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DECOMPOSITION ANALYSIS OF POPULATION CHANGE AND ITS DETERMINANTS IN BEIJING-TIANJIN-HEBEI METROPOLITAN REGION

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Abstract

This paper provides two scenarios of population change and its spatial distribution at the county level in the Beijing-Tianjin-Hebei Metropolitan Region: three residential patterns and three population growth groups. The findings show that population change in this region mainly agglomerated to the urban districts and areas of fast population growth in the period of 1990-2000. Regression results also provide details on the contribution of a number of determinants to the population change in the divisions of each scenario. This research concludes by arguing the necessity of future population studies in terms of different regional or local conditions.

JEL Classification: J00, J60

Keywords: Decomposition; Population change; Determinants; Beijing-Tianjin-Hebei

1. Introduction

Much research has been done to analyze the population change and its determinants in the Beijing-Tianjin-Hebei Metropolitan Region (Jing-Jin-Ji region for short). Li and Deng (2007) examined the factors related to population mobility in the Jing-Jin-Ji region in 1990 and 2000 and showed that the difference in per capita GDP, tertiary industry and market openness are the major influencing factors. Ye et al. (2008) performed a cluster analysis and established that the immigrants in the Jing-Jin-Ji region mainly agglomerated to the downtown areas of Beijing and Tianjin as well as to several surrounding districts (Men Tougou, Tanggu, Dagang and Hangu). Li and Chen (2009) explained the population increase in Jing-Jin-Ji (1990-2000) related to demographic, geographical and economic factors. Results show that areas of comparative lower altitude, fast per capita GDP growth, strong tertiary industry growth and large market potential usually have rapid population increase. Sun, et al. (2009) used regression analysis related to the population distribution in Jing-Jin-Ji and found that the spatial distribution of population had shifted from concentrating in few core cities like Beijing and Tianjin in the 1980s to a stage with people diffusing from the core city areas and concentrating on several sub-centers in the 1990s.

Basically, the research presented above has provided detailed analysis to population change and its influencing factors in the Jing-Jin-Ji region. However, this research presents population change and factors' influence at the regional level. How this influence is spatially differentiated within the region has not been well researched. In fact, spatial population distributions differ due to

demographic, economic and geographic factors. For example, population tends to concentrate in urban areas and their surrounds while remote areas usually have slow population increase. However, this difference is not clearly shown when the analysis focuses only at the regional level. Bearing this in mind, this paper aims to investigate the differences in population change and their determinants at the county level in the Jing-Jin-Ji region.

The paper structure is as follows: the second section reviews theories of population change and its spatial distribution; the third section is used to describe the decomposition of population change in the Jing-Jin-Ji region in terms of residential patterns and population growth rates. Regression analysis of the factors influencing population change in the decompositions is also utilized. The paper finally concludes with a discussion on the findings and implications.

2. Research background

Generally, population change consists of both natural population growth and migration. The initial population size mainly dominates the natural population growth. Rural-urban migration is however, mainly induced by socio-economic factors. In the dual economy theory, Lewis (1954) stated that surplus rural laborers would move from agricultural sectors to modern industrial sectors due to differences in production efficiencies. In this process, agricultural production efficiency would increase while industrial sectors would achieve further development. Schultz (1962) considered migration to the production sectors as a choice made after balancing the migration costs and potential profits. According to Bogue (1959), the pushing forces from the out-migration places and the pulling forces from the in-migration places jointly induce population flows. Todaro (1969), Harris and Todaro (1970) added that employment opportunities in cities and higher income were the major reasons to the rural-urban migration.

Brueckner and Zenou (1999) however, pointed out that continuous immigration from villages to cities would lead to the increase of urban land price which may discourage and dampen the enthusiasm of the potential migrants. Besides, the ever decaying urban natural environment and severe congestion problems propel more and more residents to move to suburbs and peri-urban areas: they are commuting to the downtown areas to work every day. Rogers (1960) considered such out-migration in cities as a choice of combining country life in the suburbs with employment in the cities. Three residential patterns could be drawn based on the above review: urban districts,

suburbs or small towns in the peri-urban areas, peripheral areas.

This theoretical depiction is also applicable to the Chinese context. In an over thirty-year period after reform and opening-up in 1978, the Chinese economy achieved tremendous growth both in cities and in villages. However, long-term dual social structure has produced huge inequality between urban and rural areas. Thus, large numbers of rural laborers migrated to cities for high-paying jobs and a better urban life. According to the Comprehensive Statistical Data and Materials on 50 Years of New China (1999), about 174 million people have migrated from rural areas to cities from 1978 to 1999. This number contributed to 74.88% of the urbanization growth in China in this period. Correspondingly, urban size in China increased dramatically. The number of cities increased from 193 in 1978 to 467 in 1990 while urban population grew from 117 million to 335 million in the same period (National Bureau of Statistics of China, 1999).

Out-migration from urban districts to city suburbs occurred in the large cities of China in the late 1980s. Zhou and Meng (1998) found that in the period 1982-1990, population in the urban districts of Beijing decreased by 3.38% while residents living in the suburbs increased by 40.46%. In the same period, residents in the urban districts of Dalian and Shenyang decreased by 11.82% and 6.73% while people living in suburbs increased by 56% and 31.04% respectively. In addition to the out-migration to the suburbs, China initiated the strategy of “urbanization from below” which aims to prohibit large amounts of rural immigrants into big cities. This strategy calls for the development of small towns and rural industries so as to provide sufficient job opportunities for rural residents. In the period of 1978-1994, the population employed in rural enterprises increased from 22.18 million to 120.17 million which was 27% of rural laborers in China (National Bureau of Statistics of China, 1995).

Based on the above review, this paper hypothesizes that the causes of population changes in the three residential patterns are different. Initial population size, the economy, industrial structure and geographical factors contribute differentially to population changes in each of the residential patterns. Thus, the paper decomposes population change at the county level in the three residential patterns. This decomposition is intended to discover differences in the determinants of population change in each residential pattern. Considering the fact that urban districts and their surrounding counties belong to the same urban administration, the paper also decomposes population change

according to the annual average population growth of the counties in Jing-Jin-Ji. This decomposition is used to show the determinants' influence on the population change which is beyond the administrative city boundaries.

3. Methodology and empirical results

The Jing-Jin-Ji region (183,000 km^2) includes Beijing and Tianjin (directly-governed cities under the jurisdiction of central government) as well as eight prefecture-level cities in Hebei Province (Zhang Jiakou, Chengde, Qin Huangdao, Tangshan, Langfang, Cangzhou, Baoding and Shi Jiazhuang)[1] (Figure 1). Beijing is the capital of China and Tianjin is the third largest city in China. Hebei Province is located in the Huabei Plain of China and surrounds Beijing and Tianjin. This region is considered as the "third engine" to promote the Chinese economy further in the twenty-first century besides the Yangtze River Delta (Shanghai as the central city) and the Chu Chiang Delta (Guangzhou as the central city). In 2008, there were 78.6 million people in this region producing 9.9% of the GDP in China (National Bureau of Statistics of China 2009).

Figure1. *Cities in Beijing-Tianjin-Hebei Metropolitan Region*

3.1 Methodology

Factors influencing population change in the Jing-Jin-Ji region can be divided into two groups:

[1] Besides these eight cities, Hebei Province also includes other three prefecture-level cities in the southern part: Hengshui, Xingtai and Handan. However, most research on the Jing-Jin-Ji region does not include these three cities. In this paper, Hebei Province follows this division and only consists of eight prefecture-level cities.

Demographic/economic factors and geographic factors.

1) **Demographic and economic factors:** The initial population density (D_{90}) of each county or urban district is selected to show the influence of initial population size on the natural population growth. N_{90} and N_{00} are the population of each county or urban district in 1990 and 2000. Per capita GDP in 1990 ($Pgdp_0$), its increase from 1990 to 2000 ($\Delta Pgdp$), and the increase of the ratio of non-agricultural industrial employment between 1990 and 2000 (ΔNA) are selected to test how the economy and industrial structure influence population change.

2) **Geographic factors**. Two groups of geographic factors are selected: factors reflecting the size of the built environment, and factors describing the counties' or urban districts' accessibility. The increase of the ratio of built land in relation to total land between 1990 and 2000 (ΔB) represent the first group. The second group of factor is based on an Accessibility Index, showing the accessibility of each county or urban district in the region. This index is used as an approximate measure of a number of variables which normally show spatial co-variation, such as access to market and finance. Normally, the index consists of the aggregated accessibility of each unit to all other units. However, we hypothesize that migration to each unit is dominated mainly by its accessibility to the central cities. Thus, the paper computes the aggregated accessibility of each county or urban district to the ten central cities (Beijing, Tianjin and eight prefecture-level cities in Hebei Province). The formula can be written as follows:

$$Ac_i = \sum P_j \Big/ d_{ij}^{\beta} \quad \text{(j, j≠i)} \qquad \ldots\ldots (1)$$

Ac_i is the aggregate accessibility index of ith unit (i=1, 2, 3…129), P_j is the population size of the jth central city, d_{ij} is the distance between ith unit and jth central city (j=1, 2, 3…10). Considering the population change in each city in the period of 1990-2000, the paper uses the index variation of each city in this period. Ac_{90} refers to the accessibility of all the units in 1990.

The research uses PASW Statistics 18.0 to test the influence of these factors on the population development in Jing-Jin-Ji as a whole and with the counties and districts of the region divided in residential patterns and grouped after growth, respectively.

First, a correlation analysis was conducted to test for autocorrelation among the variables. The analysis showed that for two types of districts—urban districts and fast growing districts—the increase of the ratio of built land (ΔB) was very strongly correlated to the initial population density. Thus, this variable was excluded from the regression analyses for these types of districts.

The regression model can be written:

$$\ln N_{00} - \ln N_{90} = \alpha + \beta(D_{90}, Pgdp_0, \Delta Pgdp, \Delta NA) + \gamma(\Delta B, Ac_{90}) + \varepsilon \quad \ldots\ldots (2)$$

The economic data derives from the Hebei Economic Yearbook, the Beijing Statistical Yearbook and the Tianjin Statistical Yearbook in the same calendar years 1991 and 2001. The land data is taken from the Chinese National Land Cover Database (CNLCD) and developed by the Chinese Academy of Sciences (Liu, et al., 2005a and 2005b). The demographic data comes from the Fourth and Fifth Population Censuses of China that were conducted in 1990 and 2000 by the National Bureau of Statistics of China.[2] According to the census of 1990, the Jing-Jin-Ji region consists of 129 units: ten urban districts and 119 counties. Because there are administrative adjustments in this period, the paper adjusts the demographic and economic data in 2000 to be in accordance with the administrative division in 1990.

3.2 Empirical results

Figure 2 presents the three residential patterns in the Jing-Jin-Ji region. The surrounding counties of each urban district are marked in the figure. The other counties are the peripheral areas of the region. According to the population change in the decomposition presented in Table 1, urban districts have the highest population change rate followed by their surrounding counties and other peripheral counties. Moreover, urban districts also show the largest population change in the whole region. Over half of the population change in the Jing-Jin-Ji region took place in the urban districts in the period of 1990-2000. These figures also imply that population tends to concentrate in the urban districts. The surrounding counties have the potential to accommodate the out-migration from the urban districts due to their geographic adjacency. Additionally, surrounding counties are also the new location for many of the immigrants from the peripheral areas. Thus, the annual population

[2] The Sixth Population Census started in 2010. Due to the data availability, the paper only uses the Fourth and Fifth Population Census.

increase in the surrounding counties remains at the second position after the urban districts. The peripheral counties have slow population growth from 1990 to 2000. Population in 23 peripheral counties even experienced decreases in this period. This can be mainly attributed to out-migration from these areas.

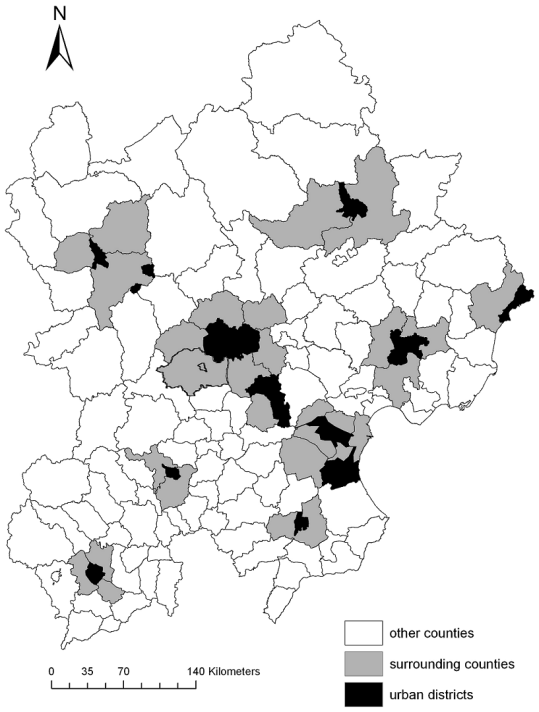

Figure2. *Three residential patterns in Jing-Jin-Ji region*

Table1. *Population change in the three residential patterns, 1990-2000*

Division	Number of units	Population change (million)	Ratio in the whole region (%)	Annual average increase (%)
Urban districts	10	4.29	53.29	2.38
Surrounding counties	28	1.36	16.89	1.06
Peripheral counties	91	2.40	29.82	0.67
Jing-Jin-Ji region	129	8.05	100	1.20

Table 2 presents the regression results of population change in the three residential patterns and three population growth groups. In the Jing-Jin-Ji region as a whole, the initial population size and the initial per capita GDP were the only significant variables related to the counties' and urban districts' population change.

In the first decomposition, population size in 1990 is the only significant variable associated with the population increase of the urban districts. Within this group, the larger the population, the

larger was its increase. This implies that agglomeration forces are the strongest factor affecting population growth in this group, with all other variables not statistically significant.

Population increase in the surrounding counties was attributed to the initial per capita GDP and its increase as well as the increase in built land size. In the peripheral counties, the increase of per capita GDP and the accessibility in 1990 were the significant factors behind the population increase. Thus, population increase in the surrounding and peripheral counties differed from that in the urban districts in the sense that it was not governed by the agglomeration of people but by economic and geographic factors.

Table2. *Regression results of determinants of population change in the two decompositions and the whole Jing-Jin-Ji region*

Region	D_{90}	$Pgdp_0$	$\Delta Pgdp$	ΔNA	ΔB	Ac_{90}	R^2
Jing-Jin-Ji region	0.742 (12.907)**	0.126 (2.122)**	0.086 (1.566)	0.016 (0.345)	0.067 (1.365)	-0.049 (-0.928)	0.734
Urban districts	1.044 (3.261)**	-0.091 (-0.326)	-0.068 (-0.273)	0.291 (1.290)	_____	-0.173 (-0.752)	0.814
Surrounding counties	-0.101 (-1.005)	0.494 (3.775)**	0.365 (3.070)**	-0.190 (-1.684)	0.268 (2.043)*	0.046 (0.404)	0.829
Peripheral counties	0.157 (1.581)	0.065 (0.567)	0.311 (2.739)**	-0.156 (-1.542)	-0.046 (-0.474)	0.226 (2.089)**	0.258
Fast growth	0.971 (11.650)**	0.003 (0.029)	0.071 (0.816)	0.048 (0.637)	_____	-0.046 (-0.437)	0.964
Medium growth	0.822 (6.313)**	0.191 (1.480)	0.141 (1.783)*	-0.090 (-1.095)	-0.001 (-0.014)	-0.002 (-0.020)	0.904
Slow growth	0.651 (8.508)**	0.061 (0.757)	0.225 (3.192)**	-0.138 (-2.183)*	-0.021 (-0.344)	0.119 (1.850)*	0.702

Note: Figures in parenthesis are associated *t* values. *= sig. < 0.1, **= sig. < 0.05

Given the fact that urban districts and their surrounding counties belong to the same urban administration, the first decomposition does not provide the causes of population change among different urban administrations. Therefore, the second decomposition is based on the annual population change rates of all the counties and urban districts in the Jing-Jin-Ji region. This decomposition is generated to show the determinants' influence on the population change beyond

the administrative boundaries.

The annual average population increase in the Jing-Jin-Ji region was 1.20% in the period 1990-2000 while the annual population increase in China was 1.11% during the same period (National Bureau of Statistics of China, 1990 and 2000). Thus, the paper divides population change of all the units in this region into three groups according to their annual population change rates. These are the fast growth group (above 2%), the medium growth group (between 1% and 2%) and the slow growth group (below 1%). Figure 3 shows that the fast growth group includes the main urban districts (Beijing, Shi Jiazhuang, Baoding, Cangzhou, Zhang Jiakou, Chengde and Baoding) and counties around Beijing and Tianjin. The medium growth group mainly consists of counties surrounding Beijing, Tianjin, Shi Jiazhuang and Langfang. Counties in the slow growth group are roughly in the peripheral areas. As shown in Table 3, over 60% of the population change in Jing-Jin-Ji region took place in the fast growth group in the period of 1990-2000.

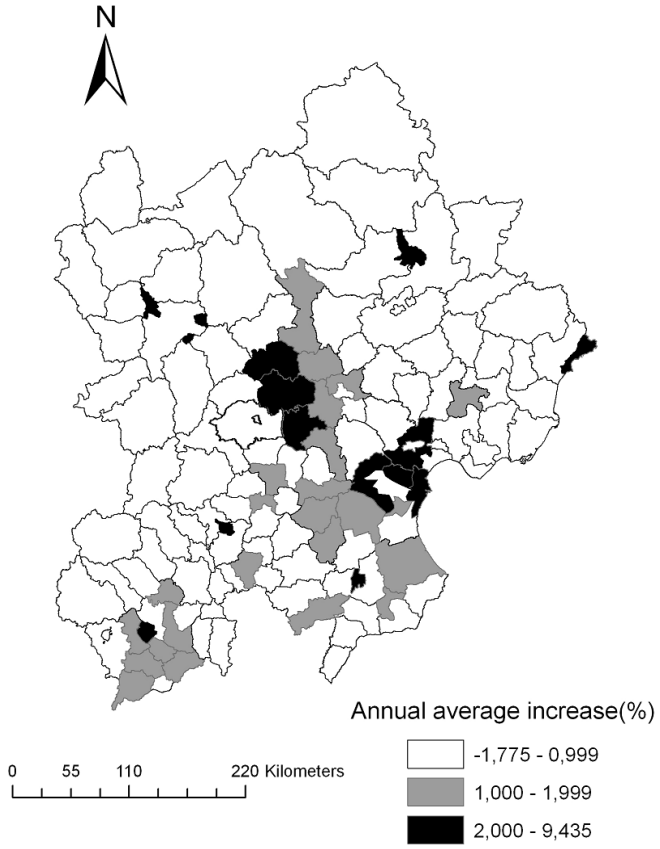

Figure3. *Three population growth divisions in Jing-Jin-Ji region*

Table3. *Population change in the three population growth groups, 1990-2000*

Division	Number of units	Population change (million)	Ratio in the whole region (%)	Annual average increase (%)
Fast growth	14	5.06	62.86	3.41
Medium growth	24	1.52	18.88	1.30
Slow growth	91	1.47	18.26	0.36
Jing-Jin-Ji	129	8.05	100	1.20

For the fast growth group, the regression results in Table 2 are similar to those of the urban districts. Initial population is the only significant variable and it evidences an even stronger influence than in the urban districts. Initial population size exerts a positive influence on population growth also in the medium growth group, as does the growth of GDP per capita. In the slow growth group, initial population size, increase of per capita GDP and accessibility in 1990 were significant factors behind the population development. The change in the ratio of non-agricultural employment also had an impact, albeit a negative one, in the slow growth group. A possible explanation to this perverse result might be that outmigration of peasants is strongest from the least industrialized counties and that this outmigration results in rising shares of non-agricultural employment.

A comparison between the two decompositions provides some interesting similarities and differences. As noted above, in the urban districts and the fast growing districts/counties it was only the initial population size that showed to be significant, while in the other groups other variables also evidenced impacts. Furthermore, when divided after growth, all three groups had the initial population size as a significant factor, while in the division after residential patterns it was only in the urban districts that initial population size exerted any significant influence. This seems to imply that the agglomeration factor is of importance also for medium and slow growth counties. However, when the counties are divided on a center-periphery scale, the composition of the groups makes initial population size insignificant. It should also be noted that the R-squares for the center-periphery division are lower than for the division after growth. This holds in particular for the peripheral counties compared with the slow growth group.

4. Discussion and concluding remarks

This research provides two scenarios of population change and its spatial distribution in the Jing-Jin-Ji region in the period of 1990-2000: three residential patterns and three divisions in terms

of population change rate. Compared with previous studies, this research makes more clear the relationship between population change and its spatial distribution in the Jing-Jin-Ji region. Evident differences of population change and its determinants at the county level have been disclosed using these two types of decompositions.

Research findings show that population change in this region mainly concentrated in the urban districts and counties of fast population growth in the research period. However, when controlling for position in the center-periphery hierarchy and after growth rates respectively, population change of the groups of these two of decompositions was often not affected by the same determinant factors. This difference could be attributed to the different situations in each of the decompositions. The initial demographic, economic and geographic conditions of the groups of these two decompositions vary, as do their changes in the following ten years. Thus, these differences contribute differently to the population change in the groups of these two decompositions.

Although out-migration from urban districts had been found in the large cities of China in the 1980s (Zhou and Meng, 1998), urban districts in the Jing-Jin-Ji region saw continuous population increases in the period of 1990-2000. Such increases were also seen in the fast population growth counties which surround the urban districts of Beijing and Tianjin. This implies that resource flows within the Jing-Jin-Ji region tended to agglomerate to the urban districts from 1990 to 2000. Thus, congestion problems would probably be induced in the urban districts of this region. In fact, urban districts of this region have seen problems such as land price increases, traffic jams and environmental degradation, supporting the research prediction based on the findings in the period of 1990-2000.

To a large extent, the research revealed the spatial differences of population change in different areas of different conditions in the Jing-Jin-Ji region. The major finding of this study is that it is not enough to investigate the determinants of population change in a region—or a country—as a whole. For various sub-regions, other factors than those related to the whole region might have an impact, as e.g. the accessibility for the peripheral and the slow growth counties. Thus, the research can serve as reference for future demographic studies. Besides, for China and other developing countries trying to curb the expansion of their largest metropolitan cities, this research could also be an argument to develop policies adapted to regional and local conditions.

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