RESEARCH ARTICLE

The impact of population migration on regional economic gap in the Yangtze River economic belt and its spatial spillover effect

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Abstract: There has always been a debate on whether population migration has an expanding effect or a narrowing effect on the regional economic gap. This paper makes a further analysis of this issue by using the spatial panel data of 104 cities in the Yangtze River economic belt from 2001 to 2017. The main conclusions are as follows: (1) for the overall regional economic gap, there is an inverted "U"-shaped nonlinear relationship between population flow, population migration and economic gap: expansion effect in the early stage, and the convergence effect in the later stage, which is consistent with China’s gradient development strategy and the phased development concept of “the rich first pushing those being rich later, and finally realizing common prosperity”. (2) For the regional economic gap in the province, population flow also shows the role of expanding first and then converging, while population migration only shows the effect of expansion rather than convergence. The difference between population mobility and population migration originates from the spatial transformation of economic behavior and resource allocation brought about by the change of the latter’s household registration. (3) Considering the spatial effect, the endogenous relationship between population migration and regional economic gap becomes relatively complex, but more comprehensive and objective. The effect decomposition shows that population mobility and population migration are ultimately conducive to balanced regional development, with spillover effect playing an important role.

Keywords: Population migration; Regional economic gap; Spillover effect; Balanced development; Yangtze River Economic Belt

In May 2021, the main data of the seventh national census was released, in which the floating population reached 376 million, a significant increase of nearly 70% compared with the sixth census (Ning, 2021), which attracted wide attention. Since the reform and opening up, the rapid economic development has brought about large-scale population migration. The increase of the frequency of population movement across region has made the floating population one of the factors that promote the regional economic development. China’s economic achievements show that demographic dividend is one of the main reasons for China’s rapid development, in which labor migration and floating population play an important role (Cai, 2013). Reviewing China’s cognition and governance process of population migration and mobility is a process from restriction to freedom. Although the current population mobility is free in space, identity has not yet achieved “free conversion”, and the registered residence system is still the key factor restricting the full free migration of floating population. China’s registered
residence system reform is still dominated by local governments. Under the increasingly widening regional economic gap and decentralization and political promotion mechanism, local governments generally resist the free movement of population which makes the idea of central government’s to decentralize power to local governments to achieve “completely liberalizing registered residence control and realize free migration of population” unrealistic (Zhang, 2012). The floating population group with identity and welfare significance will continue to exist for a certain period of time. However, as China’s population fertility rate remains at a low level, labor force competition has become an important direction of local government’s work, which can be reflected in the “population competition” by liberalizing the settlement conditions in many cities in recent years. Whether registered residence system reform or not, it is an undeniable fact that population mobility is conducive to sustainable economic development is universally recognized by theory and practice, and has also been shown in the practice of local government competition. For inflow or developed areas, the population without registered residence is the basic guarantee for the developed areas to maintain lower labor costs and reduce social security expenditure, and is conducive to maintaining the competitive advantage and growth of the local economy. For outflow or underdeveloped areas, the registered residence of the outgoing population is retained locally, which is conducive to continuing to enjoy the financial transfer payment of the higher authorities, and the income from the population of migrant workers is beneficial to local consumption because of the “migratory bird” style movement, which is conducive to the growth of local economy.

Therefore, from the perspective of competition between local governments, the flow of population cut by identity and welfare under the registered residence system is beneficial to inflow and outflow place. However, this leads to another problem: population mobility is conducive to regional economic growth, but its relationship with regional economic gap is not unified. At the same time, there are many discussions abroad about the impact of population migration on regional economic gap, because it does not strictly distinguish between population migration and mobility, and uses “migration” as the definition. However, due to the registered residence system, conceptual understanding and statistical differences, there are relatively few studies on the impact of population migration in China (Liu, Liu, and Cao, 2021). Li and Miao (2017) believe that population mobility has the most prominent impact on regional economic differences. However, there are still disputes about whether population mobility should narrow or expand the regional development gap. Many foreign studies on the relationship between population mobility and regional economic gap have given opposite conclusions. For example, Barro and Sala-i-Martin (1990) systematically tested the existence of economic convergence in the United States from 1840 to 1988. When they further introduced population migration (immigration) into the economic convergence of Japan and the United States, they found that population migration could not play an important explanatory role in economic convergence (Barro and Sala-i-Martin, 1993), which was also the case in several European countries, including Spain, Germany, Italy and so on. Taylor (1997) studied 17 countries with a large number of immigrants in the organization for economic cooperation and development, but believed that population mobility was the main factor in the convergence of labor rate and wage rate. The relevant research conclusions in China are also diversified. Some studies believe that with the reduction of population mobility barriers, its role in narrowing the regional gap is increasing. Population mobility can promote economic convergence and narrow the development gap between regions in China (Zhang and Cai, 2013; Hou and Chen, 2016). However, some people also believe that population mobility does not have a convergence effect on China’s economy, and even has a trend of divergence and expansion, especially having an adverse impact on the outflow areas of population in Central China (Duan, 2008; Mao and Zhai, 2013). Liu and Wang (2016) analyzed the impact of the economic development gap in Beijing, Tianjin and Hebei, and found that labor mobility did not play a role in narrowing the per capita GDP gap; Peng (2015) pointed out that with the relaxation of labor mobility restrictions, skilled labor in the central and western regions flows to the eastern region, further widening the regional development gap.

To sum up, the relationship between population mobility and migration and regional economic development gap is not linear, but may be nonlinear, that is, it may expand or narrow the economic gap between regions. However, the existing studies rarely consider the nonlinear relationship between the two. At the same time, the economic gap obviously involves different regions, which is a typical spatial problem. Many literatures point out the spatial spillover effect of economic activities and economic output, and the economic gap is no exception (Zhong and Li, 2010; Zhu, Qiao, and Yu, 2014; Liu, Jia, and Peng, 2019), while the spatial spillover may further affect economic convergence (Sun, Chen, and Li, 2017). When the spatial spillover effect is included to study the impact of population mobility on economic gap, the problem is relatively complex (Li and Ou, 2017; Zhou and Chen, 2020). Therefore, the research on this topic is rare and does not fully answer whether population mobility reduces or expands the regional gap. Therefore, more empirical studies in different periods and regions are needed. Moreover, there are obvious differences between population mobility and population migration in China, while the research on the impact of the latter’s economic differences is very rare, which also provides space for in-depth research. Therefore, based on the existing research, this paper will further distinguish and discuss the nonlinear impact of population flow and population migration on the economic gap after superimposing the spatial spillover effect. Taking the urban agglomeration of the Yangtze River economic belt as the analysis sample, this paper will investigate the
characteristics of urban economic gap since the great western development of g balanced regional development in China in the new century.

1. Research Design

1.1 Study Area Selection

The Yangtze River economic belt is an extremely important development axis in China’s land development and economic construction (Duan, Yu, and Zhou, 2015). The Outline of the Yangtze River Economic Belt Development Plan\(^1\) clearly puts forward “improving the system and mechanism conducive to the rational flow of population” and “innovating the system and mechanism of regional coordinated development”. Population migration and regional balanced development are the strategic objectives of the Yangtze River economic belt. Whether there is an internal relationship between population migration and regional economic gap is a new topic worthy of exploration. In terms of the characteristics of the Yangtze River economic belt, on the one hand, the number of floating population and migrant population is huge, which not only accounts for an important proportion of the total population, but also an extremely active labor capital, which has a great impact on economic growth; on the other hand, the Yangtze River economic belt spans the east, middle and west regions, which is the epitome of the change of China’s floating population and the process of regional development. The Yangtze River economic belt covers 11 provinces and cities, including Shanghai, Jiangsu, Zhejiang, Anhui, Jiangxi, Hubei, Hunan, Chongqing, Sichuan, Yunnan and Guizhou. The land area accounts for 21% of the country, and the total population and economy account for about 40% of the country. According to the summary data of the sixth census (Census Office of the State Council, 2012), the total scale of floating population in the Yangtze River economic belt is 108 million, accounting for about 42% of the total floating population in China. Among them, the inter provincial flow scale is 72.91 million and the intra provincial flow scale is 35.31 million. Therefore, studying the relationship between population migration and economic gap in the Yangtze River economic belt is a regional model for understanding China’s population change and economic change.

1.2 Theoretical Analysis

In the case of surplus labor supply, underdeveloped areas are often accompanied by insufficient labor posts. On the contrary, developed areas have surplus labor demand and sufficient labor posts, so they form a spatial gradient. Developed areas have a “pull” effect on the surplus labor force in underdeveloped areas and attract the cross regional flow of labor force; similarly, underdeveloped areas have a “push” effect on their labor force and promote labor outflow (Figure 1). In addition, China’s economic development is concentrated in big cities, the coastal areas have priority over the central and western regions, and all kinds of production factors such as capital flow from underdeveloped areas to developed areas, which makes the growth of innovation level, income and consumption level in developed areas faster than those in underdeveloped areas. Therefore, the economic gap between regions in the early stage of reform continues to be widened. In recent years, due to the dynamic influence of free migration and urbanization, the number of permanent residents in some cities has increased sharply, and the crowding effects such as factor cost, transportation, education, housing price and pollution are obvious, which has brought some negative effects. In addition, the economy began to transform from high-speed growth to high-quality development, and the economic growth in developed regions slowed down; coupled with the long-distance mobility needs to take into account the cost of child support and elderly support. The pursuit of “urban dream” has cooled down, the proportion of migrant workers employed nearby has been rising, and underdeveloped areas have given play to their late development advantages, ushering in rapid economic development. Therefore, the economic gap between regions may be narrowing. From the perspective of theoretical analysis, the regional economic gap is in a dynamic change process, and there is a coupling relationship between population flow, population migration and regional economic gap in theory, but the population migration itself and the regional economic gap show an expansion effect or a narrowing effect, or exist at the same time, which requires an empirical study of its internal coupling mechanism and quantitative relationship through data.

1.3 Methods and Strategies

The empirical part of this paper considers two issues: the nonlinear relationship between population migration and regional economic gap, and the impact of spatial spillover effect. Therefore, the core explanatory variables of the spatial panel data model constructed in this paper are population mobility, population migration and its square term. The spatial panel data model is based on the ordinary panel model. There are many forms of spatial panel data models. The most classical models are spatial lag model (SLM) and spatial error model (SEM). The spatial panel lag model assumes that the dependent variable

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The impact of population migration on regional economic gap has spatial dependence. The model in this paper is set as follows:

$$y_{it} = \alpha + \rho W y_{it} + \beta_1 m_{it} + \beta_2 m_{it}^2 + \phi X_{it} + \epsilon_{it}$$

(1)

Figure 1. The relational framework of population mobility and urban economic gap.

Where: $W$ is the spatial weight matrix; $\rho$ is the spatial lag coefficient; $y$ is the dependent variable regional economic gap; $m$ is the population flow or population migration; $X$ is other control variables; $i$ and $t$ are cities and years respectively; $\alpha$ is intercept item; $\beta$ and $\phi$ is the variable coefficient; $\epsilon$ is the error term. Therefore, the specific form of the nonlinear relationship between $\beta_1$ and $\beta_2$ can be obtained by judging their significance and sign direction. The spatial panel error model assumes that the error has spatial dependence (where $\lambda$ is the spatial error coefficient), and the model in this paper is set as:

$$y_{it} = \alpha + \beta_1 m_{it} + \beta_2 m_{it}^2 + \phi X_{it} + \epsilon_{it}$$

(2)

$$\epsilon_{it} = \lambda W \epsilon_{it} + u_{it}$$

(3)

Where: $u$ is the error term. Spatial lag coefficient $\rho$ in the above model and spatial error coefficient $\lambda$ cannot accurately refer to the spatial spillover effect of population migration on economic gap. It is necessary to jointly estimate the specific impact degree of the two through direct effect and indirect effect (spatial spillover effect). According to Elhorst (2012) on the matrix form of the partial derivative of the explanatory variable to the explained variable, the average value of the elements on the diagonal of the matrix is the direct effect of the explanatory variable on its own economic gap, and the average value of the elements on the non diagonal of the matrix is the spatial spillover effect or indirect effect of the explanatory variable on its surrounding regional economic gap.

1.4 Variables and Data

The dependent variable is the regional economic gap, in which the common definition is the difference between the per capita GDP of the city and the average per capita GDP of all cities (Lu and Jia, 2018), which is called the global regional economic gap. To further analyze the locality of economic disparities, there is another way to defined: the difference between the GDP per capita of the city and the average of all cities in the province where the city is located is called the regional economic gap within the province. The core explanatory variable is the scale of floating population or the scale of migrant population $m$ and its square term $m^2$. For the scale of floating population, the state has not publicly released the statistical data of floating population in cities at prefecture level and above for consecutive years, so it is impossible to
accurately obtain the accurate panel data of the number of urban floating population. The data on the number of urban floating population in the existing research mainly come from the national census or sampling survey. These data lack time continuity and are difficult to effectively meet the requirements of panel model econometric analysis. The *Statistical Yearbook of China’s Urban Construction* publishes the data of urban temporary resident population (China’s Ministry of Housing and Urban-Rural Development, 2019) and defines it as “people who leave the urban area or township or town where they have permanent residence and live in the city for more than half a year”. Therefore, the temporary resident population published therein is defined as urban floating population (Yang, 2019). Although the short-term temporary resident population of less than half a year is not included in the statistics, it may lead to incomplete accuracy. However, when the data of floating population is extremely scarce, it can be regarded as a feasible proxy data. For the size of the migrant population, the algorithm refers to the calculation formula of Liu (2021) and Li (2015): migrant population = population at the end of the year – population at the end of the previous year – natural population growth rate; China’s city registered residence statistics are the source of the data. The population data of the yearbook are registered residence data, which provide more accurate statistics of the household migration population. In terms of other control variables, according to the neoclassical growth model, capital, labor and human capital are the main growth factors. On this basis, some indicators are selected by referring to other relevant literature on economic growth. The specific control variables include: (1) material capital \( K \), which is expressed as the proportion of total fixed asset investment in GDP of the current year; (2) the number of labor force \( L \), which is intended to be expressed in the proportion of the working population to the total population. However, since there is no separate statistics on the working population and only the number of employees per unit, it is expressed as the proportion of working population per unit to the total population, which can also be called labor force participation rate or demographic dividend; (3) human capital \( H \), which is expressed as the proportion of the number of students in colleges and universities to the total population, which also means the dividend of population quality. In addition to the above three, there are many factors that may be related to regional economic differences or economic convergence (He, 2021) including: (4) innovation ability, science and technology is the primary productive force. Scientific and technological innovation has long become an important driving force to promote economic development. The number of urban invention patents represents the regional innovation ability. (5) Consumption power is also an important channel to promote economic growth. Especially in China, as one of the troikas driving economic development, consumption power is characterized by the proportion of total social consumption retail sales to total GDP. (6) The marketization level is an important indicator of the business environment, and a good business environment may also promote the expansion of the local economy and other regional economies (Dong and Cui, 2020). The marketization level is characterized by the proportion of the number of private and individual employees in the total employment. (7) The research shows that foreign direct investment will also affect the economic gap between regions (Zhou, 2020). This paper also takes into account the factors, and expresses foreign direct investment \( FDI \) as the proportion of foreign direct investment in total GDP. This index is also a way to show the degree of regional opening to the outside world. (8) In addition, the level of urbanization has also played an important role in China’s modernization process, but its role in economic differences needs to be further discussed. Wang (2017) pointed out that large urbanization (more than one million people) will promote the convergence of economic conditions between Chinese cities, while the impact of urbanization in a general sense has not been discussed in depth, and this index has also been included in the analysis. It should be noted that there is no comprehensive data on the urbanization population or urbanization rate of Chinese cities in consecutive years. The proportion of non-agricultural population is used as the proxy index of urbanization. Among the above variables, patent data comes from China research data service platform\(^2\), and other indicators come from China city statistical yearbook.

It should be pointed out that due to the lack of data in some cities and autonomous prefectures, it is not possible to fully collect the data of all cities in the Yangtze River economic belt. For example, the China city statistical yearbook fails to collect the data of autonomous prefectures such as Liangshan Prefecture, Aba Prefecture and Ganzi Prefecture in Sichuan Province. At the same time, due to the long-time span and the change of administrative division, some cities cannot have long-term continuous data. For example, Bijie City and Tongren City in Guizhou changed greatly when they were relocated and established as cities, so that the statistics have not been made in China’s city statistical yearbook. The change of Chaohu City in Anhui Province between district, prefecture level city and county-level city also make the data incomplete. Therefore, the data of 104 cities in the Yangtze River economic belt from 2001 to 2017 were collected; although there are still a small number of cities with missing data in individual years, the missing data are processed by the year before and after the missing data. In addition, the urban data includes all county units of municipal districts, counties and county-level cities, that is, the whole city division. Therefore, the research object is defined as regional economic differences rather than real urban economic differences.

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\(^2\) Chinese Research Data Service Platform. https://www.cnrrds.com/Home/Login
2. Empirical Analysis

2.1 Analysis on the Spatial Pattern of Floating Population and Migrant Population in the Yangtze River Economic Belt

First, let's look at the spatial pattern of floating population, and draw the average annual scale change of floating population during the study period as shown in Figure 2a. Overall, the inflow population of Jiangsu, Zhejiang and Shanghai urban agglomeration basically exceeds 100,000, of which the inflow population of major cities such as the Yangtze River Delta and the capital of central and western provinces is large, more than 500,000. From 2001 to 2017, the average annual floating population in Shanghai was 6.71 million, with a peak of 9.96 million. Look at the spatial pattern of migration. The migration of population is the net migration of registered residence population. By calculating this value, we can see that the net migration amount of some city is positive, and that of some city is negative. For this purpose, the spatial pattern analysis is also made on the mean value of the migrant population in all years in the study period (Figure 2b). The cities with positive migration population in the Yangtze River economic belt are not absolutely located in the eastern cities, nor are the cities with negative increment located in the central and western regions, but are distributed in the eastern, central and western regions. Among them, the cities with positive increment are mainly key cities, such as municipalities directly under the central government and provincial capital cities. Statistics show that the number of cities with positive immigration population in the Yangtze River economic belt is 49 and 55 are negative, and the number of net outflow cities is slightly more than that of net immigration cities. Chengdu has the largest net immigrant population, with an average annual population of 220,000; Hefei has an average annual net migration of 140,000 people, ranking second. Ziyang City in the West and Lu’an City in the middle have the largest net outflow, with an average annual net outflow of about 90,000 people. Overall, the average net migration of all cities in the Yangtze River economic belt is 7,500, indicating that the Yangtze River economic belt has the power to attract population migration at the national level.

2.2 Spatial Pattern Analysis of Urban Economic Gap in the Yangtze River Economic Belt

In fact, the urban economic gap is the manifestation of the spatial heterogeneity of the level of economic development. It has a different meaning from the level of urban economic development itself. The gap contains (non) balanced meaning and can better reflect the spatial or regional effect. This paper first analyzes the spatial pattern of urban economic gap in the Yangtze River economic belt. From 2001 to 2017, the overall regional economic gap of cities and the regional economic gap within the province (Figure 3) show that the cities with the overall regional economic gap higher than the average value of more than 20,000 yuan are concentrated in the Yangtze River Delta, with Shanghai, Hangzhou and Nanjing as the core, a total of 14 cities; there are 24 cities with an average of 0-20,000 yuan higher than the average. The majority of cities are below the average, including 32 cities above 10,000 yuan and 34 cities below 10,000 yuan (Figure 3a). The regional gap distribution in the province is relatively balanced, which also shows that the economic gap in the province is relatively small (Figure 3b). Among them, in addition to the cities in the Yangtze River Delta with an average value of more than 10,000 yuan, the provincial capitals and some cities in the central and western regions also rank among them. Among the regional economic disparities in the province, the gap between northern Jiangsu and southern Jiangsu and the gap between southern Zhejiang and northern Zhejiang are obvious, while the internal gap between central and western provinces is relatively small.

In order to further analyze the spatial agglomeration characteristics of economic gap, the spatial autocorrelation method
is used to test whether the regional economic gap in the Yangtze River economic belt has spatial dependence and spatial heterogeneity. The global spatial autocorrelation test shows that the global Moran’s $I$ of the global regional economic gap is 0.4888, the $Z$ statistical test quantity is 6.61, which is greater than the statistical value of 5% significance level of 1.96, and the probability of no spatial autocorrelation is 0, indicating that there is a significant spatial dependence of the regional economic gap in the Yangtze River economic belt, that is, the spatial distribution of the economic gap is not random, but has a certain spatial law, mainly showing spatial clustering and heterogeneity, which also shows that the spatial effect needs to be considered in the subsequent analysis of regional economic gap. The global Moran’s $I$ of the regional economic gap in the province is 0.2571, which is consistent with the global regional economic gap, but Moran’s $I$ is smaller, which indicates that the aggregation characteristics are not so prominent. Local spatial autocorrelation analysis examines the spatial clustering and contiguous distribution of differentiated economic disparities. Local Moran’s $I$ is usually used and analyzed by making an agglomeration map. The significant high concentration area (H-H area) of the overall regional economic gap is concentrated in southern Jiangsu, which is a typical developed area in China; low-low concentration area (L-L area) is concentrated in Northeast Sichuan, which is a relatively poor contiguous area in China; there are very few high and low concentration areas (H-L area) and low-high concentration areas (L-H area), which are scattered respectively (Figure 4a). The aggregation characteristics of regional economic disparities in the province are relatively not obvious, among which the low-level aggregation areas (L-L areas) of several cities in Northern Jiangsu are relatively concentrated, which further shows that the gap characteristics within the eastern provinces are obvious (Figure 4b).

![Figure 3. Spatial distribution of annual average regional economic gap in the Yangtze River economic belt from 2001 to 2017 (a. Overall situation; b. Within the province).](image)

![Figure 4. Regional spatial autocorrelation agglomeration distribution of regional economic gap in the Yangtze River economic belt from 2001 to 2017 (a. Overall situation; b. Within the province).](image)

### 2.3 Spatial Panel Estimation of Population Migration and Urban Economic Gap

The spatial panel estimation results are shown in Table 1. The explanatory variable in columns (1)-(4) is population mobility, and the explanatory variable in columns (5)-(8) is population migration. It should be noted that the panel data estimation adopts the fixed effect method, because the assumption of random effect requires that the unobserved effect is not related to the explanatory variable, while the fixed effect does not need such a strict assumption, allowing the
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unobserved effect to be related to the explanatory variable (Miller and Upadhyay, 2002). This assumption of random effect is considered inappropriate (Peng, 2015; Zhou and Chen, 2020), and it needs to be estimated by using fixed effect. Therefore, starting from the prior theory, the fixed effect method is also directly used. The spatial lag modeling SLM and spatial error modeling SEM are carried out for the population flow, population migration and regional economic gap of urban agglomeration in the Yangtze River economic belt, and eight models are obtained.

Table 1. Spatial panel estimation results of population migration and regional economic differences

<table>
<thead>
<tr>
<th>Variables</th>
<th>Population mobility</th>
<th>Population migration</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Global difference</td>
<td>Interprovincial</td>
</tr>
<tr>
<td></td>
<td>SLM</td>
<td>SEM</td>
</tr>
<tr>
<td>Population movement/migration (m)</td>
<td>0.654***</td>
<td>0.695***</td>
</tr>
<tr>
<td></td>
<td>(0.105)</td>
<td>(0.104)</td>
</tr>
<tr>
<td>Population movement/migration square (m²)</td>
<td>-0.043***</td>
<td>-0.047***</td>
</tr>
<tr>
<td></td>
<td>(0.010)</td>
<td>(0.010)</td>
</tr>
<tr>
<td>Physical capital (K)</td>
<td>-1.026***</td>
<td>-0.955***</td>
</tr>
<tr>
<td></td>
<td>(0.144)</td>
<td>(0.152)</td>
</tr>
<tr>
<td>Human capital (H)</td>
<td>0.001***</td>
<td>0.001***</td>
</tr>
<tr>
<td></td>
<td>(0.000)</td>
<td>(0.000)</td>
</tr>
<tr>
<td>Labor input (L)</td>
<td>2.048***</td>
<td>2.154***</td>
</tr>
<tr>
<td></td>
<td>(0.467)</td>
<td>(0.461)</td>
</tr>
<tr>
<td>Innovation</td>
<td>0.091***</td>
<td>0.168***</td>
</tr>
<tr>
<td></td>
<td>(0.029)</td>
<td>(0.033)</td>
</tr>
<tr>
<td>Consumption</td>
<td>-0.668***</td>
<td>-0.788***</td>
</tr>
<tr>
<td></td>
<td>(0.108)</td>
<td>(0.115)</td>
</tr>
<tr>
<td>Marketization</td>
<td>0.001***</td>
<td>0.001***</td>
</tr>
<tr>
<td></td>
<td>(0.000)</td>
<td>(0.000)</td>
</tr>
<tr>
<td>FDI</td>
<td>-6.248***</td>
<td>-6.179***</td>
</tr>
<tr>
<td></td>
<td>(1.365)</td>
<td>(1.378)</td>
</tr>
<tr>
<td>Urbanization</td>
<td>-0.639***</td>
<td>-0.957***</td>
</tr>
<tr>
<td></td>
<td>(0.110)</td>
<td>(0.138)</td>
</tr>
<tr>
<td>rho</td>
<td>0.217***</td>
<td>-0.103***</td>
</tr>
<tr>
<td>lambda</td>
<td>0.286***</td>
<td>0.002</td>
</tr>
<tr>
<td>Observed value</td>
<td>1,768</td>
<td>1,768</td>
</tr>
</tbody>
</table>

Note: (1) the values in brackets indicate standard error; (2) *, **, *** represents significant levels of 10%, 5% and 1% respectively. Table 2 is the same.

From the impact of population mobility: for the overall regional economic gap and the regional economic gap within the province, the results show that the primary term of population mobility is significantly positive and the secondary term is significantly negative, indicating that the population mobility in the Yangtze River economic belt presents an inverted “U”-shaped relationship with the regional economic gap, that is, within the threshold range, population mobility will expand the economic differences between regions and show the expansion effect. When it exceeds a certain threshold, population mobility will narrow the economic differences between regions and show convergence effect, that is, comprehensively speaking, population mobility is ultimately conducive to the balanced development of regional economy. This coincides with China’s macro development strategy. Since China’s reform and opening up, the phased development strategy of “the rich first pushing those being rich later, and finally realizing common prosperity” has been put forward, which is not only applicable to groups, but also applicable to regions. In the early stage of reform and opening up, China took the lead in promoting the first development of some regions through the regional gradient development model,
promoted the flow of population from underdeveloped areas to developed areas, and exacerbated the economic development gap between regions. With the concept response and policy implementation of the regional balanced development strategy, such as the western development and the rise of central China, the role of population mobility has changed into the driver of regional balanced development, and the growth of floating population has reduced the regional economic gap. The internal mechanism may be the increase of population return scale or nearby flow scale. The growth of floating population scale is mainly reflected in the flow scale of adjacent cities and counties, while the long-distance inter-provincial flow scale has slowed down. Therefore, population flow has improved the economic development level of underdeveloped areas to a greater extent, so as to narrow the regional economic gap. The Yangtze River economic belt is a horizontal axis and transportation corridor across the east, central and western regions and can represent China’s gradient development strategy, which is in line with China’s overall development strategy.

From the impact of population migration, for the global regional economic gap, population migration and the global economic gap show an inverted “U”-shaped relationship, which is consistent with the impact of population mobility. However, for the regional economic differences in the province, the primary term of population migration is significantly positive, while the secondary term is negative, but they are not significant, indicating that population migration has only an expansion effect on the economic gap between cities in the Yangtze River economic belt, but no convergence effect, which is inconsistent with the impact of population mobility. The city’s registered residence and population migration are related to the change of population and the associated supply of public services. Although the direction of population migration and migration in the province is mainly concentrated in a few core cities, such as provincial capital cities and planned cities, but unlike population movements, registered residence has changed after migration, and the production behavior of the population has been changed. Consumption behavior is a kind of complete output (population flow is similar to a state of semi-urbanization or semi-output). The government public services allocated according to the “head” will also be reduced, and the agglomeration effect of immigration will further widen the regional economic gap between immigration and emigration. The macro manifestation is that the gap between core cities dominated by population immigration and ordinary cities dominated by population emigration continues to increase, and there is no convergence trend in the study time range. Although the possibility of narrowing the regional economic gap may not be ruled out in the future, the current population migration still plays an expanding role in the regional economic gap in the province.

From the perspective of spatial parameters, except for the two models (4) and (8), the spatial parameters of SLM and SEM are significant, indicating that the economic gap has spatial autocorrelation, that is, the spatial lag term of dependent variable and the spatial lag term of error term have correlation effect. Based on this, the application of spatial panel data model can better describe the relationship between population migration and regional economic gap. Among them, the spatial parameters of the overall regional economic gap are significantly positive, that is, the economic gap between adjacent cities will significantly expand the gap between the target city and other cities; the spatial parameters rho of regional economic gap in the province are significantly negative, while lambda are not significant, indicating that the economic gap in the province is suitable for spatial lag modeling. The results show that the economic gap between adjacent cities in the province will significantly reduce the gap between the target city and other cities. In terms of other control variables, the coefficient of material capital (\(K\)) is significantly negative, indicating that urban material capital investment will narrow the economic gap between regions. For the central and western regions, investment, as the main driving force to promote economic development, is also an important means for the country to catch up with and reduce the economic gap with developed regions from a macro perspective. The level of urban human capital (\(H\) and innovation ability have significantly expanded the overall situation and the regional economic gap in the province. In fact, the essence of urban human capital and innovation ability is the same. They are synonymous with the level of science and technology. As the primary productive force, science and technology will significantly improve the level of local economic development and expand the development gap with the surrounding areas. The estimation result of labor force proportion (\(L\)) shows that it significantly expands the overall regional economic difference, but does not significantly affect the regional economic difference in the province. Here, \(L\) is the proportion of the employed population of the unit in the total population (the labor proportion at the general level is the proportion of the population aged 15-64 in the total population). The employed population of the unit is mainly “all the people who work in state organs, political party organs, social organizations, enterprises and institutions at all levels and obtain wages or other forms of labor remuneration”, that is to say, the employed people of the unit are mainly “state workers”. The more the group is in a city, the more important the city is, and the greater the state’s investment in the city, which will widen the economic gap between it and other cities. However, for a province, the city which is “being think highly of” is beneficial to the whole province. It will always narrow the economic gap between cities in the province. Consumption power significantly reduces the regional economic gap and the economic gap within the province. The possible reason is that many consumer goods in target cities will not only promote the local economic growth, but also promote the growth of surrounding cities, so as to narrow the regional gap. The marketization level
significantly widens the regional economic gap between the two, because the marketization level can not only characterize the economic vitality, but also reflect the business environment. A high level of economic vitality and a good business environment will continue to attract resource inflow and investment from the surrounding areas, so as to expand the economic gap between the local and the surrounding cities. Foreign direct investment (FDI) has a significant convergence effect on the regional economic gap, indicating that attracting foreign investment has a positive effect on the balanced development of the region. The mechanism may be the crowding out effect of capital. The massive introduction of FDI may crowd out local capital and invest in the surrounding areas to promote the development of surrounding cities and narrow the economic gap between the local and surrounding areas. Urbanization significantly reduces the regional economic gap. The reason may be that the urbanization process is the process of integrating the surplus working population in rural areas or backward areas into the city. From the characteristics of the relative change of population, this will improve the per capita economic level in backward areas and reduce the per capita economic level in developed areas, that is, urbanization will narrow the economic gap.

2.4 Spatial Effect Decomposition: Estimation of Direct Effect and Spatial Spillover Effect

When there is spatial spillover effect, the change of an influencing factor will not only affect the economic gap between the local and other regions, but also affect the economic gap between its adjacent regions and other regions, and cause a series of changes and adjustments through circular feedback. Further decompose the impact of various factors on the economic gap into direct effect and indirect effect (LeSage and Pace, 2009): the overall impact of the change of a variable on the local economy is called direct effect, which includes spatial feedback effect, that is, the circular process in which the change of a factor in the target area affects the economic development of the adjacent area, and the economic development of the adjacent area in turn affects the economic development of the target city; the impact of a variable change on the regional economy around the target city is an indirect effect, that is, spatial spillover effect.

From the decomposition results of spatial effects (Table 2), it is found that:

First, for the global regional economic gap, regardless of population mobility or population migration, the core explanatory variables \( m \) and \( m^2 \) are consistent with the regression results in Table 1, and the spatial effect also has an inverted “U”-shaped relationship, which is significant, indicating that both have direct effect and spatial spillover effect, and form a total effect. Specifically, the direct effect and spillover effect of \( m \) are significantly positive, and the direct effect and spillover effect of \( m^2 \) are significantly negative. The explanation of the direct effect is consistent with the previous text and will not be repeated. The inverted “U” relationship of spatial spillover effect means that the population flow in the target area has an expanding effect on the economic gap between surrounding regions within the threshold, and there is a convergence effect after exceeding the threshold. In addition, the estimation coefficient symbols of indirect effect and direct effect are the same, and the action direction is the same. The former has a strengthening effect. Therefore, the total utility is greater than the direct effect, indicating that the impact of population migration on regional economic gap is higher than that estimated by conventional methods, and the effect estimated by traditional methods is underestimated to some extent.

From the perspective of spatial effect decomposition, it shows that the impact evaluation of population migration on regional economic gap needs to be comprehensively analyzed, fully consider the spatial interaction of the whole region, and emphasize the spatial correlation and spatial spillover effect between the target region and the surrounding region.

Table 2. Decomposition results of spatial effects

<table>
<thead>
<tr>
<th>Variables</th>
<th>Population mobility</th>
<th>Population migration</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Direct effect</td>
<td>Indirect effect</td>
</tr>
<tr>
<td>( m )</td>
<td>0.658*** (0.105)</td>
<td>0.163*** (0.035)</td>
</tr>
<tr>
<td>( m^2 )</td>
<td>-0.043*** (0.011)</td>
<td>-0.011*** (0.003)</td>
</tr>
<tr>
<td>( K )</td>
<td>-1.034*** (0.136)</td>
<td>-0.255*** (0.047)</td>
</tr>
<tr>
<td>( H )</td>
<td>0.001*** (0.000)</td>
<td>0.000*** (0.000)</td>
</tr>
<tr>
<td>( L )</td>
<td>2.093*** (0.478)</td>
<td>0.517*** (0.134)</td>
</tr>
</tbody>
</table>
Therefore, the research based on nonlinearity is a more comprehensive strategy. For the second question, this paper holds that regional economic difference and distribution is a typical spatial phenomenon, which contains spatial relations and spatial laws. Therefore, the conclusion under the assumption of spatial homogenization is debatable. Based on the above considerations, the possible innovation of this paper is to confirm that there is a nonlinear relationship between population migration with typical spatial attributes and regional economic gap. At the same time, the only direct effect in the traditional research can not fully reflect all the causal response relationship between the two. This paper integrates the spatial effect to comprehensively judge whether the population migration is narrowing the gap or widening the gap, and fully consider the regional synergy rather than the conclusion obtained by the spatial independence hypothesis.

The specific empirical results show that the population flow, population migration and the overall regional economic gap in the Yangtze River economic belt, population migration and the regional economic gap in the province all show an inverted “U”-shaped nonlinear relationship, that is, it shows the phased effect of expanding first and then converging, which is consistent with China’s phased development strategy of “the rich first pushing those being rich later, and finally realizing common prosperity”. The relationship between population migration and regional economic differences in the province is only linear, showing an expansion effect rather than a convergence effect, which may be related to the output of economic behavior and the reduction of public finance after population migration, thus widening the regional economic gap between immigration and emigration. From the perspective of spatial effect, the regional economic gap has spatial autocorrelation,
so the spatial model can better describe the relationship between the change of floating population and regional economic gap. The spatial effect decomposition shows that, on the whole, population flow and population migration ultimately have a balanced economic effect. Population flow and migration, like an “invisible hand”, has promoted the balanced development of China’s regional economy.

There are the following deficiencies in this study: (1) due to the lack of data in some cities, this paper only studies 104 urban samples in the Yangtze River economic belt, and more than 20 samples are not included in the study due to data limitations, which may cause estimation bias. (2) Due to the lack of accurate statistical data of the floating population in each city for consecutive years, this paper uses the urban temporary resident population to characterize the floating population. Although it is the official authoritative data, the two are not completely equal after all, which may have a certain impact. (3) Due to space limitation, the transformation process and internal mechanism of the expansion effect and equilibrium effect of population migration on regional economic gap are not discussed in depth from the perspective of time and space, and there is also a lack of comparative analysis of the differences within specific provinces or urban agglomerations. These are the key points to be studied in the next step.

Population migration is the basic process of current social operation. Large cities similar to the Yangtze River economic belt will continue to maintain a high proportion of input scale in a certain period of time, while small and medium-sized cities or backward cities may continue to maintain a certain proportion of output population. The debate between population migration and regional economic gap will also exist for a long time. From the perspective of balanced regional development, the long-term goal of promoting population migration is to narrow the gap and promote regional coordinated development. The ultimate goal of China’s gradient development strategy and the concept of “the rich first pushing those being rich later, and finally realizing common prosperity” is obviously conducive to the balanced development of the whole region, the whole people and all-round balanced development. Population migration plays a complex role in China’s regional development strategy. According to the estimation results of this paper, the early population migration and migration have an expanding effect on the overall regional economic gap in the Yangtze River economic belt, and show a convergence effect in the later stage or at the present stage, indicating that population migration is ultimately conducive to regional balanced development. Although the effect of population migration on the regional economic gap in the province mainly shows the expansion effect, which is not conducive to the balanced development of the region in the province, it is only limited to the direct effect, and its indirect effect or spillover effect is conducive to the balanced development of the region. If the provincial local government can deal with the scale and direction of population migration, it can also maximize its balanced effect and narrow the regional gap in the province. The empirical study of the Yangtze River economic belt shows that population migration is not only conducive to regional economic growth, but also conducive to regional economic balance.

Therefore, the marginal contribution of this study lies in the deepening understanding of the relationship between population migration and regional economic gap, and also makes a more comprehensive and objective research and summary on the role of population migration in regional balanced development. It is also a beneficial and historical trend to further guide the reform of registered residence system by rationally guiding and promoting the inter regional mobility of population. Megacities with a large floating population present certain challenges to their governance. In addition to problems such as conventional urban diseases, the recent COVID-19 outbreak also shows that population mobility and the risk of disease transmission are positively correlated. Cities with large population density and large scale are generally more serious than the small and sparse rural areas with large population size, so the risk of big cities is greater. However, the wealth effect, spillover effect and technology concentration advantage produced by the agglomeration process of population size in large cities improve their ability to resist risks, and the population size cannot be simply related to risks (Ren, 2020). To further understand the geographical process and temporal and spatial evolution law of population mobility, we should not worry too much about China’s large-scale floating population, but apply its law to help epidemic prevention and control and even the construction of governance system of mega cities. Therefore, the governance of floating population in mega city cannot be handled in a single way, but the reform of registered residence system should be strengthened, with special emphasis on the protection of the welfare rights and interests of floating population. The intensive reform measures in recent years are indeed conducive to the well-being of the floating population and people-oriented, but we just hope that the policy can really be “on the ground”.

Conflict of Interest
The authors declared no conflict of interest.

References


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