Research Paper

A spatial analysis of the migration behaviour of floating population in the Yangtze river delta urban agglomeration

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Abstract

Based on the dynamic data of China's migrant population in 2017, this paper firstly used spatial measurement methods to introduce indicators such as population migration selection index, sub-index heterogeneity, isolation index, etc., then summarize the migration flow in the Yangtze River Delta. Secondly, paper established the index of the factors affecting the choice of different subordinate areas and use the regression model of geographical characteristics to study the spatial characteristics of the migration behaviour on urban migrant population. Finally, paper analysed the reasons behind the relevant urban and regional policies, the level of industrial structure, the division of functions, and social systems, and made relevant recommendations.

Keywords

Floating population, Migration behaviour, Spatial characteristics, Spatial econometric statistics, Geographically weighted regression

1. Introduction

Since the 1980s, along with the deepening of China's reforms, population mobility has become an important phenomenon in the country's socio-economic development. The study of the spatial distribution dynamics of population mobility and the spatial redistribution and combination with other factors it causes is bound to have a significant impact on socio-economic development and the urbanisation process (Shao & Zhang, 2012; Wang, 2001). Scholars in the fields of geographic science and urban planning have conducted many studies on the spatial patterns of population mobility, but there are still some shortcomings that need to be supplemented and refined. At the scale of research, there are studies on the spatial distribution of inter-provincial and inter-urban population flows on a national scale (Gu, Liu & Shen, 2019; Gu, et al, 1999), as well as microscopic studies focusing on the street scale within cities (Zhong & Feng, 2017; Lu, et al, 2005; Huang & Hou, 2019), but studies at the district and county level are particularly rare, while such detailed analysis at the mesoscopic scale is precisely a very important reference value for regional socio-economic development planning and urbanisation strategy implementation (Xiao & Zhu, 2014). In terms of research perspectives, geography often takes geographical spaces such as cities and urban agglomerations as the basic unit of study to present the spatial phenomenon of population mobility (Yuan, Xv & Xue, 2007 & Wang, et al, 2021), and there are also sociology-related studies that focus on the micro-influencing factors of migration behaviour from the perspectives of structural attributes and socio-psychological attributes of individuals and families (Zhou, et al, 2020; Chai & Feng, 2016; Wu, Qi & Feng, 2003). However, as a socio-economic and cultural complex, the city's own development conditions also influence the choice of migration behaviour in the process of population mobility, and these internal and external, subjective and objective factors need to be incorporated into a systematic analytical framework; in terms of research methods, a large amount of literature uses mathematical and theoretical models such as migration choice indices, locational entropy and gravitational models to analyse the relationship between basic research units based on statistical data of the floating population (Zhong & Feng, 2017; Li, 1994; Liu, Gao & Wang, 2020), and also through statistical software such as SPSS to However, there is a lack of research methods that can combine mathematical statistics and spatial analysis.

In this paper, the scope of the study is selected in the Yangtze River Delta urban agglomeration and using data from the 2017 China Mobility Monitoring Survey, we summarize the spatial characteristics of the migratory behaviour of the migrant population in the Yangtze River Delta urban agglomeration and further analyse the influencing factors of the migrant population's choice of inflow location at the district and county scale. Firstly, the analysis of the spatial characteristics of the population is carried out from both the inflow and outflow areas: spatial econometric statistics are used to summarise the multi-scale spatial distribution pattern of their migration behaviour in terms of agglomeration characteristics, flow trajectories and association strength. Secondly, in order to further explore the influencing factors on the choice of place of inflow, a system of influencing factors on the choice of place of inflow is established and a Geographically Weighted Regression (GWR) model is applied to investigate the influence of each factor on the choice of place of inflow of the overall migrant population and different types of migrant population. Finally, an attempt is made to analyse the underlying spatial reasons from the perspective of city and regional policies, the level of industrial structure and division of labour, and the social welfare system, and to make relevant recommendations.

2. Data sources and research methods

2.1. Data sources

The data on the floating population in this study were obtained from the 2017 China Floating Population Dynamic Monitoring Survey data published by the National Health and Wellness Commission, covering various aspects such as basic demographic information, employment, mobility and willingness to stay, health and public services, and social integration of the floating population and family members, which can effectively screen out individual and family factors that influence the migration behaviour of the floating population (Zhang, et al, 2018). Other data in the study were obtained from the 2018 Statistical Yearbook of each city within the Yangtze River Delta Urban Agglomeration and the 2018 Basic Urban Land Use Type Mapping of China (EULUC-China).

2.2.Research methods

(1). Migration Preference Index

This study uses the Migration Preference Index (Wang, 2000) to analyze the attraction regions of the Yangtze River Delta urban agglomeration in attracting floating population. The Migration Preference Index represents the ratio of the actual number of people moving from one region to another to the desired number of people, and can be used to measure the amount of interaction between different regions in terms of population migration (Tan & Chen, 2018).

$$I_{ij} = \frac{M_{ij}}{(P_i/P_t)[P_j/(P_t-P_i)]\sum_{ij} M_{ij}} K \quad (1)$$

Where, I_{ij} is the Migration Choice Index, M_{ij} is the number of people moving from the out-migration to the in-migration, P_i is the number of people moving from the out-migration, P_j is the number of people moving to j, P_t is the total population of the country, K and is a constant. In this study, the migration choice index is graded using the interquartile method, and provinces in the top 25%, top 25%-50%, top 50%-75% and bottom 25% of the migration choice index are classified as strong, moderately strong, moderately attractive and weakly attractive areas of the inflow, respectively, based on the interquartile interval.

(2). Spatial autocorrelation

To further investigate whether there are significant spatial clustering characteristics of population outflows at the intercity level, a global spatial autocorrelation analysis was applied to verify this using Moran's index (GETIS , 1992) (abbreviated as I), calculated as:

$$I = \frac{N\sum_i\sum_j w_{ij}(x_i-\bar{x})(x_j-\bar{\bar{x}})}{(\sum_i\sum_j w_{ij})\sum_i(x_i-\bar{x})^2} \quad (2)$$

where N is the total number of spatial units in the study area, w_{ij} is the spatial weight matrix, x_i and x_j is the size of the outflow population (in terms of households) in the region i and j in the study area respectively, $\bar{x}$ indicating the average value of the floating population in the study area. Since the results of the global spatial autocorrelation analysis do not reflect the spatial correlation between the cities in the outflow area, further local spatial autocorrelation analysis was conducted through the hotspot analysis method (G_i^*), calculated as:

$$G_i^* = \frac{\sum_{j=1}^{n} W_{ij}x_j - \bar{x}\sum_{j=1}^{n} W_{ij}}{s\sqrt{\frac{n\sum_{j=1}^{n} W_{ij}^2 - \left(\sum_{j=1}^{n} W_{ij}\right)^2}{n-1}}} \quad (3)$$

(3). Location-quotient, Index of Segregation and Index of Isolation

The spatial distribution of the floating population relative to the resident population in each district and county within the Yangtze River Delta urban agglomeration is measured by calculating the Location-quotient (LQ_i), calculated as:

$$LQ_i = (F_i/G_i)/(F_t/G_t) \quad (4)$$

Where F_i and G_i are the number of floating and resident population in spatial unit i, and F_t and G_t are the total number of floating and resident population in the city where the inflow is located. LQ_i < 1 indicates relative dispersion and LQ_i > 1 indicates relative concentration.

The Index of Segregation and Index of Isolation are commonly used to measure socio-spatial differentiation. The Index of Segregation is a measure of the degree of spatial differentiation between a group and all other groups, while the Index of Isolation actually examines the absolute concentration of the population(Li, Wu & Xiao, 2014) and is calculated as:

$$IS = 0.5 \times \sum\left[\left|\frac{x_i}{X} - \frac{y_i}{Y}\right|\right] \quad (5)$$

$$II = \sum\left[\left(\frac{x_i}{X}\right) \times \left(\frac{x_i}{t_i}\right)\right] \quad (6)$$

In (5), x_i is the number of floating population in spatial unit i ; X is the total number of floating population; y_i is the number of resident population in spatial unit i; and Y is the total number of resident population. IS<0.30 means low variation, and IS>0.60 means high variation. In equation (6), t_i is the total population of spatial unit i. The rest is the same as equation (5).

(4). Geographically weighted regression

Geographically weighted regression (GWR) extends the linear regression model by adapting the regression equation to local spatial elements as much as possible, with regression coefficients β that are no longer globally uniform but spatially variable, so that they can better reflect the effect of the independent variable on the dependent variable as a function of spatial location (Zhang, et al, 2013), in order to observe the spatial non-stationarity and heterogeneity of the study population, calculated as

$$y_i = \beta_0(u_i v_i) + \sum_{i=1}^{k} \beta_i(u_i, v_i) x_{ik} + \varepsilon_i \quad (7)$$

Where y_i is the dependent variable at the first point; x_{ik} is the value of the k^{th} independent variable at the i^{th} point; ε_i is the residual; (u_i, v_i) is the spatial coordinate of the i^{th} sample point; $\beta_i(u_i, v_i)$ is the value of the continuous function $\beta_i(u, v)$ at the point i.

3. Spatial Distribution Pattern of Floating Population in Yangtze River Delta City Cluster

3.1. Spatial Distribution Patterns of Population Outflows

(1) At the provincial level, the spatial distribution of outflows from the Yangtze River Delta urban agglomeration is uneven, concentrated along the Yangtze River (Figure 1). To facilitate comparison, the natural interruption point grading method was used to divide the energy levels into five classes, and it can be seen that the outflow areas are mainly concentrated in the provinces of Anhui, Jiangsu, Henan, Zhejiang, Jiangxi, Sichuan, Guizhou and Hubei, with the total number of migrants imported from only three provinces - Anhui, Jiangsu and Henan - already exceeding half (56.3%) of the total Yangtze River Delta migrant population.

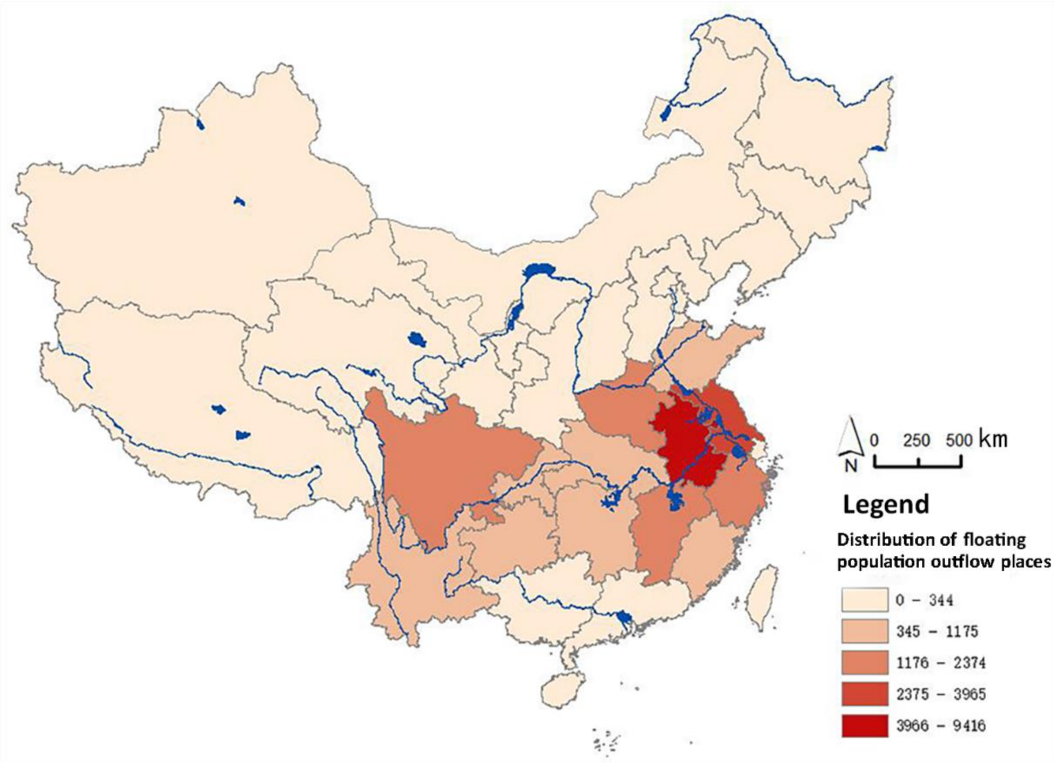

Figure 1. Provincial distribution of outflow of floating population. Source: Author.

(2) At the municipal level, there is a significant spatial clustering of outflow areas of the migrant population in the Yangtze River Delta urban agglomerations, and the links between the eastern and central urban agglomerations are strengthening. The global Moran's value for the spatial distribution of outflow areas of the migrant population in the Yangtze River Delta urban agglomeration is 0.395574, with a value of 22.38719, which is greater than 1.96 and significant at the 0.001 level.

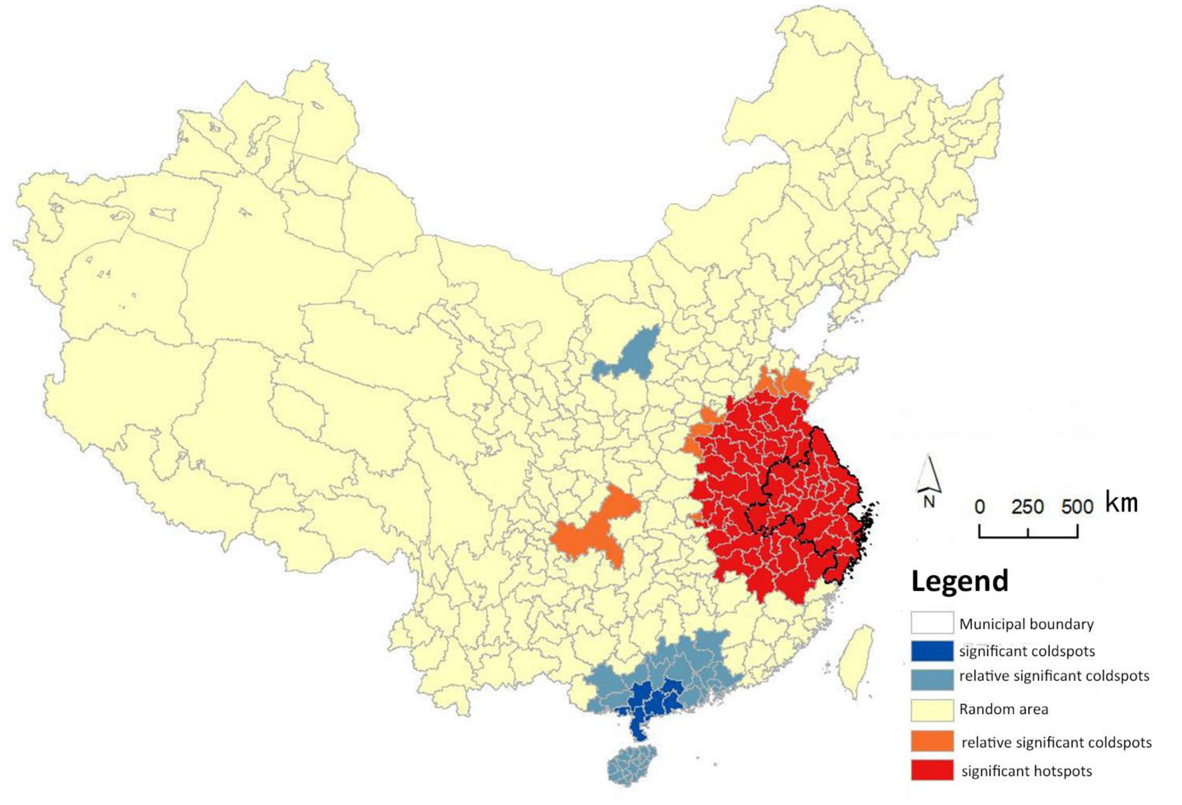

Figure 2. Hotspot Analysis of Mobility Outflows in Yangtze River Delta City Cluster. Source: Author.

3.2. Spatial Distribution Patterns of Population Inflows

The spatial distribution of inflow areas forms a unipolar distribution in Shanghai and a polycentric distribution in cities near Shanghai and provincial capitals. According to the spatial autocorrelation analysis, the global Moran's of the spatial distribution of the inflow areas of the floating population in the Yangtze River Delta city cluster is 0.38, with values of 12.04 and 1.96, which are significant at the p 0.01 level, indicating that the inflow areas of the floating population in the Yangtze River Delta city cluster have significant spatial clustering characteristics.

High-density areas for floating populations are mainly located in industrial concentrations and urban centres. The differentiation index of the floating population in the Yangtze River Delta urban agglomeration is 0.31, indicating a low degree of spatial differentiation between the floating and resident populations in the Yangtze River Delta urban agglomeration as a whole; the segregation index of the floating population is 0.60, indicating a high degree of floating population concentration.

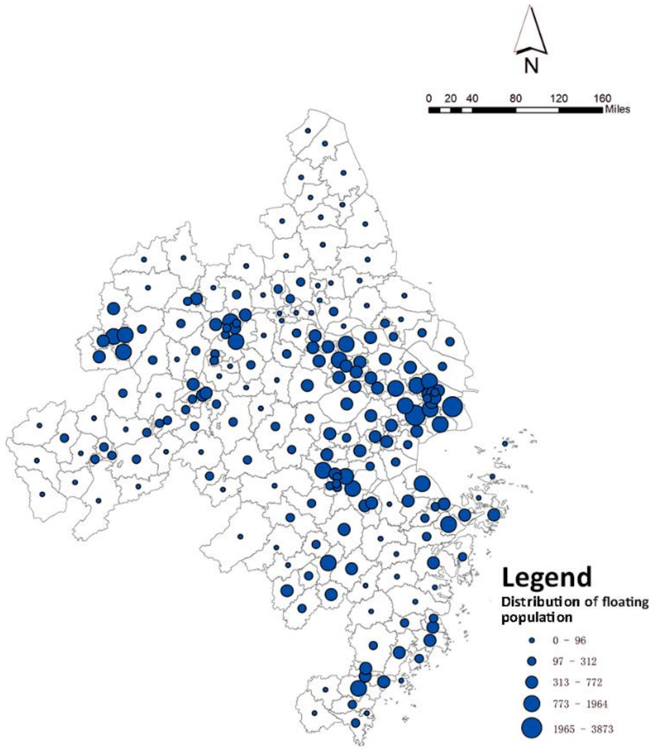

Figure 3. Distribution of floating population in the Yangtze River Delta city cluster. Source: Author.

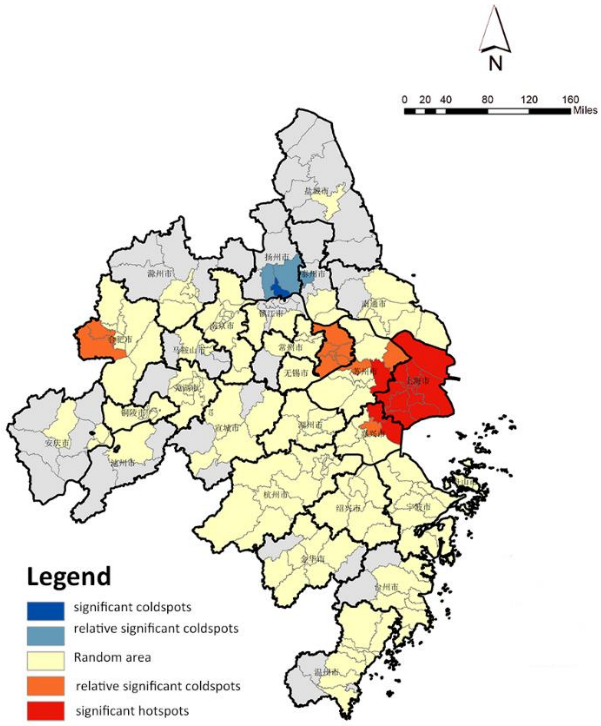

Figure 4. Hotspot analysis of the distribution of floating population numbers in the Yangtze River Delta city cluster. Source: Author.

4. Analysis of the Spatial Choice of Migration Behaviour of Migrants in the Yangtze River Delta

4.1. Variables Selection

(1). The number of transients in each district and county reflects the choice of the transient population for the city of migration, i.e., the dependent variable, which counts the number of members of the household of the survey respondents in each district and county whose current place of residence is "local".

(2). A system of indicators of the factors influencing the migration of the migrant population is established in three aspects: the demand characteristics of the migrant population in the region, the living standard characteristics of the migrant families and the characteristics of the inflowing cities. ① The demand characteristics of the migrant population describe the attributes of the migrant population attracted to the region, characterised by the proportion of agricultural households and the proportion of those with no higher education. ② The living standard characteristics of floating households reflect the living standard of the floating population in the region. In particular, the rent-to-income ratio reflects the cost of migration for households, which is usually considered to be below 25%, 25%-30% in the affordable range, and over 30% indicating an excessive rent burden. ③ The urban characteristics of the inflow area reflect the level of urban development and the level of public services provided to the migrant population in the area. The completeness of the high-speed railway station reflects the region's ability to receive medium and long-distance passenger flows, the medical insurance application rate reflects the level of medical services for the migrant population, and the sense of social belonging reflects the degree of acceptance of the migrant population in the region.

4.2. Model construction

As the global spatial autocorrelation analysis of the dependent variable is significantly spatially clustered (see 3.2 above), estimation using a general linear regression model would be biased, so a geographically weighted regression model was used for the next step of the analysis. The model was constructed as follows.

$$
\begin{aligned}
y_i = \beta(u_i, v_i) &+ \sum_{j=1}^{k} \beta(u_i, v_i) x_{ij}(NYHK) + \sum_{j=1}^{k} \beta(u_i, v_i) x_{ij}(WSJY) + \sum_{j=1}^{k} \beta(u_i, v_i) x_{ij}(JTSZ) \\
&+ \sum_{j=1}^{k} \beta(u_i, v_i) x_{ij}(ZFFD) + \sum_{j=1}^{k} \beta(u_i, v_i) x_{ij}(CSE) + \sum_{j=1}^{k} \beta(u_i, v_i) x_{ij}(CST) \\
&+ \sum_{j=1}^{k} \beta(u_i, v_i) x_{ij}(YLBX) + \sum_{j=1}^{k} \beta(u_i, v_i) x_{ij}(SH)
\end{aligned}
$$

The GWR model regression coefficients were obtained using the geographically weighted regression tool in GWR4 software, where the model bandwidth was calculated using the AICc method, and the least squares (OLS) model related parameters were calculated using ArcGIS software. A comparison of the OLS and GWR model results shows that, in all sets of regression results, the goodness of fit of the GWR model is much greater than that of the OLS model, indicating that the regression relationship of the model is spatially non-smooth.

4.3. Factors influencing the spatial choice of migratory behaviour of the floating population in the Yangtze River Delta

(1).The pattern of spatial differentiation in the influence of urban economic level on the choice of inflow location of floating population

The economic level of cities and counties in the Yangtze River Delta urban agglomeration are positively correlated with the choice of migrant inflow locations, and an increase in the economic level of cities significantly attracts migrant inflow. In terms of the spatial distribution of the significant regression coefficients (Figure 5), the regression coefficients show an overall high spatial distribution pattern on both sides of Anqing, Chizhou and Tongling cities in Anhui Province, and Ningbo and Zhoushan cities in Zhejiang Province. Compared with Shanghai and Hangzhou, which are large cities with high economic levels dominated by technology and capital-intensive industries, there are more labour-intensive industries with lower per capita output in these cities, and an increase in unit GDP also means a large supply of jobs, so the floating population in these areas is more sensitive to the factors influencing urban economic levels.

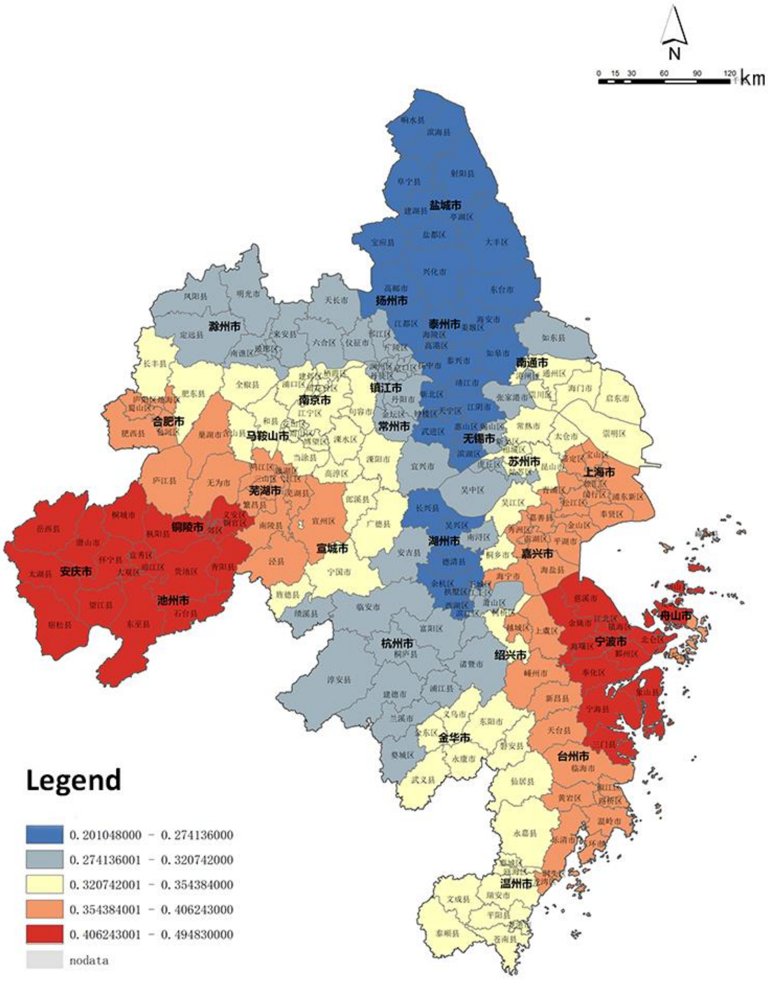

Figure 5. Spatial distribution of regression coefficients of the GWR model city economic level Source: Author.

(2). Spatially divergent patterns of the influence of railway passenger conditions on the choice of inflow location of the floating population

The conditions of railway passenger transport and the choice of floating population inflow in all districts and counties of the Yangtze River Delta city cluster are positively correlated. The spatial distribution of the significant regression coefficients shows that the regression coefficients form a circle structure with Shanghai as the core spreading to the periphery (Figure 6). Good passenger transport is an important condition for reducing the cost of population movement and attracting population inflow. Railways, especially high-speed railways, have become an important driving force for co-location.

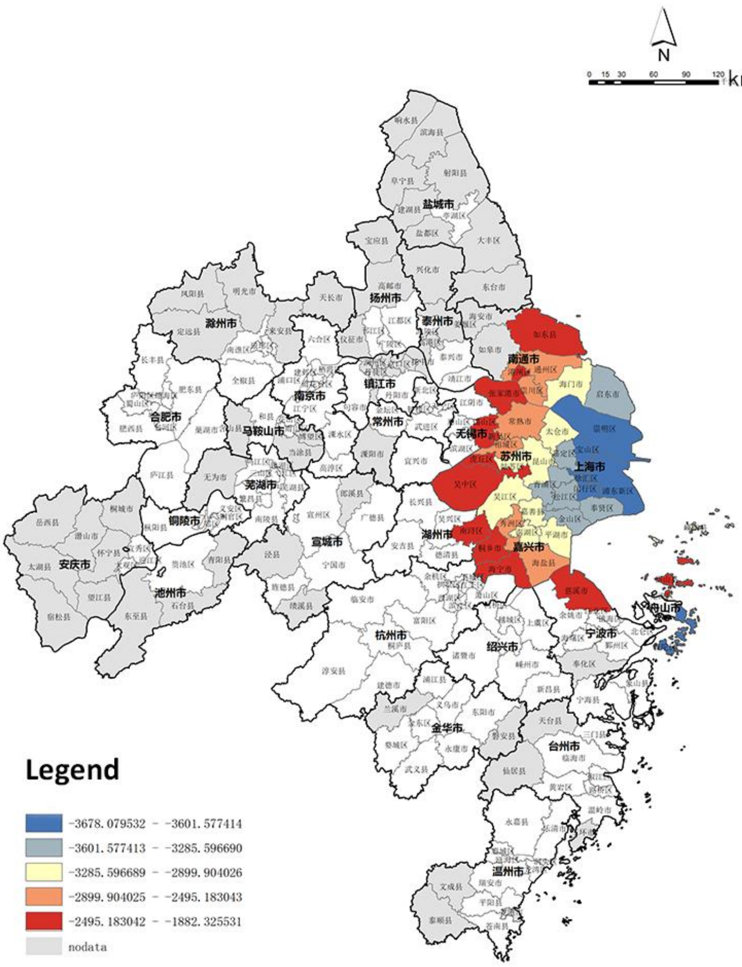

Figure 6. Spatial distribution of regression coefficients for GWR model rail passenger conditions Source: Author.

(3). Spatially divergent patterns of the influence of the level of medical services on the choice of inflow location of the floating population

For some districts and counties in the eastern coastal region with a high level of economic development, an increase in the level of medical services can significantly attract population inflows. The regions with significant influence on the level of medical services are mainly located in Shanghai, Nantong, Wuxi and Suzhou and their subordinate districts and counties, with Nantong as a whole having the highest influence (Figure 7). Nantong has a relatively low level of medical services compared to Shanghai, but its strong economic power is an important factor in attracting population inflows, so improving its internal public services on this basis will certainly attract more floating people. However, in some areas of Jinhua and Taizhou, the level of medical services and the choice of floating population inflow are negatively correlated, and the reasons behind this need to be further explored.

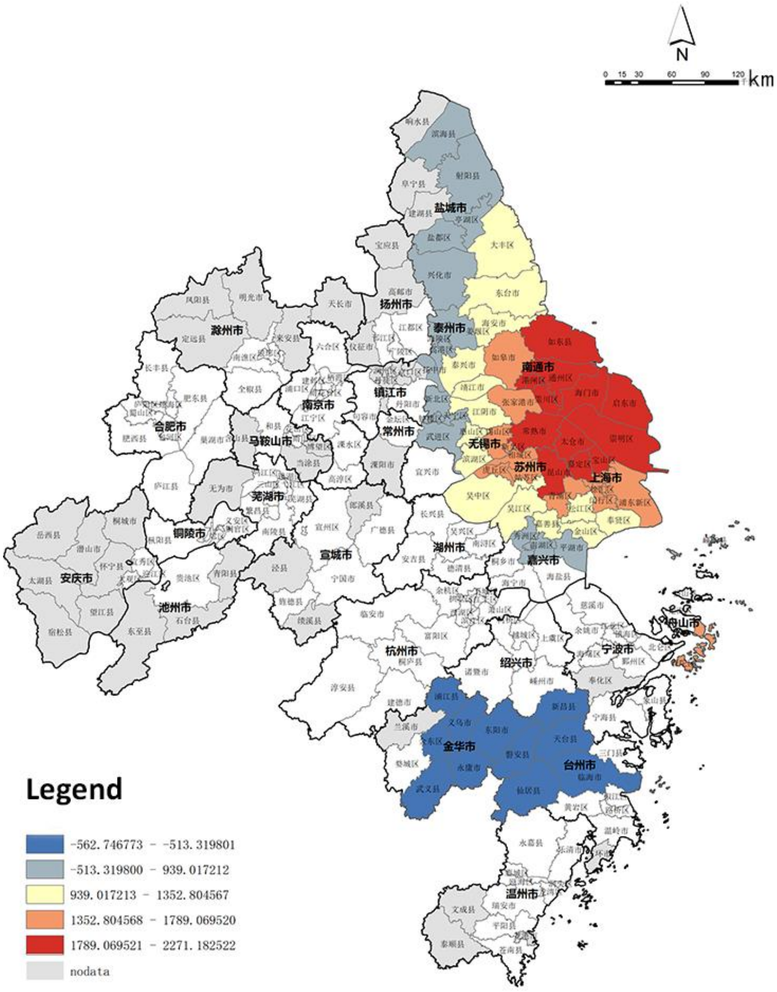

Figure 7. Spatial distribution of regression coefficients for GWR model health service levels Source: Author.

(4). Spatially divergent patterns of the influence of the proportion of households with high rental burden on the choice of place of inflow of floating population

Rail passenger conditions and the choice of floating population inflow locations are negatively correlated across the Yangtze River Delta city cluster. The spatial distribution of the significant regression coefficients shows an increasing circle distribution around Shanghai within the Shanghai metropolitan area. The negative effect of rising urban rental costs on population inflow is significant, and is strongest in the near-Shanghai region. Although Shanghai, as the central city of the Yangtze River Delta urban agglomeration, has a strong attraction to the incoming population in terms of location, transportation, economic development and social health insurance, the increase in rental costs will significantly discourage the inflow of migrants. In a cost-benefit perspective, the choice of migration behaviour is not only a result of the expected benefits, but the high cost of living in the inflow area can sometimes have a negative impact on the inflow (Figure 8).

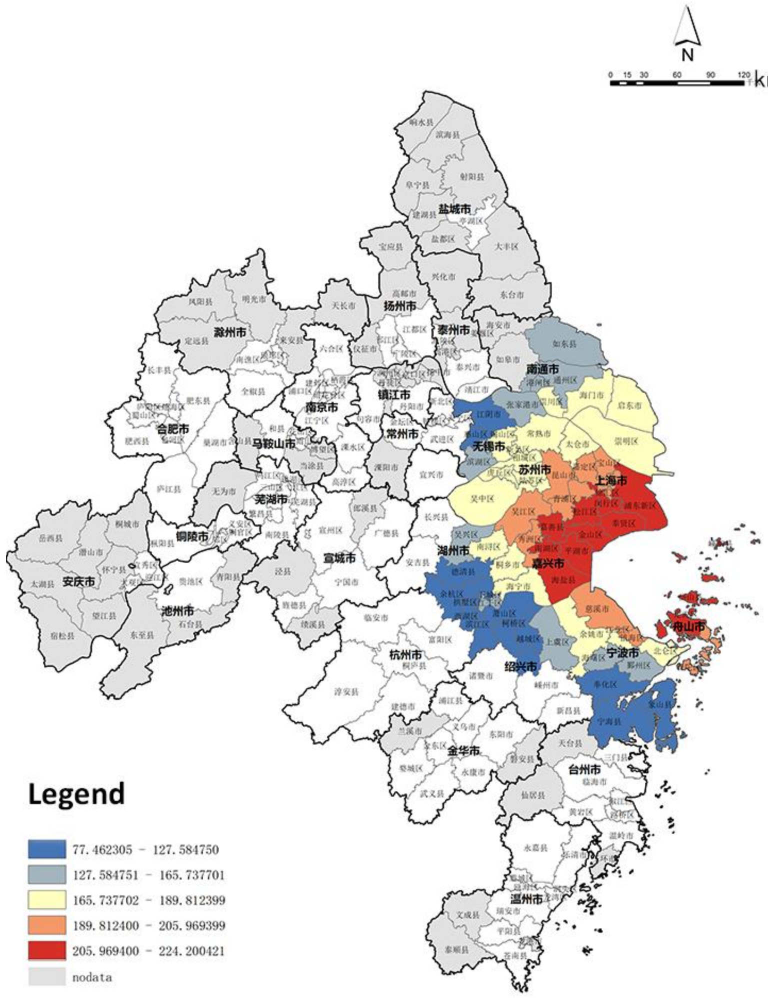

Figure 8. Spatial distribution of regression coefficients for GWR model rental affordability levels Source: Author.

5. Conclusions

Using data from the 2017 China Mobility Monitoring Survey, this paper conducts a spatial analysis of the migration behaviour of the migrant population whose current residence is located in the Yangtze River Delta urban agglomeration, and draws the following main conclusions: ① The Yangtze River Delta urban agglomeration attracts population mainly from its neighbouring provinces, and the population outflows are spatially concentrated and contiguously distributed with the Yangtze River Delta as the core, and in addition to population flows between cities within the agglomeration, some In addition to population flows between cities within the city cluster, some cities also form closely linked population transport channels with Chongqing. ②Population inflows are concentrated in Shanghai and its surrounding cities and provincial capitals, with industrial zones and central urban areas being more attractive to them, and some cities still have obvious spatial differentiation of floating populations. ③ The level of urban economic development, passenger and transportation conditions, the level of medical service supply and the cost of urban rental housing have a significant impact on the spatial choice of the migrant population's migration behaviour. However, the high cost of living and the lack of urban services in these areas have also greatly hindered the spatial migration choices of the migrant population.

The above findings have important implications for the construction, management and services of towns and cities within the Yangtze River Delta urban agglomeration. ① Near-Shanghai districts and counties in the Shanghai metropolitan area with strong economic development should increase investment in the construction of public service facilities for the urban resident population, promote universal access to basic public services, including medical insurance, for all floating populations, further strengthen their own economic construction strength as well as the level of urbanization and integration with Shanghai, and promote inter-city passenger transportation corridors by improving public services, reducing the cost of living, and building Inter-city decentralization of floating population.② Shanghai, as the central city of the Yangtze River Delta city cluster, needs to pay more attention to the problem of "difficult" and "expensive" rental housing for the floating population, taking into account the family characteristics and education level of the urban floating population and other attributes, combined with urban public transport stations and industrial parks, and strengthen the supervision of the urban rental market to reduce the cost of living of the floating population. ③ Strengthen the links between the Yangtze River Delta city cluster and the central and western city clusters, strengthen economic linkages and factor exchanges by supporting inter-provincial and inter-city infrastructure development, and form stable channels for the transportation of people and talents. ④The convenience of railway passenger transport is an important influence on the spatial choice of floating people with a large mobility span, and this influence is even more pronounced in the near-Shanghai region. In the vicinity of the near-Shanghai region, there are still depressions with insufficient railway transportation construction, such as along the G60 science and innovation corridor. In the future, railway transportation and station construction in these areas should be strengthened, so that they can be better integrated into the national railway network, strengthen the population flow links with extra-territorial regions, and attract high-end talents and labour to serve innovation development.

Finally, there are still some shortcomings in this study, such as the lack of comprehensiveness of the indicator system, with fewer indicators reflecting the level of industrial and economic development of the inflowing regions; the data used in the study are rather outdated and cannot reflect the dynamic changes in the spatial choice preferences of the floating population in the Yangtze River Delta under the new policy situation; the analysis of group differences is inadequate, without further classification and analysis of people with multiple differences, thus ignoring the differences in the needs and choice preferences of different The analysis of group differences is inadequate, and the needs and choice preferences of different groups are ignored. In future research, the comprehensiveness and timeliness of the data can be improved, and a more comprehensive spatial preference indicator system can be constructed to reflect the latest spatial patterns and demand preferences of the migrant population. At the same time, a longitudinal historical comparison can be conducted to study the spatial distribution pattern and the historical evolution of the demand preferences of the migrant population, and to explore the impact of various backgrounds and policies in the context of the development characteristics and policies of China in various periods. Finally, it is possible to fine-tune the classification of migrant population groups and gain a more comprehensive understanding of the spatial characteristics of migrant migration behaviour and its influencing factors.

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