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Analysis of Influencing Factors on Population Change in Honam Region Considering Spatial Autocorrelation

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Abstract:
The purpose of this study is to analyze the impact on population change in the Honam region, and to analyze the policy implications derived. The analysis target was set for 41 cities, counties, and districts in the Honam region comprising Gwangju Metropolitan City, Jeollanam-province and Jeollabuk province. As an analysis method, we performed an empirical analysis by comparing Ordinary Least Squares(OLS), Spatial Lag Model(SLM)and Spatial Error Model (SEM) by measuring Moran's I considering spatial autocorrelation. First, through the Moran's I index, it was confirmed that there is spatial autocorrelation in the population changes of the Honam region, and the SEM was found to be the most suitable model. Next, as a result of the regression analysis, it is also confirmed that among various variables, the population density, the number of one person households, the number of manufacturing establishments, the number of old houses, the number of private institutes and the number of childcare facilities had a positive effect on the population growth in the Honam region. And the number of registered foreigners was identified as a negative influence factor, and the number of students per teacher, area of greenlands per person and distance from the base city and city/county , failed the significance test at 10% level. These analysis results indicate that the population of Honam region is clearly concentrated in cities and has a close relationship with the number of foreigners. Based on the research results, the government and local governments will have to devise timely policies.

Keywords:
population ;spatial autocorrelation ; Honam ; spatial autocorrelation ; spatial error model

1. Introduction

According to a recent announcement, Korea's population is known to have the lowest fertility rate among OECD countries. The population decline has already been foreseen and will have an all-round impact on Korean society. Such population decline is a very urgent issue not only at the national level but also at the regional level, and it is affecting the existence of the region. Changes in the national population as well as the local population are affected by many complex factors such as economy, society, and policy and so on. Among such factors, Korea intensively nurtured key industries in a specific region for compressed growth, which brought about an imbalance in economic growth and caused considerable adverse effects on the population structure and population of each region.

Recognizing this problem, academia conducted research focusing on economic factors to identify the causes of regional population change, and the government implemented a policy of re-decomposing resources into the national land to overcome the disproportionate phenomenon of the population problem. So, the government made large-scale investments in SOC to create employment growth and expected that the population was to increase naturally in the area. However, recently, in addition to these economic incentives, living conditions are also being considered. The goal is to increase the number of convenience facilities such as education, housing, and environment necessary for living, so that the area can be selected as a residence. Therefore, how effectively these overall living conditions affect population growth is a subject of study. So main aim of this study is to analyze the impact on the change of the local population by considering the economic, social, and environmental requirements and variables suitable for regional characteristics.

Studies so far have been conducted at the national level or in preparation for the metropolitan area and the non-metropolitan area. On the other hand, there is very little research on the regional level targeting the Honam region. Also, even if there is an analysis of a regional unit, it may not reflect the characteristics of the city, county, and district in it well. Therefore, we will proceed with a microscopic analysis of the 41 areas belonging to the Honam region. The Honam region consists of Gwangju Metropolitan City, Jeollabuk-province, and Jeollanam-province. Honam has a similar culture, history, and economic structure. Above all, the results of this study will suggest many implications in the Chungcheong region and Gyeongnam region, which have similar structures as they are made up of metropolitan cities and rural-type metropolitan cities as like Honam.

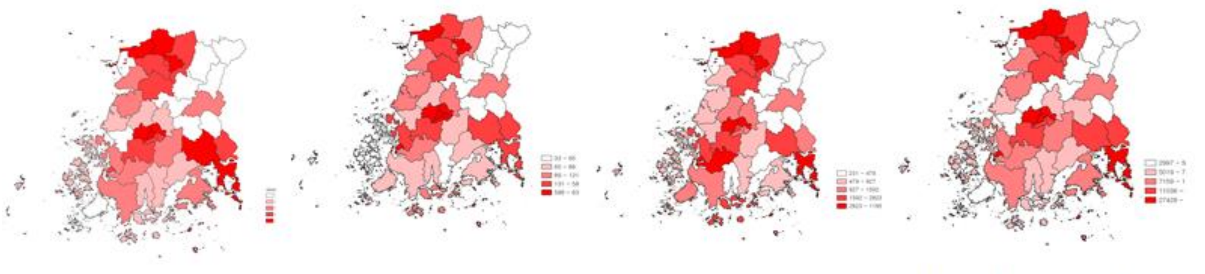
In this study, in order to more accurately analyze the characteristic factors that affect population change, the analysis is carried out considering the characteristic of space. A region is a space formed on the basis of land. It is natural that the properties of a space are formed face-to-face with other local spaces surrounding it and that they influence each other. In fact, distortion may occur if these spatial characteristics are not taken into account. Therefore, it has to analyze the factors affecting the population based on the spatial autocorrelation of the population in the Honam region. The GIS and GeoDa program were used to analyze the spatial characteristics.

2. Methodology

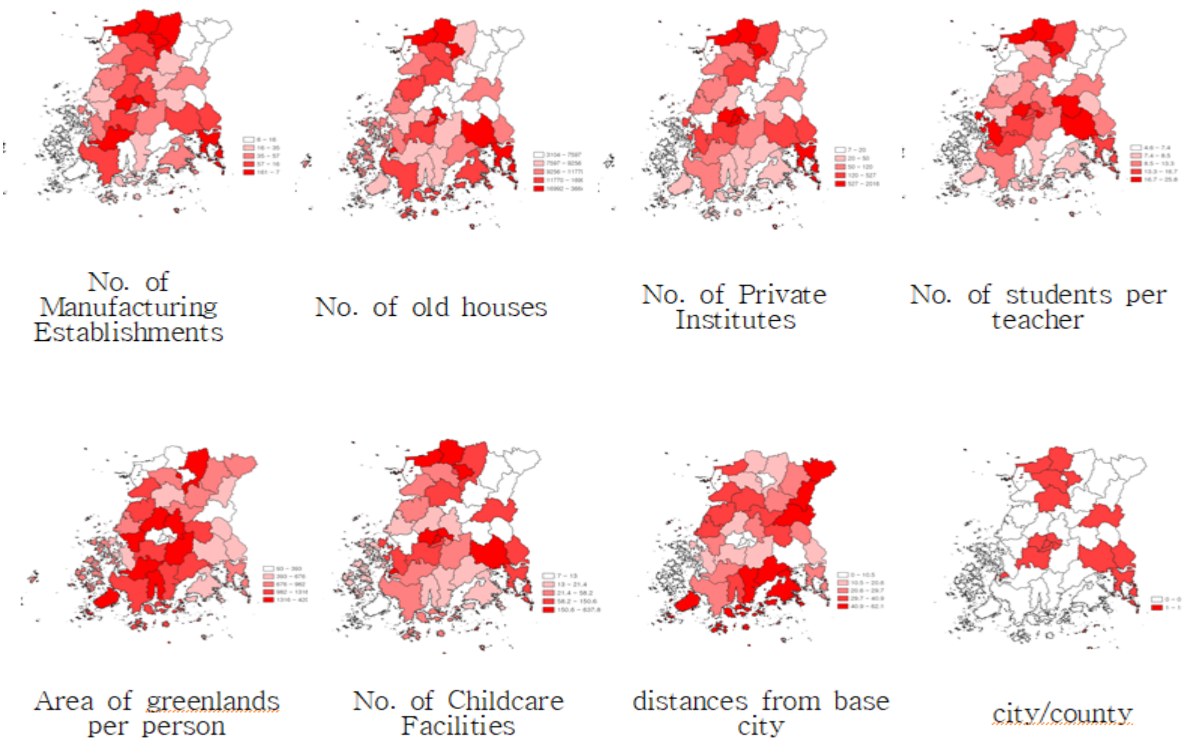
2.1 Data

This study used various variables to analyze the factors that influence the population change in Honam area. All the raw data came from the Korean Statistical Information Service(http://kosis.kr)The dependent variable is the registration population of the Honam region. In order to reduce data distortion for a specific year, the average data for five years from 2015 to 2019 was used. As explanatory variables, first of all, population density in terms of space, number of registered foreigners and number of one-person households in terms of demographic structure, number of manufacturing establishments in terms of economics, number of old houses in terms of housing, and number of private institutes and students per teacher in terms of education. In terms of number and environment, area of greenlands per person was used, the number of childcare facilities in terms of social welfare, distance from the base city in terms of geographic location, and city/county status as dummy variables.

Figure 1. The descriptive statistics of the variables using GIS



Population | Population density | No. of Foreigners | No. of one preson households

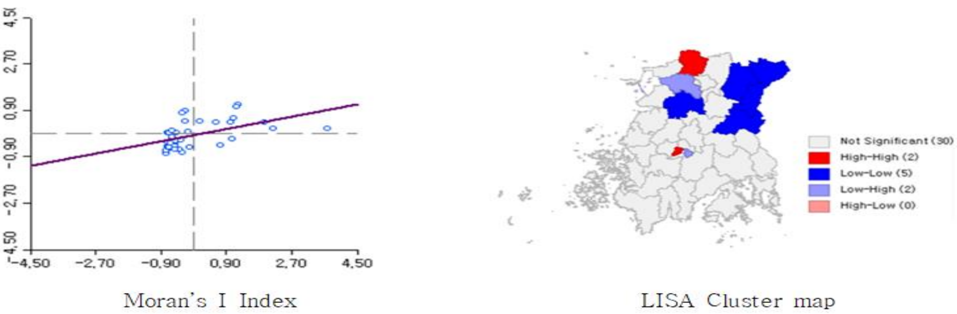


2.2. Measures of Spatial Dependence and Heterogeneity

In order to use the spatial regression model, the dependent variable must be spatially correlated. Also, the result of verifying the preconditions of OLS, a traditional regression method, must be inappropriate. Therefore, the verification of the Moran's I value and the test which spatial regression method is most suitable must first be done.

In this study, the spatial correlation of the population of the Honam region was confirmed through the Global Moran's I index. In general, the value of Moran's I has a value between -1 and 1, and it can be interpreted that the closer to -1 and 1, the greater the spatial correlation. The value of the Global moran's I index of the population of the Honam region was 0.2649, and the p-value was 0.0080, which was found to be statistically significant. It can be concluded that the population of any city, county, or district in the Honam region affects the population change of the neighboring region and as the population increases, the number of neighboring cities, counties and districts may also increase. Next, as to the Local moran's I(LISA) autocorrelation, in the 41 city, county, and district of the Honam region, there were 2 high-high clusters and 5 low-low clusters. High-High clusters appeared in the northern regions of Jeollabuk-province and Seo-gu regions of Gwangju Metropolitan City, and the Low-Low clusters were mainly found in the northeastern regions of Jeollabuk-province. It was analyzed through GeoDA program and the mapping result is shown in Figure 2.

Figure 2. Moran's I and LISA in Honam area



2.2 Spatial Regression Models

In this study, the location information of administrative districts provided by Statistical Geographic Information Service was used separately from Honam area to analyze the spatial effects of foreign residents. Spatial econometrics is a model that considers the correlations including the aesthetic and economic relations between regions. The general linear regression model is as follows.

$$y = X\beta + \mu \quad (1)$$

Considering the spatial autocorrelation(ρ=0) of the dependent variable in Equation (1), it is called the Spatial Lag Model (SLM), and is shown in Equation 2 below.

$$y = \rho Wy + X\beta + \epsilon \quad (2)$$

Considering the spatial autocorrelation (λ=0) of the error term, it is called the Spatial Errors Model (SEM). Unlike the spatial parallax model, the spatial parallax term is included in the error term, not the explanatory variable term.

$$y = X\beta + \mu, \mu = \lambda W\mu + \epsilon \quad (3)$$

Multicollinearity is a problem that indicates how similar the variables are. Montgomery and peck (1992) determined that there is no serious multicollinearity if the value of the multicollinearity condition number (multicollinearity determination index) does not exceed 100. In this study, the value of this index calculated from GeoDa was found to be 39.2, and it was determined that there was no serious multicollinearity problem.

The spatial quantification model presupposes that the spatial dependence is controlled and analyzed only when it is verified that the dependent variable has a spatial correlation between adjacent regions. In other words, the limitations of the OLS model must be shown through the BP test (Breusch-Pagan test), which verifies the equality of residuals assumed in the general regression model, and the JB test (Jarque-Bera test), which diagnoses the non-normality of the error term. As a result of verification, it was found to be significant at the 1% level (p<0.0000) in both the BP test and the JB test. In other words, it was judged that heteroscedasticity exists in the residuals and normality does not exist in the error term.

3. Result

3.1. Estimation Results and Model Comparisons

In terms of model fit, $R^2$was very high, 0.996, at the same time, it was higher than that of the OLS model. Compared with the OLS model, the log-likelihood value increased and the AIC decreased. Since the λ (Lamda) value was found to be statistically significant, the spatial error model is judged to be the most appropriate.

Prior to analyzing the influence factors of the Honam region's population, in the case of a spatial metric model, a preliminary test is required to establish the most appropriate spatial regression model. To test spatial dependence and spatial heterogeneity, Lagrange Multiplier (LM) and Robust LM tests are conducted. From the results of spatial regression analysis, the LM(err) value was 6.1297 and the Robust LM(err) value was 9.2330, which was more statistically significant. This confirms that the spatial error model is more suitable than the spatial lag. As a result of empirical analysis in consideration of spatial correlation.

Through the regression results, the factors affecting the population in the Honam region were statistically within the 10% significance level, the population density, the number of foreigners, the number of one person households, the number of manufacturing establishements, the number of old houses, the number of private institutes, and the number of childcare facilities were shown to be significant. Except that the number of foreigners has a negative (-) effect, all other factors have a positive (+) effect. On the other hand, the number of students per teacher, green area per person, distance from the base city, and city/county status were not statistically significant.

Table 1. Regression Results

Model	OLS	SEM
λ(Lamda)		0.731517***
CONSTANT	2973.06	-10181.1
Population density	2.19572	4.14276*
No. of Foreigners	-6.29922	-5.08615*
No. of one person households	4.29645***	4.21655***
No. of Manufacturing Establishments	132.634*	144.984***
No. of old houses	1.39319*	2.4701***
No. of Private Institutes	55.1778	48.0889*
No. of students per teacher	-494.566	-234.948
Area of greenlands per person	1.87138	1.07567
No. of Childcare Facilities	315.871*	306.356***
distances from base city	-92.4578	-50.1914
city/county(dummy)	4338.61	-8300.82
R^2	0.99392	0.99618
LOG LIKLEHOOD	-438.694	-432.430
AIC	901.39	888.86

note: p<0.01***, p<0.05**, p<0.10*

4. Discussion and Conclusion

This study analyzed various factors affecting the population of the Honam region, focusing on the problem of population decline, which is the biggest characteristic of regional imbalance. Spatial regression analysis was used to identify more accurate causal relationships, and implications were derived from the results.

The main results are summarized as follows. First, it was confirmed that the population of the Honam region has a close correlation with the neighboring regions. The Global moran's I index had a positive(+) value and was statistically significant. The results of this analysis indicate that the population of a certain region has a positive effect on the neighboring region, and that a successful population growth policy in one region has the potential to increase the total population of the Honam region. Second, the factors that positively affect the population of the Honam region are the population density, the number of one person households, the number of manufacturing establishments, the number of old houses, the number of private Institutes and the number of childcare facilities. Among the positively influencing factors, the manufacturing industry still supports the local economy and the remaining factors are indicators of the degree of urbanization. Therefore, it can be confirmed that the higher these indicators are, the more closely related to population growth. The number of foreigners having a negative impact is presumed to lead to the replacement of simple labor workers in the manufacturing sector and elderly workers in rural areas. Third, the number of students per teacher, area of greenlands per person, distance from the base city and city/county status were not statistically significant. It is understood that the simple difference between the concentration of population in the villages and the presence of cities and counties has little to do with the demographic change in the Honam region.

The results of the previous analysis have several implications for the population policy of the Honam region. The most important thing is that the population of Honam is already concentrated in urban areas. In the future, the population will be more concentrated in cities, and small rural areas are expected to continue to decline. Therefore, it is necessary to select and focus on the center of a large city and seriously consider how to maintain the urban function and population for the rest of the region. For example, Rural small and medium-sized cities where the population is declining have to become a compact city by concentrating the population and facilities rather than expanding the city. In order to create good jobs, it will be necessary to develop small-scale manufacturing industries suitable for the region, such as village enterprises. In addition, the number of foreigners is continuously increasing, and they are in charge of employment in manufacturing and agriculture. Measures to increase the local population beyond the level of replacing simple tasks and policies that can harmoniously settle in our society should be implemented.

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