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THE INFLUENCE OF POPULATION AGGLOMERATION ON THE UPGRADING OF THE INDUSTRIAL STRUCTURE — EVIDENCE FROM CHINA

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ABSTRACT

As an important component of economic, social, and industrial development, changes in the labor force affect a country's economic development in terms of fiscal expenditure, consumption structure, and production capacity, which also promote or inhibit the upgrading of the overall industrial structure and internal structure. Based on the inter-provincial panel data of 30 provinces, autonomous regions, and municipalities (excluding the Tibet Autonomous Region) in mainland China from 2010 to 2019, this paper conducts an empirical analysis of the impact of population agglomeration on the upgrading of the industrial structure and the contribution rate of tertiary industry output value in different regions. We conclude: (1) Generally speaking, population agglomeration has the effect of promoting the upgrading of the industrial structure. (2) The impact of population agglomeration on the industrial structure is different in different regions, hindering the upgrading of the industrial structure in eastern provinces, having no significant impact on the western region, and encouraging the upgrading of the industrial structure of central provinces. (3) Concerning the tertiary industry, population agglomeration significantly promotes the contribution rate of the tertiary industry output value in different regions. Therefore, the following suggestions are put forward: (1) Promote the reform of the household registration system. (2) Increase investment in human capital.

Contribution/Originality: The research introduces the population agglomeration factor into the rate of industrial structure upgrading and regional heterogeneity and discusses the favorable and unfavorable effects that population agglomeration has on economic development using an empirical SDM model.

1. INTRODUCTION

As an important component of economic, social, and industrial development, changes in the labor force affect a country's economic development in terms of fiscal expenditure, consumption structure, and production capacity, which in turn promote or inhibit improvements to the country's overall industrial structure and internal structure. Whether seen in terms of geography or population, China is undoubtedly a big country. The population structure and industrial structure of the east, middle, and west of China each have their own characteristics. Taking the Hu line as a boundary, China's population density exhibits a trend of sparse northwest and dense southeast and is centered on megacities with tens of millions of people, such as Beijing, Shanghai, Guangzhou, and Shenzhen. Since the establishment of the market economy system, population flow has become freer and freer, increasing the significance of the population density differences between different regions and relying on the vast labor market to achieve outstanding advances in economic development. The development of labor-intensive industries has injected a strong impetus into the country's overall economic development. The study of the relationship between population agglomeration and upgrades to the industrial structure plays an important role in China's long-term development.

In current academic circles, the research on the subject of population agglomeration is not closely integrated with that on industrial structure upgrading. Many papers study population agglomeration from the perspective of population growth mechanisms or the pressure on economic development; the research on industrial structure upgrading often takes the direction, speed, and regional differences of industrial structure upgrading as its starting point, and rarely considers how the level of population agglomeration affects the industrial structure. Therefore, this paper introduces the factor of population agglomeration into the study of industrial structure upgrade speed and regional heterogeneity and discusses the advantages and disadvantages of population agglomeration for economic development. Thus, it aims to enrich the results of the population agglomeration research field and provide this field with more reference materials.

To better understand the role of population factors in the upgrading of industrial structures and the differences between different regions, as well as to make more effective use of the benefits of population factors and to avoid the disadvantages of population agglomeration on the economy, the paper is based on ten years of provinces' population data, ensuring that the empirical results are more comprehensive and authentic. The analysis of the empirical results provides suggestions for the policy orientation of industrial structure upgrading, especially the policies involving population factors.

2. LITERATURE REVIEW

2.1. Current Status of Population Agglomeration Research

Chinese scholars mostly study population agglomeration by investigating the causes of population agglomeration and its impact on the environment. The factors affecting population agglomeration include environmental ecology, innovation drive, economic development, etc. Yuan, Caoyong, Ni, Qiuhai, and Zhou (2020) used a stepwise multiple regression model to conduct an empirical analysis and found that a good ecological environment, including a suitable temperature, altitude, and amount of precipitation, is an important factor in attracting population, and that haze pollution correlates negatively with population agglomeration. Moreover, Zhu and Zhao (2021) believed that by starting from population and consumption, regional joint prevention and control policies could offer a powerful measure to prevent smog. In addition, demographic factors play an intermediary role in real estate prices and economic development. Economic agglomeration stimulates innovation input, which in turn drives up real estate prices, while high housing prices inhibit population agglomeration. To a certain extent, transportation convenience determines the efficiency of population flow. As China's transportation routes become more and more smooth, areas with more trains are often areas with higher population density. In other words, a well-developed transportation system has a strong effect on the accumulation of human capital. Generally, cities with high levels of economic development rely on a variety of industries, abundant jobs, and an active and avant-garde living atmosphere to attract young people.

In academic circles, varying views are held on the impact of population agglomeration. In terms of the ecological environment, He (2019) used the least squares method to conduct an empirical analysis of provincial data and proposed that through an increase in average education level, the increase in pollution caused by population agglomeration can be alleviated, whereas industrial pollution is not directly caused by population agglomeration. Liu and Leng (2020) empirically analyzed the threshold model and found that the impact of population agglomeration on haze pollution shows a diminishing margin after crossing the threshold. In terms of economic development, population agglomeration brings about an agglomeration of human capital and an increase in energy consumption, thereby promoting economic development. Zhou, Wang, and Zhang (2021) conducted an analysis based on the spatial Durbin model and concluded that population agglomeration brings information consumption dividends, thereby promoting information consumption. Sun (2021) showed that population gatherings boost the development of the circulation industry. However, Wang, Nian, and Wang (2017) argued that a population density that is too high will inhibit per capita output, and there is an optimal balance between city size and economic development. Li, Yan, and Xiaosang (2020) also held this view but believed that most cities in China had not yet reached the stage of restraint.

Other scholars' research on population agglomeration has also focused on the above two aspects. Chen and Wei (2014) pointed out that employment opportunities, per capita income, public goods, and immigration path dependence were important factors affecting population agglomeration. Han, Wang, Tao, and Gao (2014) analyzed the attractiveness of cities to the population through complex niches and showed that there is a threshold effect in complex niches. Wang et al. (2018), among others, used remote sensing to draw a population density map of China that improved the spatialization model of population. Shen, Chen, Yang, and Zhang (2019) conducted a variety of empirical analyses and showed that city scale has a positive impact on urban productivity, but excessive population gatherings have a negative effect on productivity development and have spillover effects.

2.2. Current Status of Research on Industrial Structure

Chinese scholars mainly conduct research and analysis on the factors that affect the upgrading of the industrial structure. Chen (2021) argued, based on panel data analysis, that government financial investment, human capital, urbanization, and the urban-rural income gap significantly affect industrial upgrading and have space for spillover effects. The establishment of the free trade zone has effectively promoted technological innovation and thus promoted the upgrading of the regional industrial structure. As financial agglomeration and regional housing prices change, the industrial structure shows a corresponding trend. Transportation infrastructure also plays an obvious positive role in facilitating the upgrading of the industrial structure of a region, as well as that of neighboring regions. The impact of environmental regulations on the upgrading of the industrial structure takes the shape of an inverted U - shaped curve. At present, China is still in a stage where strengthening environmental regulations can stimulate the optimization of the industrial structure. Fu (2021) confirmed through a PSTR model that the expansion of the scale of international trade has a diminishing effect on the upgrading of the industrial structure.

The upgrading of the industrial structure includes both the overall upgrading of the industrial structure and the internal upgrading of the industrial structure, which not only touches on the rationalization of the industrial structure but also includes the progress of its integration. The significance of upgrading the industrial structure is not that the tertiary industry is more important, but that it requires the balanced development of all industries, that is, maintaining the stability of the primary industry, strengthening the secondary industry, and allowing the tertiary industry to prosper. In the dynamic stochastic overall model, the manufacturing industry will produce strong externalities, and its structural changes will curb energy adjustment and promote the adjustment of greenhouse gas emissions. The adjustment of the industrial structure reflects the dynamic relationships between the industries. The development speed of the industrial structure and changes in the proportion of industries are important factors affecting economic growth. The lack of hardware and software facilities is another important obstacle to the upgrading of the industrial structure. Lihong (2011) believed that the theory of the circular economy provided useful ideas for optimizing and upgrading the industrial structure. Xuejun, Bingqian, Jiaxu, and Xiangyue (2018) argued that China should strengthen human capital and foreign investment, optimize the business environment, expand intellectual property trade, build a global innovation chain, and promote industrial upgrading to enhance its status in the international division of labor. Yu and He (2012) concluded that the blueprint for upgrading the industrial structure was a light industry structure and a low-carbon energy environment.

After reviewing a large number of studies on population agglomeration and industrial structure upgrading, a few conclusions can be drawn. First, few academic studies have analyzed the effect of population agglomeration on industrial structure upgrading, so there is a significant gap in this area. Second, most studies take the national or provincial level as their overall research object, and few studies have investigated the regional level. Third, at present, there are still differing opinions on the impact of population agglomeration on the upgrading of the industrial structure, and more empirical research is needed to adequately characterize it.

3. THE MECHANISM BY WHICH POPULATION AGGLOMERATION AFFECTS THE UPGRADING OF THE INDUSTRIAL STRUCTURE

This paper holds that the Lewis dual economic model can explain the problem of migrant workers entering cities in China. Since a large number of migrant workers entering a city forms a population agglomeration there, it follows that the Lewis dual economic model can, to a certain extent, provide theoretical support for the influence of population agglomeration on the industrial structure.

American economist Walter Izard integrated the principles of time, hierarchy, and traditional three-dimensional space transformation in the study of economics, and put forward the concept of spatial economics. In Von and Johann (1842) studied the issue of agricultural location in his book "The Relationship between Isolated Countries and Agriculture and National Economy" and proposed that the most important factor that affects the variety and management of farms was distance. If the sum of freight and marginal cost caused by increased input was higher than the price, then the input would not be increased; only when freight and marginal cost were less than the price, could an increase in input bring benefits and the scale of production expand. After the Industrial Revolution, the theory of industrial location emerged. Christaller (1933) proposed that given the constraints of resource supply and product sales, the network node analysis method was the best solution to solve the optimal positioning problem of the manufacturer to minimize transportation costs, and George Picker used mathematical methods to prove it. Subsequently, Kristelle put forward the theory of the central area in his 1933 book "The Central Area of Southern Germany". Central area theory explained the existence of cities and towns and the factors that affected their development. These three spatial economic theories all discuss static partial equilibrium. In Lösch (1938) introduced general equilibrium in spatial research in "Location Economics", making distance itself the center. Space economics has since been further developed.

Since the 1970s, the combination of econometrics and spatial economics has given rise to spatial econometrics. In 1979, Palink proposed five criteria for the development of spatial measurement models, which laid a good foundation for the development of spatial measurement. Prior to this point, econometrics had mainly studied the relevance of variables in time, while ignoring their mutual influence in space. In the real world, variables cannot meet the requirements of complete independence and randomness, and there are often temporal and spatial correlations between variables. It is precisely because of the spatial correlation of variables that econometrics cannot satisfy the classical assumption of independence and identical distribution. In the spatial measurement model, the spatial weight matrix is introduced to reflect the interactive relationships of variables in space. The spatial weight matrix takes many forms, such as the adjacency matrix and inverse distance matrix. At present, spatial measurement models mainly include spatial autoregressive models, hybrid regression-spatial autocorrelation models, spatial error models, spatial Doberman models, and so on. The spatial Durbin model considers not only the lag effect of the variable but also includes the error effect of the variable.

This paper uses the Spatial Durbin Model to conduct an empirical analysis of the impact of population agglomeration on the upgrading of the industrial structure. The field of spatial econometrics provides a solid theoretical basis for the research of this paper.

4. EMPIRICAL ANALYSIS OF THE IMPACT OF POPULATION AGGLOMERATION ON THE UPGRADING OF THE INDUSTRIAL STRUCTURE

4.1. Construction of the Indicator System

This paper refines indicators such as urban output efficiency. The selected indicators in this paper are all available from official data from 2010 to 2019. The indicators selected in this paper reflect the level of population agglomeration and the current status of industrial structure upgrading. Yet, while the index system reflects as much as possible the various aspects of population agglomeration and industrial structure upgrading, at the same time, it must have a strong systemic connection. The indicators must conform to the characteristics of the region and be able to reflect the differences between the upgrading of industrial structures in different provinces.

Concerning the selection of explained variables, the degree of advanced industrial structure is used as a measure of the level of industrial structure. The specific calculation is as follows:

$$INS = \sum_{i=1}^{3} Y_i \times i = Y_1 \times 1 + Y_2 \times 2 + Y_3 \times 3 \quad (1<INS<3) \tag{1}$$

Equation 1 presents the calculation of the degree of advanced industrial structure, where Y_i represents the contribution rate of the output value of the tertiary industry to the province's GDP. The closer the index value is to 3, the higher the industrial structure of the city. By assigning different weights to the three industries, this indicator emphasizes the importance of the tertiary industry.

Concerning the selection of explanatory variables, the degree of population agglomeration is calculated as the quotient of the population density of a province and the national population density, as follows:

$$PA_{it} = \frac{(P_{it} / P_{nt}) \times 100\%}{(S_{it} / S_{nt}) \times 100\%} = \frac{P_{it} / P_{nt}}{S_{it} / S_{nt}} \tag{2}$$

Equation 2 presents the degree of population concentration, where PA_{it} represents the t year of the i province's population agglomeration, P_{it} represents the number of t year of the i province's population (ten thousand), P_{nt} represents the t year of the total national population (ten thousand), S_{it} refers to the t year of the i province's land area (square kilometers), and S_{nt} refers to the national administrative land area (square kilometers).

The control variable per capita GDP is used for the city's output efficiency. Per capita GDP can measure a city's per capita output level. The higher the per capita output level, the higher the city's output efficiency. The degree of government support is measured by the proportion of a province's fiscal expenditure to its GDP. The higher the proportion, the higher the degree of government support. The average number of years of education is used as an indicator of the level of human capital. The greater the number of years, the higher the average academic level of the province and the greater its human academic talent. Table 1 presents the variables and measurement methods.

Table 1. Variables and measurement methods.

Variable	Symbol	Basic Meaning	Measurement Method
Explained variable	INS	Industrial structural upgrade	Advanced degree of industrial structure.
Core explanatory variables	PA	Population agglomeration	The quotient of the proportion of a certain city's population to the country's population and the proportion of the city's administrative area to the country's land area.
Control variable	PGDP	Urban output efficiency	GDP per capita.
	HR	Human capital level	Average years of education.
	GOV	Government support	Government spending as a proportion of GDP.

This paper uses the data of 30 provinces in mainland China (excluding the Tibet Autonomous Region) from 2010 to 2019 to measure and analyze the impact of population agglomeration on the upgrading of the industrial structure. The data is taken from the website of the National Bureau of Statistics and the websites of the provincial statistical bureaus from 2010 to 2019. As relevant data cannot be found for many indicators of the Tibet Autonomous Region, the province is excluded. To eliminate the influence of heteroscedasticity, the data of industrial structure level, population agglomeration level, government support level, and urban output efficiency are processed in logarithm. Table 2 shows the descriptive statistics of the variables.

Table 2. Descriptive statistics of variables.

Variable	Obs.	Mean	Std. Dev.	Min	Max
HR	300	9.101	0.934	6.764	12.782
LNINS	300	0.871	0.053	0.761	1.041
LNPA	300	0.613	1.362	-2.853	3.292
LNGOV	300	-1.424	0.393	-2.184	-0.282
LNPGDP	300	1.493	0.471	0.262	2.802

4.2. Model Setting

4.2.1. Spatial Weight Matrix

The meaning of the spatial weight matrix is that the closer the geographical distance, the deeper the mutual influence will be. This paper adopts a 0-1 adjacency weight matrix, based on whether two provinces are adjacent to each other geographically; 1 means that two provinces are adjacent, and 0 means that they are not adjacent.

4.2.2. Moran Index

This paper uses a Moran index to test the degree of spatial autocorrelation between population agglomeration and industrial structure level. It is calculated as follows

$$Moran'I = \frac{\sum_{i=1}^{30}\sum_{j=1}^{30} w_{ij}\left(x_i - \bar{x}\right)\left(x_j - \bar{x}\right)}{s^2 \sum_{i=1}^{30}\sum_{j=1}^{30} w_{ij}} \tag{3}$$

Where x_i represents the concentration of population of i province and w_{ij} is the spatial weight matrix. The range of the Moran index is from -1 to 1. The larger the value, the greater the spatial correlation of the index. A positive index indicates a positive spatial correlation between regions; 0 indicates that the variable is randomly distributed; a negative index indicates a negative spatial correlation between this indicator in each province. Table 3 presents the results of the Global Moran index in 2019.

Table 3. Global Moran index in 2019.

Variables	I	E(I)	Sd(I)	z	P-value
LNINS	0.26	-0.03	0.11	2.66	0.004***
LNPA	0.58	-0.03	0.12	5.10	0.000***
HR	0.35	-0.03	0.11	3.45	0.000***
LNGOV	0.46	-0.03	0.12	4.01	0.000***
LNPGDP	0.35	-0.03	0.12	3.16	0.001***

Note: *** indicates significance levels at 1%.

For the 2010 -2019 panel data, the Global Moran index indicates that industrial structure upgrading, the degree of population agglomeration, the extent of government support, urban productivity, human capital level are all significant at the 99% confidence level (see Table 3). The Z- score value is greater than 1.65, reflecting a clear positive spatial autocorrelation, so the data is suitable for use in a spatial autocorrelation model.

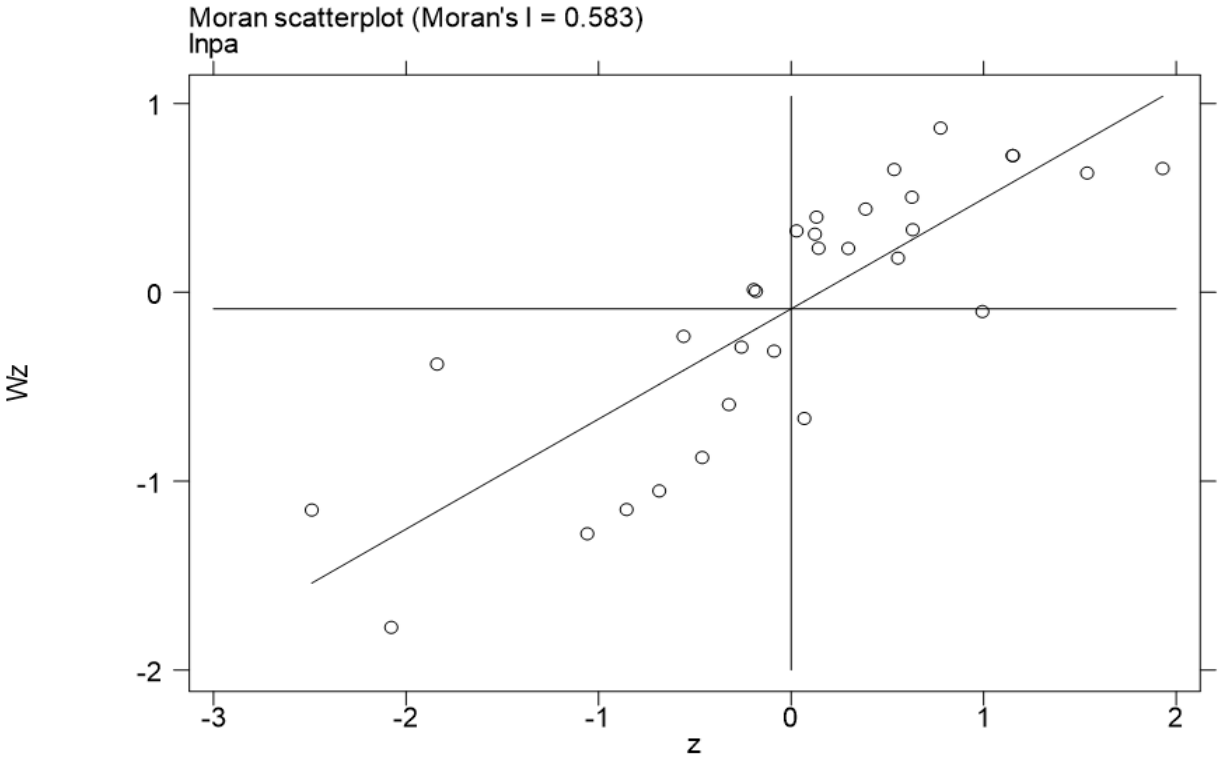

Figure 1. Moran scatterplot of population agglomeration.

Figure 1 illustrates the Moran scatterplot of the population agglomeration. The Moran scatter plot demonstrates that the population agglomeration indicators of 28 of the provinces are in high-high or low-low agglomeration areas, and only 2 provinces are in high-low or low-high agglomeration areas, with strong spatial freedom. Moreover, the provinces in high-high concentration areas are grouped more densely.

4.3. Model Selection and Testing

Table 4 shows the results of model selection and testing. The Lagrangian multiplier test results show that there are spatial errors and spatial lag effects at the 99% confidence level. Therefore, it is determined that the data used in this paper has the above two effects, making it suitable for the spatial Durbin model. The likelihood ratio test and Wald test are performed in Stata, and the P-value of the two tests is 0, which means that the spatial Durbin model cannot be split into a spatial lag model and a spatial error model. The Hausmann test on random effects and fixed effects is also performed in Stata. The null hypothesis of random effects is rejected at the 99% confidence level, therefore this paper chooses to apply the spatial Durbin fixed-effects model.

Table 4. Model selection and testing.

Testing method	Estimated value	P-value
Hausman test-statistic	215.531	0.0000***
Wald_spatial_lag	42.142	0.0000***
Likelihood-ratio test (Assumption: sar_a nested in sdm_a)	60.603	0.0000***
Likelihood-ratio test (Assumption: sem_a nested in sdm_a)	66.902	0.0000***
Lagrange multiplier (Spatial error)	210.032	0.0000***
Lagrange multiplier (Spatial lag)	139.612	0.0000***

Note: *** indicates significance levels at 1%.

4.4. Empirical Analysis

Since the level of industrial structure is the explanatory variable in this paper, one of the economic indicators involved is GDP. Changes in systems and policies, such as changes in certain tax rates, have a significant impact on GDP. At the same time, institutional factors also appear to be accompanied by changes over time, so this paper considers time fixed effects. In addition, the individual fixed effects and double fixed effects are estimated, and the results prove that the time-fixed model has the largest value and the best degree of fitness. Therefore, the spatial Durbin model is set as follows:

$$\begin{aligned}\ln \mathrm{INS}_{it} = {} & \delta \sum_{j=1}^{N} W_{ij} \ln \mathrm{INS}_{it} + \beta_1 \times \ln PA_{it} + \sigma \sum_{j=1}^{N} W_{ij} \ln \mathrm{PA}_{it} + \beta_2 \times \ln GOV \\ & + \beta_3 \times \ln PGDP_{it} + \beta_4 \times HR_{it} + \mu_i + \varepsilon_i\end{aligned} \tag{4}$$

In which $\delta, \sigma, \beta_1, \beta_2, \beta_3, \beta_4$ are the estimated coefficients, μ_{i} represents the time fixed effect, ε_{i} expresses a random interference term. Table 5 presents the results of the spatial Durbin model.

Table 5. Time fixed effects, individual fixed effects, and fixed effects.

Variables	(Time) lnINS	(IND) lnINS	(Both) lnINS
Main			
lnpa	0.0114***(7.35)	-0.00452(-0.12)	-0.0164(-0.51)
hr	0.00972***(3.85)	-0.00478(-1.54)	-0.00177(-0.52)
lngov	0.0650***(11.77)	0.0466***(5.58)	0.0136(1.55)
lnpgdp	0.0949***(14.71)	0.0328***(5.33)	-0.04***(-4.21)
Spatial			
rho	-0.261***(-3.95)	0.513***(8.84)	-0.130(-1.51)
Variance			
sigma2_e	0.000564***(12.17)	0.000095***(11.94)	0.000065***(12.22)
N	300	300	300

Note: *t* statistics in parentheses; *** p <0.001.

The empirical results in Table 5 show, first, that the degree of population agglomeration, human capital level, urban output efficiency, and government support are all significant at the 95% confidence level, indicating that the above variables can significantly affect the optimization and upgrading of the industrial structure. Second, in terms of coefficients, the coefficients of population concentration, urban output efficiency, and human capital level are all positive, indicating that population concentration, urban output efficiency, and human capital level can promote the optimization and upgrading of the industrial structure. Among these, the coefficient of urban output efficiency is the largest, thus its explanatory capacity for the upgrading of the industrial structure is the highest.

Table 6. Fixed time decomposition.

Variables	(Direct effect)	(Indirect effect)	(Total effect)
lnpa	0.012***(0.00)	-0.003***(0.00)	0.009***(0.00)
hr	0.010***(0.00)	-0.002***(0.00)	0.008***(0.00)
lngov	0.067***(0.00)	-0.015***(0.00)	0.052***(0.00)
lnpgdp	0.097***(0.00)	-0.021***(0.00)	0.076***(0.00)
Observations	300	300	300
R-squared	0.754	0.754	0.754
Number of Provinces	30	30	30

Note: t statistics in parentheses; *** p <0.001.

The direct effect reflects the average impact of population agglomeration on the upgrading of the industrial structure in the region, the indirect effect reflects the average impact of population agglomeration on the upgrading of the industrial structure in other regions, and the total effect explains the average impact of population agglomeration on the upgrading of the industrial structure in all regions. Thus, the time fixed effect can be broken down. Table 6 presents the results of the fixed time decomposition.

The estimation results in Table 6 indicate, first, that the R^2 value is relatively large, which proves that the model is a good fit and can be used for analysis. Second, after adding the three variables of human capital, government support, and urban output efficiency as control variables, the impact of population agglomeration in a region on the upgrading of the regional industrial structure is positive. Every increase in population agglomeration promotes the structural level of the industry by 0.012 units. The impact of population agglomeration in neighboring areas on the upgrading of the industrial structure of a region is negative. Every percentage point increase in the level of population agglomeration in neighboring areas will reduce the level of industrial structure in the region by 0.003. On the whole, however, population agglomeration provides a boost for the upgrading of the industrial structure. Every increase in population agglomeration increases the optimization level of the total industrial structure by 0.009.

Third, the impact of the three control variables of human capital level, government support, and urban output efficiency on the upgrading of the industrial structure is consistent with the conclusions of many previous scholars. The impact of these three variables on the level of industrial structure is strongly significant. The coefficients in the direct effects are all positive, the coefficients in the indirect effects are all negative, and the coefficients in the total effects are all positive. The level of human capital promotes the upgrading of the industrial structure in a region while inhibiting the upgrading of the industrial structure in neighboring areas, which has obvious negative spillover effects. Each increase in the level of human capital by one unit will increase the level of the local industrial structure by 0.01 units and reduce the level of neighboring areas by 0.002 units. However, from the perspective of the total effect, the level of human capital has a positive impact on the industrial structure.

Table 7. Double fixed effects in Eastern, Central, and Western regions.

Variables	(East) lnINS	(Central) lnINS	(West) lnINS
Main			
lnpa	-0.105**(-2.99)	0.397***(5.24)	0.00547(0.04)
lnhr	0.0184(0.43)	0.0247(0.75)	-0.0206(-0.47)
gov	-0.0277(-0.60)	0.144*(2.32)	0.120*(2.45)
lnpgdp	-0.0679***(-5.73)	-0.00806(-0.71)	-0.0460**(-2.58)
Spatial			
rho	-0.0727(-0.38)	-2.186***(-5.64)	-0.231(-0.20)
Variance			
sigma2_e	0.0000320***(7.42)	0.0000155***(4.67)	0.0000524***(3.35)
N	110	80	110

Note: t statistics in parentheses; * p <0.05, ** p <0.01, *** p <0.001.

The 30 provinces studied here can be classified into the three regions of east, central, and west. The empirical analysis of spatial Durbin double fixed effects is carried out, and its results are presented in Table 7.

First, after adding the three variables of human capital, government support, and urban output efficiency as control variables, the population agglomeration in the west of the country cannot effectively explain the upgrading of the industrial structure in the region, although the population agglomeration in the central part is shown to promote the upgrading of its industrial structure. However, the level of population agglomeration in the east of the country has a restraining effect on the upgrading of the industrial structure. Each increase in the level of population agglomeration in the central region increases its industrial structure upgrade level by 0.397 units. Each increase in the level of population agglomeration in the eastern region reduces its industrial structure upgrade level by 0.105 units. The over-concentration of population in the eastern region puts too much pressure on the cities, thereby reducing production efficiency, which is not conducive to the upgrading of the industrial structure. However, the degree of population agglomeration in the western region is too low to have an effective impact on the industrial structure, so its impact on the level of the industrial structure is not significant. In contrast, the central region is currently in a stage where population agglomeration promotes the upgrading of the industrial structure.

Second, the control variable is not significant in the double fixed effects model. The level of human capital cannot effectively explain the level of industrial structure in the eastern, central, and western regions. One possible reason is that academic qualification level is not enough to summarize the overall level of human capital. In terms of their effect on the upgrading of the industrial structure, vocational skills are a more contributor to human capital. Table 8 shows the results of the effect of population agglomeration on the contribution rate of the tertiary industry output value.

Table 8. The effect of population agglomeration on the contribution rate of the tertiary industry output value.

Variables	(East) lndscy	(Central) lndscy	(Western) lndscy
Main			
lnpa	0.482***(3.72)	0.397***(5.24)	0.737**(2.64)
lnhr	-0.0713(-0.46)	0.0247(0.75)	-0.165(-0.90)
gov	-0.351*(-2.03)	0.144*(2.32)	0.822***(5.26)
lnpgdp	0.59***(13.13)	-0.00806(-0.71)	0.94***(13.66)
Spatial			
rho	-0.547*(-2.51)	-2.17***(-5.64)	-0.452(.)
Variance			
sigma2_e	0.000438***(7.64)	0.0000155***(4.67)	0.000959***(7.31)
N	110	80	110

Note: t statistics in parentheses; * p <0.05, ** p <0.01, *** p <0.001. lndscy means the contribution rate of the tertiary industry output value(logarithm).

4.5. The Impact of Population Agglomeration on the Contribution Rate of Regional Tertiary Industry Output Value

The service industry, entertainment industry, and financial industry account for a large proportion of the tertiary industry, and a prominent feature of these industries is the high proportion of labor factors. Therefore, it is conjectured that population agglomeration can significantly affect the contribution rate of the output value of the tertiary industry. Table 9 indicates the results of the robustness test.

First, after adding the control variables of human capital, government support, and urban output efficiency, the impact of population agglomeration on the tertiary industry in different regions is significantly increased. For every unit increase in the level of population agglomeration, the contribution rate of the tertiary industry output value in the eastern region increases by 0.482 units, that of the central region increases by 0.397 units, and that of the western region increases by 0.737 units.

Table 9. Robustness test.

Variables	lnINS	P-value	lnINS	P-value		
	Main		Wx			
Lnpa	0.0128 *** (6.37)	0.000	0.0307 *** (6.88)	0.000		
Lngov	0.0780 *** (14.79)	0.000	0.0936 *** (5.70)	0.000		
lnpgdp	0.0907 *** (13.45)	0.000	0.0231(1.39)	0.164		
Hr	0.00801 ** (2.76)	0.006	-0.000175(-0.04)	0.969		
Spatial						
Rho	-0.488 *** (-5.75)	0.000				
Variance						
sigma2_e	0.0005 *** (11.87)	0.000				
	LR_Direct		LR Indirect		LR_Total	
Lnpa	0.0102 *** (4.31)	0.000	0.0190 *** (5.79)	0.000	0.0292 *** (11.53)	0.000
Lngov	0.0718 *** (13.64)	0.000	0.0439 *** (4.15)	0.000	0.116 *** (11.87)	0.000
lnpgdp	0.0936 *** (12.60)	0.000	-0.0166(-1.49)	0.136	0.0770 *** (9.43)	0.000
Hr	0.0082 * (2.57)	0.010	-0.00298 (-0.76)	0.446	0.00521 * (2.12)	0.034
N	300		300		300	

Note: t statistics in parentheses; * p <0.05, ** p <0.01, *** p <0.001.

Second, among the control variables, the degree of government support is significant, and the impact of urban output efficiency on the development of the tertiary industry in the eastern and western regions is significantly increased, while the impact in the central region is not significant. The contribution rate of the human capital level to the output of the tertiary industry in the eastern, central, and western regions is not significant. One possible reason is that the structure of education does not match the needs of the industry, causing distortions, and education is, therefore, unable to promote the industry. Another possible reason is that technical ability has a more significant impact on output value, and the average number of years of education has only an indirect effect on the contribution rate of output value.

4.6. Robustness Test

Analyzing the data for random effects, it is found that the sign of the coefficient of each variable is the same as the sign of the fixed effect, indicating that the model is robust.

5. CONCLUSIONS AND POLICY SUGGESTIONS

5.1. Conclusion

First, according to the analysis of inter-provincial data, population agglomeration has the effect of promoting the transformation of the industrial structure. From a regional perspective, population agglomeration inhibits the upgrading of the industrial structure in the eastern region, promotes the upgrading of the industrial structure in the central region, and has no effect on the upgrading of the industrial structure in the western region. In terms of the analysis of the tertiary industry, population agglomeration has significantly promoted the industrial structure of the eastern, central, and western regions. The agglomeration of the population means that the labor market in the region is more abundant, which has a positive effect on the allocation of labor among industries, especially when the labor force of young and middle-aged people accounts for a large proportion of the migrating population, and this population is also more welcomed by the market. It enriches the supply of the labor market, but also attracts more advanced industries to converge in the same area, thereby achieving economies of scale and stimulating economic growth. When a large number of people pour into the same area, on the one hand, it provides a large labor supply for the tertiary industry in the factor market. On the other hand, it increases the demand for tertiary industry products in the product market. Therefore, population agglomeration can stimulate the optimization and upgrading of the industrial structure and promote economic prosperity and development. Nonetheless, excessive population in the same area may lead to traffic congestion, cost increases, and other reductions in urban efficiency, as well as an increase in urban diseases. At present, however, most provinces in China can still bear the pressure brought by population agglomeration and further advance the industrial structure.

Second, from an inter-provincial perspective, human capital plays a role in promoting the upgrading of the industrial structure. Population agglomeration promotes the accumulation of human capital, and the spillover effect of knowledge appears, improving the productivity of labor and thus increasing the marginal return of labor. The agglomeration of human capital also promotes the conversion rate of knowledge and technology, which is transformed into endogenous power, thereby promoting technological innovation, changing the labor-to-technology ratio of the industry, and biasing the industry toward technological progress.

5.2. Policy Suggestions

Based on the empirical analysis and conclusions of this paper, we can make the following policy suggestions:

First, promote the reform of the household registration system. China's household registration system is linked to many aspects, such as medical care and insurance, and is one of the important factors restricting population mobility. Cities should fully consider their own stage of development, formulate corresponding and reasonable household registration systems, and encourage productivity while providing a secure path for the floating population.

Secondly, strengthen human capital investment and promote human capital accumulation. School education has long been widely valued by the public as a potential human capital investment method, but vocational skills training should not be underestimated. Vocational skills training can quickly cultivate the working ability required for the corresponding position, bringing direct benefits to enterprises and individuals. Therefore, it is necessary to enrich human capital investment, improve vocational training standards, and cultivate more talents who can meet the needs of the industry.

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