadrants. The first quadrant is High-High Agglomeration (*HH*), which indicates that the development level of warehouse supermarkets in the region itself and surrounding areas is relatively high. The second quadrant is Low-High Agglomeration (*LH*), which indicates that the areas with low development level of warehouse supermarkets are surrounded by the surrounding areas with high development level of warehouse supermarkets. The third quadrant is Low-Low Agglomeration (*LL*). The development level of warehouse supermarkets in the region itself and surrounding areas is low. The fourth quadrant is High-Low Agglomeration (*HL*). Areas with high development level of warehouse supermarkets are surrounded by areas with low development level of surrounding warehouse supermarkets. The first and third quadrants are typical areas, and the second and fourth quadrants are atypical areas (spatial outliers).

2.3.4. Nuclear Density Analysis

The kernel density estimation method is a non-parametric estimation method to analyze the density of geographical elements within the surrounding range, which can comprehensively reflect the density attribute of warehouse supermarkets in Liaoning Province. It is used to reflect the dispersion or agglomeration characteristics of warehouse supermarkets in Liaoning Province in space [36]:

$$f_h(x) = \frac{1}{nh} \sum_{i=1}^{n} \left(\frac{x - x_i}{h} \right) \tag{5}$$

In the formula, $f_h(x)$ is the kernel function; $h > 0$ is broadband; $x - x_i$ represents the distance from the estimated value x to x_i. The larger the $f_h(x)$ value is, the denser the point distribution will be.

2.3.5. Complex Correlation Coefficient

The multiple correlation coefficient is used to study the connection between the quantity distribution of warehouse supermarkets and multivariable in cities of Liaoning Province. The complex correlation coefficient is acquired from the single correlation coefficient and partial correlation coefficient [37].

Single correlation coefficient: for two elements x and y, if their sample values are x_i and y_i ($i = 1, 2, \ldots, n$), respectively; the correlation coefficient between them is defined as:

$$r_{xy} = \frac{\sum_{i=1}^{n} (x_i - \overline{x})(y_i - \overline{y})}{\sqrt{\sum_{i=1}^{n} (x_i - \overline{x})^2} - \sqrt{\sum_{i=1}^{n} (y_i - \overline{y})^2}} \tag{6}$$

The value of r_{xy} is between $[-1,1]$ and $r_{xy} > 0$, indicating positive correlation, that is, the two elements are related in the same direction; $r_{xy} < 0$ indicates negative correlation, that is, the two elements are oppositely correlated. The closer the absolute value of r_{xy} is to 1, the closer the relationship between the two elements will be.

Partial correlation coefficient: if there are three elements x_1, x_2 and x_3, there are three primary partial correlation coefficients between them, which are $r_{12 \cdot 3}$, $r_{13 \cdot 2}$ and $r_{23 \cdot 1}$, respectively. The three first-order partial correlation coefficients can be calculated from the

single correlation coefficient. The calculation formula is as follows (only one coefficient is listed in this paper, and the other two coefficients are calculated in the same way):

$$r_{12\cdot3} = \frac{r_{12} - r_{13}r_{23}}{\sqrt{(1 - {r_{13}}^2)(1 - {r_{23}}^2)}} \tag{7}$$

Let y be the dependent variable and $x_1, x_2, \ldots, x_k$ be the independent variable, then the complex correlation coefficient between y and $x_1, x_2, \ldots, x_k$ is recorded as. $R_{y\cdot12\ldots k}$, the calculation formula is as follows:

$$R_{y\cdot12\ldots k} = \sqrt{1 - (1 - {r_{y1}}^2)(1 - {r_{y2\cdot1}}^2)\ldots\left[1 - {r_{yk\cdot12\ldots(k-1)}}^2\right]} \tag{8}$$

In this paper, y represents the development level of warehousing supermarkets in Liaoning Province, and $x_1, x_2, \ldots, x_k$ represent the influencing factors that affect the number of warehousing supermarkets in Liaoning Province.

In order to ensure the accuracy of the results, the significance test and F-test method are adopted for the multiple correlation coefficient. The statistical calculation formula is as follows:

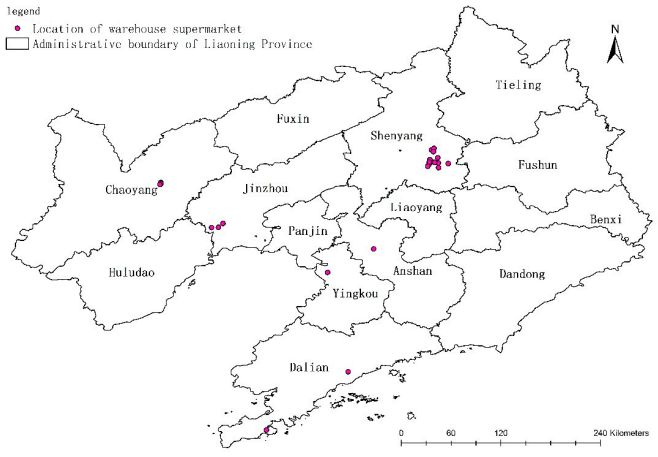
$$F = \frac{{R_{y\cdot12\ldots k}}^2}{1 - {R_{y\cdot12\ldots k}}^2} \times \frac{n - k - 1}{k} \tag{9}$$

3. Spatial-Temporal Evolution Pattern and Influencing Factors of Warehouse Supermarkets in Liaoning Province

3.1. Analysis of Space-Time Distribution Characteristics

3.1.1. Temporal and Spatial Evolution Characteristics and Attention

The number change of warehousing supermarkets in Liaoning Province from 2018 to 2022 is determined by using the information of Tianyan Search based on the registration time of enterprises (Figure 3) and visualized with Baidu map coordinate picking tool. It can be seen from the distribution of warehousing supermarkets in the figure that warehousing supermarkets in Liaoning Province are mainly concentrated in counties and surrounding areas with Shenyang and Dalian as the core cities.



(**a**)

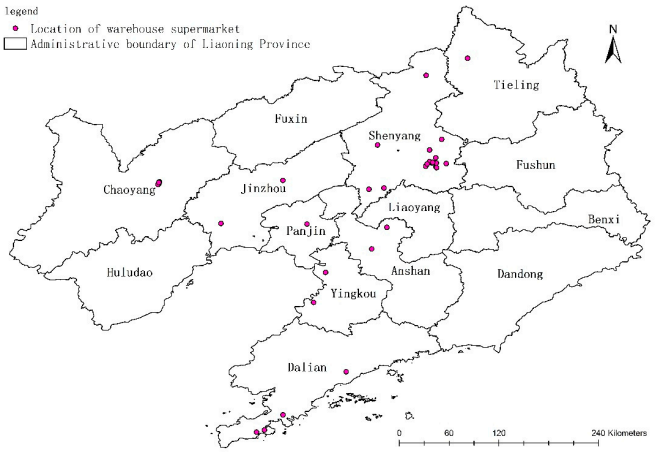


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Figure 3. *Cont.*

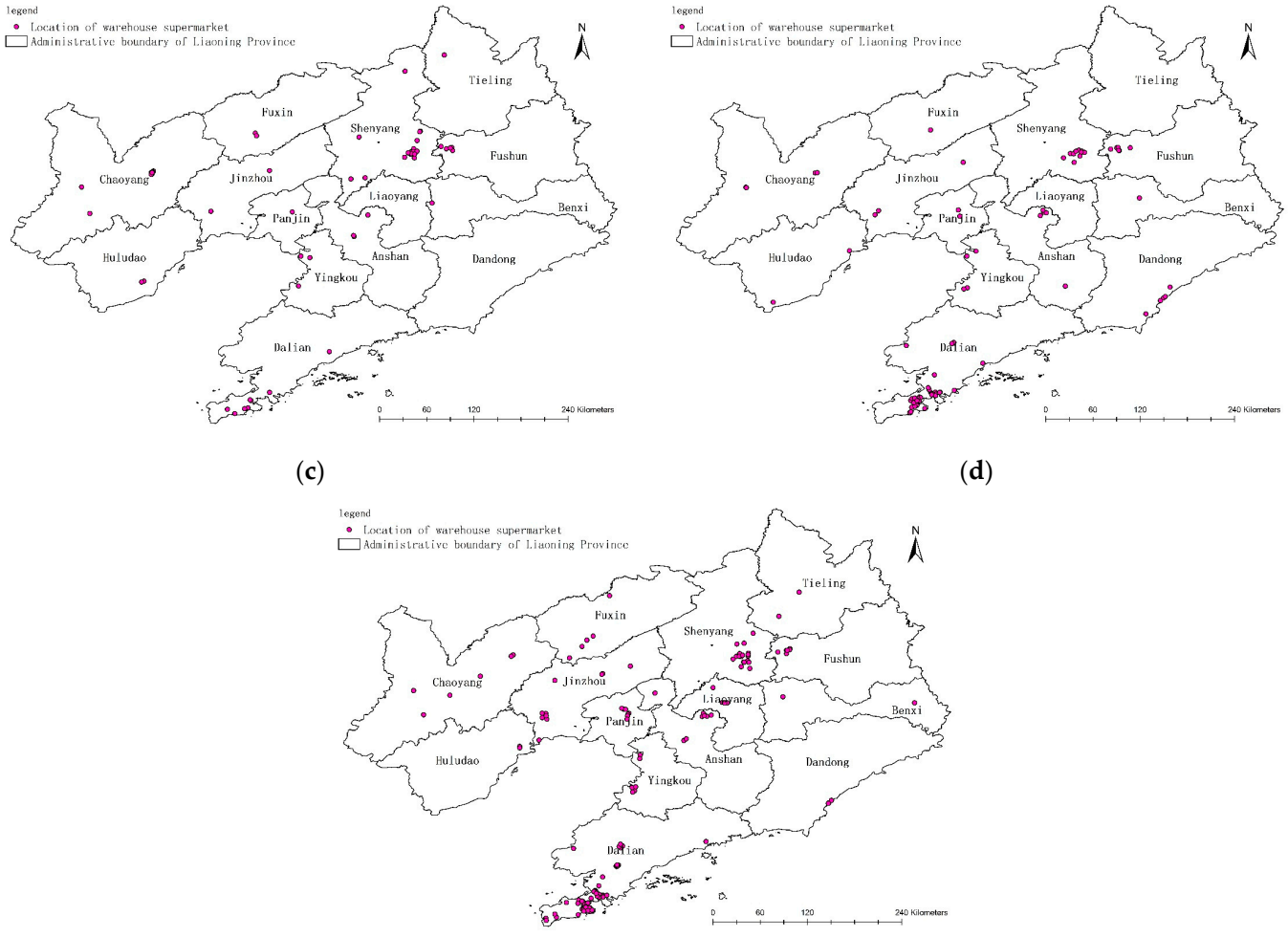

Figure 3. Dynamic changes in the number of warehousing supermarkets in Liaoning Province from 2018 to 2022. (**a**) Data for 2018; (**b**) data for 2019; (**c**) data for 2020; (**d**) data for 2021; (**e**) data for 2022.

In order to reflect consumers' concern about the operation mode of warehouse supermarkets in 2018–2022, the Baidu Index has been introduced as an indicator to reflect consumers' concerns. Through Baidu's term search, the relevant term data of the warehouse supermarket were not included, which indicates that the warehouse supermarket format is a new thing developed in recent years, and its relevant data are not perfect. Intercept the daily average search value of "warehousing" in Liaoning Province from 2018 to 2022 and compare it with the change trend of the number of warehousing supermarkets in Liaoning Province (Figure 4a). It can be seen that since 2019, consumers in Liaoning Province have paid more attention to the word "warehousing" year by year, and the changing trend of warehousing supermarkets in Liaoning Province is consistent with it. On this basis, the TGL index, namely the target group index, is introduced to reflect the strength or weakness of the group within a specific research scope (Figure 4b). It can be seen from the data in the figure that the 20–29-year-old group has a strong position in the search groups of the two terms, that is, the 20–29-year-old group is the main group focusing on "warehousing" and "large supermarket".

(**a**) (**b**)

Figure 4. Trend chart of daily average search value and TGL index of relevant terms from 2018 to 2022. (**a**) The daily average search value of relevant terms in 2018–2022. (**b**) The trend chart of TGL index from 2018 to 2022.

3.1.2. Characteristics of Spatial Distribution Type

Visualize the spatial location of warehouse supermarkets in Liaoning Province (Figure 5) and analyze the differences according to the geographical conditions of cities in Liaoning Province. According to the traditional geographical division, this paper stipulates that 14 cities in Liaoning Province are divided into four parts: western Liaoning (Jinzhou, Fuxin, Chaoyang, Huludao, Panjin), southern Liaoning (Dalian, Anshan, Yingkou, Liaoyang), northern Liaoning (Shenyang, Fushun, Tieling) and eastern Liaoning (Dandong, Benxi). Subsequent research will also be based on this division. Count the number of warehouse supermarkets in the four cities and calculate the percentage (Table 1). It can be seen from Table 1 and Figure 5 that warehousing supermarkets in Liaoning Province are unevenly distributed in the four regions and show the characteristics of centralized distribution and uneven spatial distribution in some cities. Among them, the number of warehousing supermarkets in southern Liaoning accounted for the largest proportion, reaching 57%, while that in eastern Liaoning accounted for the smallest, accounting for only 3%.

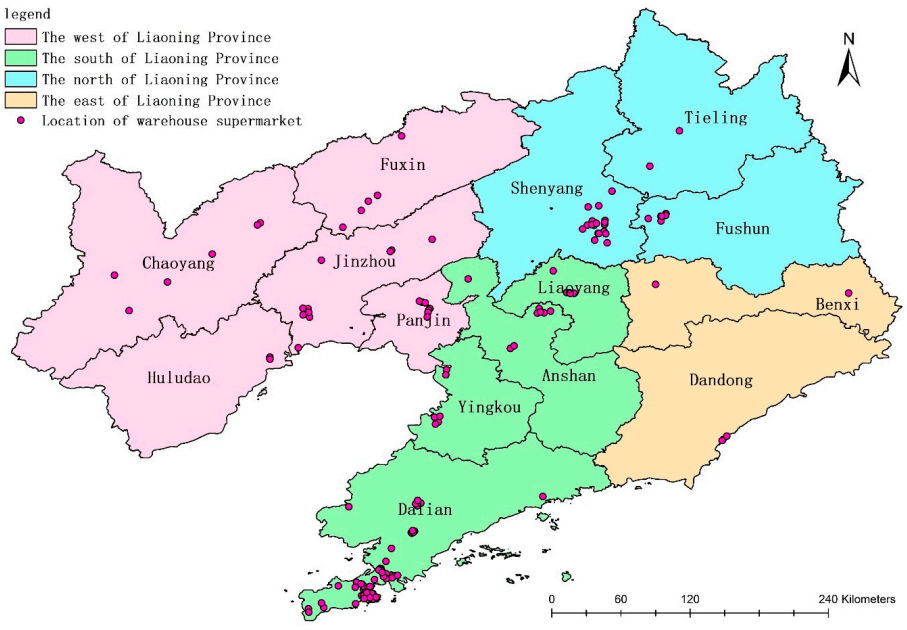

Figure 5. Location Distribution of Warehousing Supermarkets in Liaoning Province.

Table 1. Statistics of Regional Proportion of Warehouse Supermarkets in Liaoning Province.

Region	Number of Supermarkets	Proportion
The west of Liaoning Province	30	20%
The south of Liaoning Province	85	58%
The north of Liaoning Province	28	19%
The east of Liaoning Province	5	3%

In order to more clearly explain the spatial distribution type of warehousing supermarkets in Liaoning Province, the nearest neighbor index *NNI* is introduced. Through calculation, the average observation distance is 6.7 km, and the expected average distance is 16.2 km. The actual average observation nearest neighbor distance is smaller than the expected nearest neighbor distance. The nearest neighbor index is calculated to be 0.414, that is, $NNI < 1$. To sum up, the results show that warehousing supermarkets in Liaoning Province are clustered in spatial distribution.

According to Formula (2), the unbalance index of warehouse supermarkets in Liaoning Province is calculated as G = 0.602, which is large and shows a significant imbalance in spatial distribution. In order to better explain its imbalance, this paper has drawn the Lorenz curve of warehousing supermarkets in cities of Liaoning Province (Figure 6). The Lorenz curve shows a downward trend, which further shows that the spatial distribution is uneven, that is, the regional concentration of warehousing supermarkets in Liaoning Province is relatively high.

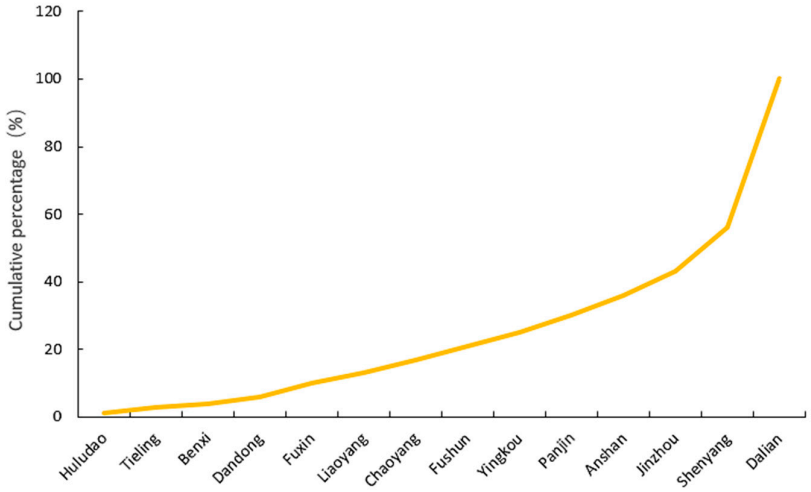

Figure 6. Lorentz Curve of the Spatial Distribution of the Number of Warehouse Supermarkets in Cities of Liaoning Province.

3.1.3. Spatial Autocorrelation Analysis

Exploratory spatial data analysis (ESDA), including global and local autocorrelation analysis, is used to process the data. Global autocorrelation analysis using Moran's I index, Combining Equations (3) and (4), Table 2 is obtained, and the results pass the significance test. The results in the analysis Table 2 show that the regions with similar development level of warehouse supermarkets in Liaoning Province tend to gather together, and the spatial distribution is highly related. (Notes: When the confidence level is 95%, the critical value of p value is 0.05; when the confidence level is 95%, the critical value of Z score is 1.96.)

Table 2. Global Autocorrelation Analysis Data of Warehouse Supermarkets in Liaoning Province.

Indicators	Results
Moran's I index	0.9748
p	0.0206 < 0.05
Z	2.3156 > 1.96
degree of confidence	95%

Further local autocorrelation analysis was carried out to obtain a scatter map (Figure 7) and a Moran local autocorrelation analysis map of the Liaoning warehousing supermarket (Figure 8). According to the Moran scatter chart, the distribution points of warehousing supermarkets in Liaoning Province are roughly positively correlated, that is, the spatial layout characteristics of warehousing supermarkets in Liaoning Province tend to be High-High concentration (HH) and Low-Low concentration (LL). According to the local autocorrelation analysis chart, the regional characteristics of each city can be further refined. Chaoyang City and Anshan City belong to Low-Low Agglomeration (LL), Jinzhou City, Shenyang City, Panjin City and Yingkou City belong to High-High Agglomeration (HH), Dalian City belongs to High-Low Agglomeration (HL), and the local spatial characteristics of other cities are not significant.

On the whole, the spatial distribution of warehousing supermarkets in Liaoning Province shows the characteristics of "high development level in individual cities, low development in most cities". Among the 14 cities in Liaoning Province, 9 cities have low concentration characteristics or local spatial characteristics are not significant. At present, the development level of warehousing supermarkets in Liaoning Province is generally low, and the number of cities with better development is small, with huge development potential.

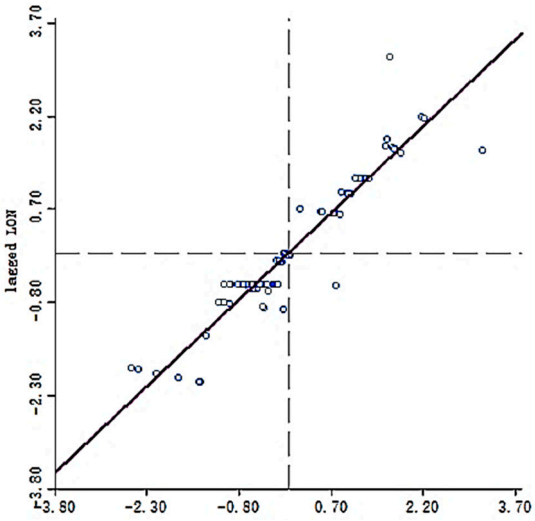

Figure 7. Moran Scatter Map of Warehouse Supermarkets in Liaoning Province.

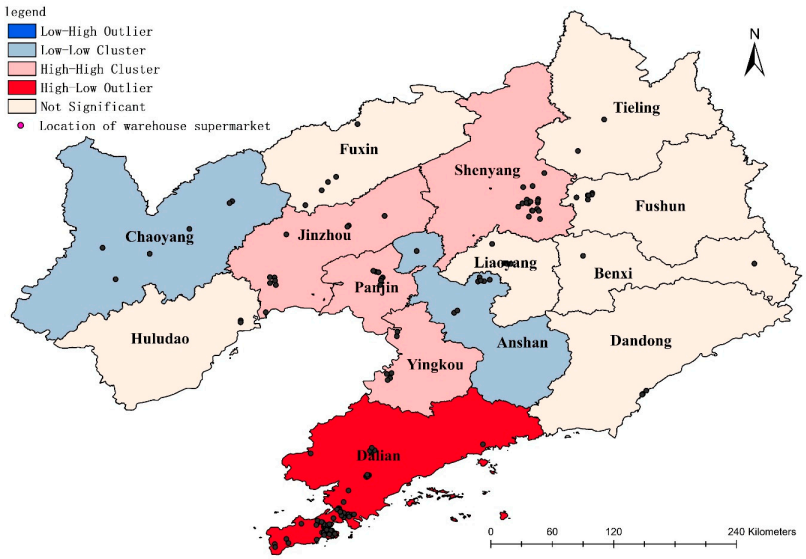

Figure 8. Local autocorrelation analysis of warehousing supermarkets in Liaoning Province.

3.1.4. Spatial Distribution Density Characteristics

From the distribution of supermarket locations, the spatial distribution of warehousing supermarkets in Liaoning Province is quite different. Supermarkets are mainly distributed in Shenyang, Dalian and their surrounding cities. There are 85 warehouse supermarkets in Shenyang and Dalian, accounting for 57.4% of the total in Liaoning Province. There is a significant difference between cities.

In order to more clearly and intuitively reflect the spatial distribution pattern of warehousing supermarkets in Liaoning Province and the nuclear density characteristics of each urban area, the nuclear density map of warehousing supermarkets in Liaoning Province is drawn based on the calculation results of Formula (5) (Figure 9). The warehousing supermarkets in Liaoning Province are mainly distributed in the urban areas of Shenyang and Dalian and their surrounding counties and spread to the surrounding areas with Shenyang and Dalian as the core. The regions with large nuclear density values are roughly distributed along the Shenyang-Dalian line. The core urban area of Dalian and its surrounding counties have the highest nuclear density values, which can reach 6.406~13.727/km^2. The core urban area of Shenyang and its surrounding counties have higher nuclear density values, which can reach 2.584~6.406/km^2. The distribution of warehouse supermarkets in these two urban areas is relatively concentrated, and the central cities are relatively significant. Most areas of Jinzhou City, Fuxin City, Panjin City, Yingkou City, Anshan City, Liaoyang City and Fushun City, as well as small parts of Benxi City and Dandong City, can have a nuclear density value of 0.646~2.584 pieces/km^2, while the nuclear density value of other areas is only 0~0.646 pieces/km^2. The development of warehousing supermarkets in Liaoning Province is characterized by "core cities driving surrounding areas", which is highly consistent with the Lorentz curve results and spatial autocorrelation results: the overall distribution is uneven, and the regional concentration is high. Notwithstanding the low core densities of the metropolitan area with Benxi City as its center and its surrounding counties, the warehouse supermarket has enormous expansion potential because of its favorable regional location. Due to their proximity to the Chinese-North Korean border, the central business district of Dandong City and the surrounding counties have clear advantages in international trade and have significant development potential.

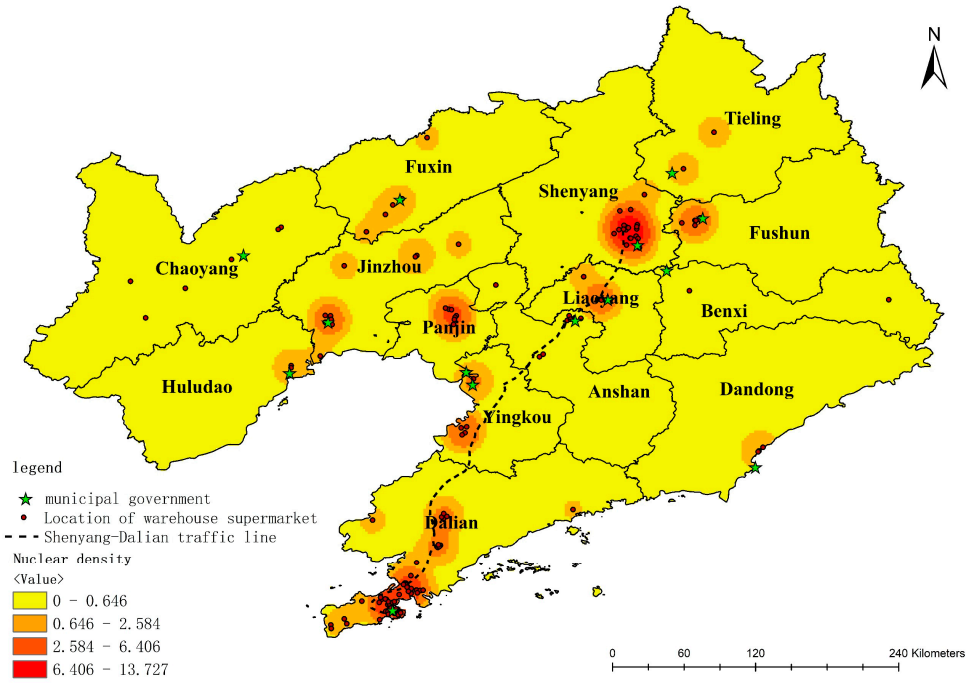

Figure 9. Number Distribution and Nuclear Density of Warehouse Supermarkets in Liaoning Province.

3.2. Study on Influencing Factors

The location selection of warehouse supermarkets belongs to the field of micro location theory [38], and the selection of influencing factors can be started by traffic factors, economic factors and location environmental factors [39]. Therefore, relevant indicators of regional highways and railways in Liaoning Province are selected to reflect the impact of regional traffic conditions on the development of warehouse supermarkets. The level of regional economic development will undoubtedly have an impact on how retail enterprises develop. Since regional GDP data are often suitable for business environment analysis at a macro scale, two indicators, regional GDP and per capita wage level, are specified to characterize the purchasing power of consumers in the region [40]. A certain scale of population is a condition that must be considered in the selection of commercial locations. Population quantity and population density are considered one of the factors affecting the spatial and temporal distribution of regional warehouse supermarkets. The quantity of urban functional areas reflects the city's overall development strategy and planning. The basis of commercial development of cities with different emphasis will also be different. In addition, as a new form of supermarket business, the development of warehouse supermarkets cannot be separated from national policy support and the regional driving role of the government.

3.2.1. Traffic Location Conditions

The traffic line serves as a connection between the cities and has a significant impact on logistical transportation. The commodity structure of warehouse supermarkets is comprehensive, and most of them adopt the form of large packaging and bulk sales to achieve low-priority sales [41]. Most of the sites are located in developed logistics areas, with convenient location conditions. The development of warehouse supermarkets is heavily dependent on traffic location, because it is a novel retail format that depends on the effectiveness of logistics and transportation as well as the convenience provided by location. Based on the relevant data of roads and railways in Liaoning Province (Figure 10a), it can be seen from the location distribution map of warehouse supermarkets in Liaoning Province that almost all warehouse supermarkets are located on both sides of the road, and most of them are located near traffic nodes such as intersections. For example, Dalian Aiyite Warehouse Supermarket is close to Shen Hai Expressway, and Shenyang Wenming Jiajiale Supermarket is near Danfu Expressway.

The 10 km highway buffer zone in Liaoning Province (Figure 10b), 5 km highway buffer zone in Liaoning Province (Figure 10c) and the 10 km railway buffer zone in Liaoning Province (Figure 10d) are established, respectively. The results demonstrate the importance of the distribution characteristics of warehousing supermarkets along the highway in Liaoning Province. There are 135 warehousing supermarkets in the 10 km buffer zone of the highway, accounting for 91.2% of the total. In order to further explain the remarkable characteristics of the distribution of warehousing supermarkets along the highway, a 5 km highway buffer zone was established again. After the buffer zone was narrowed, 110 warehousing supermarkets were distributed in the buffer zone, accounting for 74.3% of the total. In the 10 km buffer zone of the railway in Liaoning Province, the distribution of warehousing supermarkets in Liaoning Province along the railway is also significant. There are 133 warehousing supermarkets in the 10 km buffer zone of the railway, accounting for 89.9% of the total.

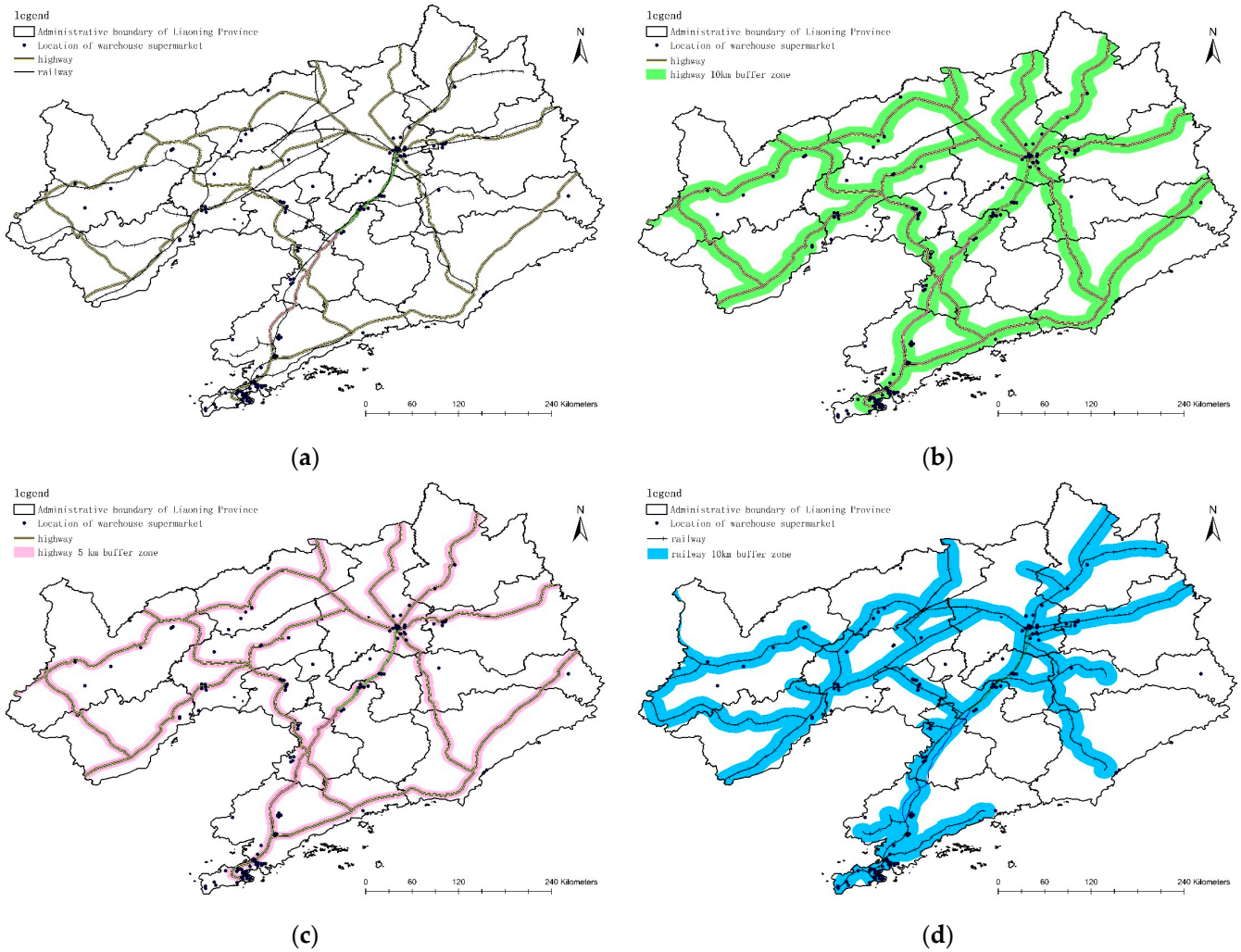

Figure 10. Schematic Diagram of Highway and Railway Distribution, and Buffer Zone in Liaoning Province. (**a**) Main traffic routes in Liaoning Province. (**b**) The 10 km highway buffer zone in Liaoning Province. (**c**) The 5 km highway buffer zone in Liaoning Province. (**d**) The 10 km railway buffer zone in Liaoning Province.

3.2.2. Economic Conditions

The economy is the material basis of human society and the vital circumstance for building human society and maintaining social development. In terms of society, the level of urban development is determined by the regional economic status. For individuals, economic conditions can be reflected by per capita wages and per capita purchasing power. The purchasing power of consumers for goods is largely restricted by the economic level, while the purchasing power of consumers affects the number of warehouse supermarkets [42]. From the perspective of urban GDP and per capita wage, this paper studies the restriction of economic conditions on the development of warehouse supermarkets. In this paper, the economic condition indicators from the research data are expressed by GDP and per capita wage level.

Gross Domestic Product (GDP for short) is the final outcome of the production activities of all permanent residents of a country (or region) in a certain period. GDP is the core indicator of national economic accounting and also an important indicator to measure the economic situation and development level of a country or region. The per capita wage level is the per capita disposable income of residents. From the economic definition, the higher the wage level, the higher the residents' wage purchasing power.

Since 2018, the registered number of warehousing supermarkets in Liaoning Province has increased significantly, showing a "blowout" development trend. Therefore, the data of the past five years from 2018 to 2022 were selected for research to ensure the timeliness of research results. GDP indicators and per capita wage level indicators are the averages of the relevant data from 2018 to 2022 (the data in 2022 are approximately expressed according to the first half of the year). A total of 14 cities in Liaoning Province were selected as research objects (Table 3).

Table 3. Index Data of Cities in Liaoning Province from 2018 to 2022.

City	Number of Warehouse Supermarkets	Per Capita Disposable Income/Yuan	GDP/100 Million Yuan
Shenyang	20	50,566	6490.798
Dalian	65	50,531	7377.896
Anshan	9	37,980	1744.152
Fushun	6	37,512	908.764
Benxi	2	39,004	822.358
Dandong	3	34,804	803.708
Jinzhou	7	37,329	1123.982
Yingkou	6	42,300	1334.724
Fuxin	5	32,842	480.078
Liaoyang	5	36,485	831.626
Panjin	7	45,398	1251.856
Tieling	2	29,955	649.144
Chaoyang	6	30,041	851.986
Huludao	2	34,852	786.396

Taking the change of the number of warehouse supermarkets in cities of Liaoning Province as the dependent variable, two independent variables are selected as the influencing factors. Regulation x_1 represents the average level of per capita disposable income of each city from 2018 to 2022. Regulation A represents the average level of GDP of each city from 2018 to 2022. Regulation x_2 represents the average level of GDP of each city from 2018 to 2022. Calculate the single correlation coefficients r_{y1} and r_{y2} between dependent variable y and independent variables 1 and 2, and then calculate $r_{2\cdot1}$, The results were 0.676, 0.877 and 0.819, respectively, which all met the 0.01 significance level, indicating that the single correlation coefficient between the dependent variable and the two independent variables was significant. On this basis, the partial correlation coefficient $r_{y2\cdot1}$ is calculated, where n is the number of samples and k is the number of independent variables (Table 4). Fourteen for n and two for k in calculation.

Table 4. Statistics of Relevant Indicators.

Indicators	Numerical Value	Critical Value	Level of Significance α
r_{y1}	0.676	0.661	0.01
r_{y2}	0.877	0.661	0.01
$r_{2\cdot1}$	0.819	0.661	0.01
$r_{y2\cdot1}$	0.764		

Combining single correlation coefficient with partial correlation coefficient, the multiple correlation coefficient between the number change of warehousing supermarkets and economic level indicators in Liaoning Province is 0.8797. In order to ensure the accuracy of the data and determine the final significance, the final multiple correlation coefficient F was tested, and the calculated value was 18.8295. According to the F critical value table, $F_{0.01}$ is 7.206. Because $F >> F_{0.01}$, that is, the multiple correlation is significant at the confidence level $\alpha = 0.01$, the number of warehouse supermarkets in Liaoning Province changes significantly with the economic conditions, which is one of the important factors affecting the development of warehouse supermarkets in Liaoning Province.

3.2.3. Population Quantity and Density

Generally speaking, a region's ability to support various sizes is mainly depends on population density [43]. The greater the population density, the more requirements for the number of regional businesses. The population factor has a profound impact on the development of large supermarkets, which to a large extent determines the scientific and rational spatial distribution of large supermarkets [44]. By consulting the Liaoning Statistical Yearbook from 2018 to 2022, the population of each city in Liaoning Province will be counted, the average value will be taken, and the correlation analysis will be conducted with the number of warehousing supermarkets in Liaoning Province.

The population density of each city is calculated according to its area and population. The population density of Dalian and Shenyang is relatively high, reaching 717.97 people/km^2 in Dalian and 574.02 people/km^2 in Shenyang. The correlation analysis is conducted on the population density, population quantity and the quantity data of warehouse supermarkets to obtain the correlation table (Table 5). The correlation coefficient between the number of warehouse supermarkets and the population reached 0.844, and the correlation coefficient between the number of warehouse supermarkets and the population density reached 0.775, both reaching a significant level of 1%. This shows that the number of warehouse supermarkets in the city is positively correlated with the population density and population number. Large warehouse supermarkets have a strong population dependence, and their outlets are set mainly according to the population number and density of the residential area [45], showing a strong consistency in the spatial pattern. (Remarks: ***, **, * represent the significance level of 1%, 5% and 10%, respectively.)

Table 5. Correlation between population and density and the number of warehouse supermarkets.

	Number of Population	**Population Density**	**the Number of Warehouse Supermarkets**
Number of population		0.892 (0.000 ***)	0.844 (0.000 ***)
Population density	0.892 (0.000 ***)		0.775 (0.001 ***)
the number of warehouse supermarkets	0.844 (0.000 ***)	0.775 (0.001 ***)	

Remarks: *** represent the significance level of 1%.

3.2.4. Regional Relevance of Urban Functions

Urban functional zoning refers to the part of urban land with different functions in a city. The functional areas interact with each other and are organically related, making the city a unified whole. Common functional areas include commercial area, residential area, scenic tourist area, cultural and educational area, comprehensive area, industrial area, etc. [46]. In order to further refine the relevance of urban functional areas for the development of warehouse supermarkets (hereinafter referred to as WS), 14 cities in Liaoning Province were selected as the detailed indicators representing the urban functional areas, including the number of colleges and universities (hereinafter referred to as C and U), the number of districts and counties (D and C), the number of A-level scenic spots (ASS), the number of streets, the number of urban commercial circles (UCC) and the number of urban districts (UD) (Table 6).

Among them, the number of colleges and universities, the number of urban districts, and the number of streets is derived from map data; the number of districts and counties, and the number of urban business circles are derived from the statistical data of the government websites of each city; and the relevant data of scenic spots are derived from the list of scenic spots of each city. Calculate the correlation to obtain the following table (Table 7).

Table 6. Index Data of Urban Functional Area.

Indicators / City	WS	UD	C and U	D and C	ASS	streets	UCC
Shenyang	20	4012	45	13	104	77	127
Dalian	65	2327	31	12	57	111	96
Anshan	9	812	9	7	52	38	32
Fushun	6	617	4	6	25	34	21
Benxi	2	379	2	6	29	25	8
Dandong	3	700	3	6	29	22	22
Jinzhou	7	1003	9	7	34	34	20
Yingkou	6	950	3	6	28	31	26
Fuxin	5	418	2	7	19	29	22
Liaoyang	5	512	3	7	17	24	10
Panjin	7	704	2	4	26	27	21
Tieling	2	682	4	7	16	13	26
Chaoyang	6	647	1	7	67	32	30
Huludao	2	672	2	6	23	35	19

Table 7. Correlation between detailed indicators of urban functional areas and the development of warehouse supermarkets.

Indicators	*p*	Significance Level	Related Coefficient
C and U	0.006	1%	0.697
D and C	0.003	1%	0.735
ASS	0.107		0.449
UCC	0.004	1%	0.718
streets	0.001	1%	0.937
UD	0.024	5%	0.599

Through data analysis, it can be seen that among the *p* values of the detailed indicators of urban functional areas, the *p* value of the number of A-level scenic spots is relatively large, reaching 0.107, and the correlation coefficient is only 0.449, which is relatively low. The number of colleges and universities, districts and counties, urban business circles and streets reached a significant level of 1%, with a correlation coefficient of 0.697–0.937, which is relatively high. The *p* value of the number of urban districts reached 0.024, meeting the 5% significance level, and the correlation coefficient was 0.599, with moderate correlation. Among the detailed indicators of urban functional areas, the number of streets has the highest correlation with the development of warehousing supermarkets, while the number of scenic spots has the lowest correlation with the development of warehousing supermarkets.

The number of Grade A scenic spots can approximately represent the regional tourism industry, which attracts a mostly mobile population and has little impact on the development of warehouse supermarkets. The number of streets and districts and counties can approximately represent the fixed resident population of the region, that is, the number of permanent residents in the region has a greater impact on the development of warehouse supermarkets. The number of colleges and universities can approximate the education level of the region, and the population in the college cluster area is mostly young people, which is the main force of consumption, consistent with the major groups that be aware of relevant terms mentioned above. The number of urban business circles can approximately represent the level of regional business development. Both of them have high correlation coefficients for the development of warehousing supermarkets, which are important factors affecting the number of regional warehousing supermarkets. On the whole, the development level of urban functional areas can have an impact on the development of warehousing supermarkets. The development of regional warehouse supermarkets is significantly influenced by a variety of factors, including the number of streets, districts and counties, the number of urban business circles and the number of colleges and universities.

3.2.5. Policy Conditions and Government Driving Role

The policy support of the state and local governments performs a critical position in guiding the transformation and development of the physical retail industry in Liaoning Province. In November 2016, the State Council issued the Opinions on Promoting the Innovation and Transformation of Physical Retailing [47], which pointed out that to extend and sink from the first tier and second tier cities to the third tier and fourth tier cities, it is essential to adjust the commodity structure and innovate the development mode.

As a result, the country's physical retail industry began to radically change and upgrade. Warehouse supermarket stores have a large business area and an extensive range of goods, which has emerged as the development direction of the physical retail industry. According to the Fourteenth Five Year Plan, China will develop a strong metropolitan area and a city circle in the future, and the functions of the central city will gradually spread to the surrounding suburbs. The location of most of the warehouses in the suburbs is highly compatible with them. With the improvement of income level and social development, the consumption concept of Chinese people has become more mature, paying more attention to high quality and high-cost performance. For the domestic market, prior to this, the warehousing retail format was almost blank. The current warehousing retail is expected to bring new vitality to the traditional retail industry in the context of favorable weather, favorable location and harmonious people.

The Fourteenth Five-Year Plan for National Economic and Social Development of the People's Republic of China and the Outline of Vision Goals for 2035 [48] mentioned that it is necessary to further promote the digital transformation of the service industry and cultivate new growth points such as smart logistics and new retail. With the support of policies, the number of warehouse supermarkets has increased extensively in recent years. The government is the main body of coverage formulation. Michael Porter believes that the role of the government is to create a suitable competitive environment for industrial development, enable the market to be in a lively competitive state, formulate competition norms and encourage innovation [49]. In order to study the impact of policy radiation on warehouse supermarkets in cities in Liaoning Province, the straight-line distance between the municipal governments of cities in Liaoning Province and the locations of warehouse supermarkets in cities is calculated, and the consequences are shown in Table 8. The distance in the table is the linear distance between the municipal government and supermarkets. In the cities of Liaoning Province, the linear distance between the municipal government and warehouse supermarkets in cities is 0.011 km at the nearest and 2.897 km at the farthest. The proportion of the number of warehouse supermarkets within a radius of 1 km is calculated by the city government as the center. Among them, Benxi City accounts for the lowest 50%, and 9 of the 14 cities in Liaoning Province account for 100%.

Table 8. Statistical Table of Distance between Warehouse Supermarkets and Municipal Government in Liaoning Province.

City	Nearest Distance/km	Maximum Distance/km	Proportion of Number/1 km
Shenyang	0.049	0.712	100.00%
Dalian	0.036	2.897	80.00%
Anshan	0.011	1.213	88.89%
Fushun	0.034	0.298	100.00%
Benxi	0.429	3.135	50.00%
Dandong	0.217	0.297	100.00%
Jinzhou	0.036	2.128	70.00%
Yingkou	0.006	0.720	100.00%
Fuxin	0.035	0.944	100.00%
Liaoyang	0.032	0.459	100.00%
Panjin	0.685	0.937	100.00%
Tieling	0.170	0.816	100.00%
Chaoyang	0.176	1.624	66.67%
Huludao	0.076	0.104	100.00%

4. Discussion

Taking Liaoning Province of China as the research area, this paper discusses the spatial and temporal evolution pattern of its existing warehouse supermarkets and its influencing factors. In order to enrich the research results in relevant fields and provide a decision-making basis for the optimal development of the warehousing form in China's supermarket industry, this paper discusses the obtained research data and conclusions combined with other literature achievements in this field.

From the perspective of temporal and spatial distribution, the warehousing supermarkets in Liaoning Province are clustered, with obvious core cities and large imbalances. When selecting the location of warehouse supermarkets, the core cities and the surrounding areas of the core cities have great development potential. With the continuous transformation and upgrading of the retail industry and the increasing acceptance of emerging supermarket formats, warehouse supermarket formats will spread from core cities to surrounding cities. Therefore, in the process of development, we should pay attention to the regional driving role of core cities and constantly shift the focus of development from the first and second tier cities to the third and fourth tier cities, to achieve the comprehensive optimization and coverage of regional emerging retail formats.

The areas with large nuclear densities of warehouse supermarkets in urban areas of Liaoning Province are roughly distributed by the Shenyang-Dalian line, and the cities along the line have great development potential. In order to promote the overall development of the province, the next step is to focus on Tieling and Anshan as the core urban areas and surrounding counties, to form a new pattern of warehouse supermarkets along the Shenyang-Dalian line.

From the perspective of influencing factors, the development of warehousing supermarkets in Liaoning Province is affected by many factors. It is mainly affected by traffic location, economic conditions, population size and density, number of urban functional areas and policy conditions. Therefore, when selecting the location of regional warehouse supermarkets, the areas with better traffic location, higher economic level and regional policy support are more competitive. The state places more emphasis on cultivating the endogenous power of economic growth in the context of the ongoing transformation and upgrading of the retail sector. It will progressively promote domestic consumption in the future and support and encourage the diversified development of retail formats, which also offers a good policy background for the warehousing supermarket industry.

5. Conclusions

Taking warehouse supermarkets in Liaoning Province as a sample, using Arcgis10.6, GeoDa, SPSS and other software, spatial autocorrelation analysis, kernel density analysis, composite correlation coefficient analysis and other methods, we analyzed the spatial-temporal evolution pattern of warehouse supermarkets and its influencing factors and obtained the following conclusions:

1. The spatial distribution of warehousing supermarkets in Liaoning Province is characterized by uneven distribution, which is concentrated in some cities. In terms of balanced distribution characteristics, the Lorentz curve shows a downward trend, indicating that the spatial imbalance of warehouse supermarkets is large, that is, the regional concentration of warehouse supermarkets is high.
2. Through global and local autocorrelation analysis, the regions with similar development levels of warehouse supermarkets in Liaoning Province tend to gather together, and the spatial distribution has a strong correlation. The partial refinement reflects the characteristics of "high development level of individual cities and low development level of most cities". Among the 14 cities in Liaoning Province, 9 cities show low concentrations or local spatial characteristics are not significant, accounting for 64.3%. At present, the development level of warehousing supermarkets in Liaoning Province is generally low, and the number of cities with better development is small, with huge development potential.

3. The distribution of warehousing supermarkets in Liaoning Province is affected by traffic location conditions, economic conditions, population quantity and population density, the number of urban functional areas, policy conditions and the role of the government. The vast majority of warehouse supermarkets are located near roads and railways. Population factors control the consumption development trend of the city and effectively guide the rational layout of various supermarkets. The well-developed transportation network provides a basis for the location and rational layout of supermarkets [50]. At the macro level, regional GDP, per capita wage level, population size and population density are important factors affecting the development of warehouse supermarkets. Warehouse supermarkets and city development are positively correlated, with the number of warehouse supermarkets increasing as the city's GDP, per capita wage, and population size and density increase. Refine the characteristics of the functional areas of the city. The development level of urban functional areas can have an impact on the development of warehouse supermarkets. Among them, the number of streets, districts and counties, the number of urban business circles, and the number of colleges and universities have a particularly obvious impact on the development of regional warehouse supermarkets.

In addition, the policy conditions and the government's leading role are also one of the important factors affecting warehouse supermarkets. With the promulgation of various documents on the development of the retail industry by the State Council and the Ministry of Commerce from 2016 to 2022, the number of warehouse supermarkets has grown rapidly in recent years with the support of the state for the transformation of the consumption mode of the retail industry. The vast majority of warehousing supermarkets in cities in Liaoning Province are located around the city government, and the regional driving role of the government has also promoted the development of urban warehousing supermarkets. In the post-epidemic era, the national epidemic prevention and control policy has been gradually relaxed, and various shopping places will be gradually opened to residents, which is undoubtedly good for the development of the emerging supermarket industry. Under this condition, China's warehouse supermarket industry will glow with new vitality and vitality.

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References

1. Rogers, D. Changes in North American supermarkets. *Retail Distrib. Manag.* **1984**, *12*, 19–23. [CrossRef]
2. Zheng, X.J. Analysis on the characteristics and problems of China's warehouse supermarket management. *J. Liaoning Univ. (Philos. Soc. Sci. Ed.)* **1999**, *5*, 26–27.
3. Cascio, W.F. Decency means more than "always low prices": A comparison of Costco to Wal-Mart's Sam's Club. *Acad. Manag. Perspect.* **2006**, *20*, 26–37. [CrossRef]
4. Li, L.G.; Zhang, P.Y.; Tan, J.T.; Guan, H.M. Analysis of the economic revitalization process of Liaoning's old industrial base from the perspective of regional economic elasticity. *Sci. Geogr. Sin.* **2019**, *39*, 116–124.
5. Improve the Quality, Efficiency and Growth of Retail Industry. Available online: http://www.gov.cn/xinwen/2021-12/26/content_5664621.htm (accessed on 12 December 2022).
6. Zhang, X.Y.; Wu, X.B. Research on the spatiotemporal evolution of shopping centers in Guangzhou and its impact on urban commercial spatial structure. *Sci. Geogr. Sin.* **2016**, *36*, 231–238.
7. Zhang, X.F. *Study on the Niche of Urban Large Retail Commercial Buildings*; Tongji University: Shanghai, China, 2007.
8. Goldman, A. The transfer of retail formats into developing economies: The example of China. *J. Retail.* **2001**, *77*, 221–242.
9. Baviera-Puig, A.; Buitrago-Vera, J.; Escriba-Perez, C. Geomarketing Models in Supermarket Location Strategies. *J. Bus. Econ. Manag.* **2017**, *17*, 1205–1221.
10. Alnahhal, M.; Noche, B. A genetic algorithm for supermarket location problem. *Assem. Autom.* **2015**, *35*, 122–127.
11. Ivan, I.; Mihai, F.C.; Despa, M. Suitable Location for A New Supermarket in Bucharest. In Proceedings of the 16th International Conference on Informatics in Economy (IE 2017): Education, Research and Business Technologies, Bucharest, Romania, 4–7 May 2017; pp. 244–246.
12. Tang, Y.F.; Zhang, Z.J.; Li, R.S.; Zhang, K.; Luo, J.W.; Cheng, Y. The location problem of multi-business combination in the new retail network. *Shandong Sci.* **2022**, *35*, 104–111.
13. Degeratu, A.M.; Rangaswamy, A.; Wu, J.N. Consumer choice behavior in online and traditional supermarkets: The effects of brand name, price, and other search attributes. *Int. J. Res. Mark.* **2000**, *17*, 55–78. [CrossRef]
14. Battini, D.; Faccio, M.; Persona, A.; Sgarbossa, F. "Supermarket warehouses": Stocking policies optimization in an assembly-to-order environment. *Int. J. Adv. Manuf. Technol.* **2010**, *50*, 775–788. [CrossRef]
15. Berry, B.J.L.; Garrison, W.L. A Note on Central Place Theory and the Range of a Good. *Econ. Geogr.* **1958**, *34*, 304–311. [CrossRef]
16. Morland, K.; Wing, S.; Roux, A.D.; Poole, C. Neighborhood characteristics associated with the location of food stores and food service places. *Am. J. Prev. Med.* **2002**, *22*, 23–29. [CrossRef] [PubMed]
17. Wang, S.J.; Hao, F.L.; Jiang, L.L. Locations and their determinants of large-scale commercial sites in Changchun, China. *Acta Geogr. Sin.* **2015**, *70*, 893–905.
18. Wang, F.H.; Chen, C.; Xiu, C.L.; Zhang, P.Y. Location analysis of retail stores in Changchun, China: A street centrality perspective. *CITIES* **2014**, *41*, 54–56. [CrossRef]
19. Fang, X. *Research on Supermarket Location Based on Consumer Convenience*; Zhejiang Gongshang University: Hangzhou, China, 2017.
20. Liu, R.; Hu, W.P.; Wang, H.L.; Wu, C.; He, J. Analysis of Road Network Evolution in Guangfo Metropolitan Area Based on Kernel Density Estimation. *Sci. Geogr. Sin.* **2011**, *31*, 81–86.
21. Liu, Y.J. *Space analysis of Large Storage Supermarket*; Southwest Jiaotong University: Chengdu, China, 2008.
22. Qin, Y.M. Thoughts on the Development of Warehousing Supermarkets in China. *Soc. Sci. Econ. Inf.* **2002**, *11*, 71–73.
23. Chen, J.; Chen, Q. An Analysis of the Competitiveness of Warehousing Supermarkets—Also on the Development Countermeasures of Warehousing Supermarkets in China. *Commer. Times* **2001**, *12*, 44–46.
24. Yu, K. The Enlightenment and Influence of Developing Warehouse Supermarket on China's Retail Industry. *J. Bus. Econ.* **2000**, *4*, 12–14.
25. Li, Y.Y. *Research on Location of Large and Medium Supermarkets Supported by GIS*; Huaqiao University: Fujian, China, 2009.
26. Lu, F.B. Construction of site selection evaluation system for large comprehensive supermarkets. *J. Shandong Inst. Commer. Technol.* **2006**, *4*, 17–20+26.
27. Qin, Q.X. Discussion on the business district analysis method of chain supermarket location. *Mark. Mod.* **2008**, *33*, 124–125.
28. Shi, Z.; Bai, G.R. An Analysis of the Spatial Location Selection of Shanghai Supermarkets. *Hum. Geogr.* **2003**, *4*, 89–92+31.
29. Lu, X.Y. *Research on Supermarket Location Evaluation Based on BP Neural Network*; Shanghai Jiao Tong University: Shanghai, China, 2008.
30. Shi, Y.S.; Wu, J.; Wang, S.Y. Spatio-temporal features and the dynamic mechanism of shopping center expansion in Shanghai. *Appl. Geogr.* **2015**, *65*, 93–108. [CrossRef]
31. Xie, S.M. *Study on the Index System of Location Selection for Large Chain Supermarkets*; Xi'an Polytechnic University: Xi'an, China, 2011.
32. Li, Q.; Wang, S.J.; Mei, L. Research on the Spatial Evolution Process and Mechanism of Large Supermarkets in the Central Urban Area of Changchun. *Sci. Geogr. Sin.* **2013**, *33*, 553–561.
33. Chen, Y.G. Intergroup imbalance index of spatial and scale distribution differences. *Acta Sci. Nat. Univ. Pekin.* **2019**, *55*, 1097–1102.
34. Sun, C.Z.; Wang, Z.Y.; Li, B.; Gai, M.; Ke, L.N. *Basic Theory and Empirical Research on The Sustainable Development of China's Marine Economy*; Science Press: Beijing, China, 2022; pp. 50–61.
35. Fang, Y.P.; Xie, M.; Zheng, X.Y. A Study on the Spatial and Temporal Evolution of China's Knowledge Intensive Service Industry Innovation Pattern—Based on Exploratory Spatial Data Analysis. *J. Cent. China Norm. Univ. (Nat. Sci.)* **2021**, *55*, 838–849.

36. Gao, C.X.; An, H.J.; Wang, Z.X.; Qiu, F. Research on the teaching method of building site survey based on GIS spatial data analysis. *China J. Multimed. Netw. Teach.* **2022**, *5*, 1–4.
37. Yang, Y. Evaluation and Analysis of Weighting Methods in Multi index Comprehensive Evaluation. *Stat. Decis.* **2006**, *13*, 17–19.
38. Yao, L.; Lu, J.; Zhang, W.K.; Jiang, H.X. Research progress of supermarket in urban spatial layout. *J. Hainan Norm. Univ. (Nat. Sci.)* **2011**, *24*, 343–347.
39. Song, Y.T. Analysis of the Internal Layout of Warehouse Supermarkets – Taking Metro Nanchang as an Example. *China Int. Bus.* **2017**, *8*, 35–36.
40. Wang, S.; Chen, Z.N.; Huang, F.F. Spatial Distribution of Guangzhou Chain Supermarkets and Its Influencing Factors. *Econ. Geogr.* **2015**, *35*, 85–93.
41. Tao, W.; Lin, M.H.; Liu, K.M. An Analysis of the Spatial Layout Pattern of Urban Large Chain Supermarkets—Taking Guangzhou "Trust Mart" Chain Supermarket as an Example. *Acta Sci. Nat. Univ. Sunyatseni* **2006**, *2*, 97–100.
42. Cai, J.; Chen, F.; Li, F. Distribution Characteristics and Influencing Factors of Large Supermarkets. *Urban Plan. Forum* **2010**, *6*, 87–94.
43. Zheng, J.; Wang, T.T.; Chen, H. Industrial Agglomeration, Urban Population Size and Economic Development. *J. Ind. Technol. Econ.* **2021**, *40*, 52–61.
44. Han, X.L. *Study on the Planning of Large Comprehensive Supermarket—Taking Xi'an Large Comprehensive Supermarket as an Example*; Xi'an University of Architecture and Technology: Xi'an, China, 2001.
45. Dong, Y.J. *Correlation Analysis of Xi'an Urban Supermarket and Population Spatial Distribution*; Northwest University: Xi'an, China, 2012.
46. Han, Q.; Gu, C.L.; Yuan, X.H. Research on Urban Master Plan and Main Functional Area Planning Control Space. *City Plan. Rev.* **2011**, *35*, 44–50.
47. The Opinions on Promoting the Innovation and Transformation of Physical Retailing. Available online: http://www.gov.cn/xinwen/2016-11/11/content_5131239.htm (accessed on 8 December 2022).
48. The Fourteenth Five Year Plan for National Economic and Social Development of the People's Republic of China and the Outline of Vision Goals for 2035. Available online: http://www.gov.cn/xinwen/2021-03/13/content_5592681.htm (accessed on 11 December 2022).
49. Zhu, Y.C. The Role of the Government in the Development of Strategic Emerging Industries. *Forum Sci. Technol. China* **2011**, *1*, 20–24.
50. Wang, G.S.; Zheng, G.Q.; Shi, L. Analysis of spatial pattern and influencing factors of supermarkets in Jinan City based on POI. *Technol. Innov. Appl.* **2022**, *12*, 40–46.