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Changing distribution of migrant population and influencing factors in urban China: economic transition, public policy, and amenities

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Highlights:

1. We examine the redistribution of the migrant population in urban China in the early 2010s, compare the changes with those of the past decade, and study the underlying factors including economic transition, public policy and amenities.

2. Migration is a tug-of-war not only between sectors and regions, but also between governments and between past and future.

3. The growth rate of migrants declines in major cities, while several provincial capitals and lower-tier cities emerge as new migration destinations.

3. The relative importance of the factors behind the redistribution of the migrant population varies greatly across regions and changes over time.

4. The service industry has become a leading source of migrant jobs, while migrants skipping cities with large agricultural and manufacturing sectors.

5. Rising housing prices and worsening air pollution have not deterred migrants.

6. Except in largest cities, the effects of state interventions and migration controls on migration have diminished.

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Abstract: Rural-urban and interregional migration has greased the wheels of China's labor market and fueled rapid urbanization. The spatial distribution of migrants has changed significantly in recent years. We create a panel of Chinese cities using decennial census and annual yearbook data, studying the distribution of migrants from 2010 to 2016, comparing with prior years, and examining factors behind the changing spatial distribution. Results show that China's maturing economy, coupled with shifting migration policy and migrants' preferences, has affected the redistribution of migrants. The spatial agglomeration of migrants peaked in the early 2010s, so did the growth of migrants—signaling a major turning point of China's urbanization. The slowdown is most evident in coastal mega-regions, while several interior provincial capitals and coastal lower-tier cities have emerged as new migration destinations. Industrial upgrading and restrictive migration rules have pushed migrants away, while strong economies and more public services have attracted migrants. However, air pollution and higher housing cost have not deterred migrants. Our findings highlight that, while institution factors and state interventions have greatly affected migration, their effects are diminishing in urban China except in largest cities. As the growth of productivity and population continues to slow, lower-tier cities can implement effective strategies to recruit migrants as part of their development plan.

Key words: Migrant redistribution; rural-urban and interregional migration; urban transformation; economic transition; floating population

1. Introduction

Since 1978, rapid economic growth has transformed China from an agricultural economy to an industrialized and urbanized one, leading to an unprecedented surge in rural-urban and interregional migration (Sun and Fan 2011; Fan 1996). With the reform of household registration (*hukou*) system and widening regional disparities, migrants have flocked to more-developed areas for better life (Zhu 2007; Fan 2005; Shen 2013). The size of the migrant population has increased from 121 million in 2000 to 221 and 247 million in 2010 and 2015 respectively[1] (ONPSS 2017). Largest migration destinations include highly industrialized and urbanized mega-regions, such as the Pearl River Delta (PRD), the Yangtze River Delta (YRD), and the Beijing-Tianjin regions (Y. Liu and Xu 2017; He et al. 2016).

Migrants are a major force in China's economic growth, contributing to 21% of annual GDP growth in the post-reform years (Cai and Wang 1999). The migrant population made up about 35% of China's total workforce in 2015—15 percentage points higher than its share of the Chinese pouplation (Freeman 2015). Rural-urban migrants—agricutural *hukou*[2] holders—made up 87% of the overall migrant

[1] We derive these data from the 2000 and 2010 decennial censuses and the 2015 one percent population survey, conducted by National Bureau of Statistics (NBS) in China. We use NBS's definition of migrant population, which refers to migrants whose residence is 'inconsistent' with their *hukou* registration (who do not have local household registration status) and who have lived in their migration destination for more than 6 months. The migrant population excludes short-distance migrants (those who moved within the same city or county) and short-term migrants (those who have lived in their migration destination for less than 6 months). According to NBS, 294 million people were in the category of 'residence-registration inconsistency' in 2015. Of those, 247 million were part of the migrant population.

[2] There are two major aspects to the *hukou* system of China. One is the distinction between agricultural *hukou* and nonagricultural *hukou*. Nonagricultural *hukou* holders, who made up 29% of China's population in 2010, live in cities (PCOSC and NBC 2012). In contrast, many agricultural *hukou* holders have disengaged from agricultural activities and moved to cities. The second aspect is the location of the *hukou* registration. Many major cities still heavily subsidize residents with local *hukou* registration (J. Liu 2018; Lin et al. 2019).

population in 2010 (PCOSC and NBC 2012). Finally, migrants are vital for rural-urban integration —a key policy goal of the Chinese central government (CPC and State Council 2014; Cai et al. 2018).

There has been gradual, but significant, changes in China's internal migration in recent years. First, many coastal cities have begun to replace labor-intensive manufacturing activities with service and creative industries, reducing the demand for unskilled labor (Y. Liu and Shen 2017; Wu et al. 2018). Second, rapidly increases in housing cost have affected migrants in major cities (Zang et al. 2015; Yu 2017). Third, the central government has given more controls of migration to cities, especially if the city's urban population is above 3 million (J. Liu 2018). Meanwhile, cities have had diverging views on migrants. Tire-1 cities, such as Shanghai and Beijing, are increasingly hostile to unskilled migrants (Cheng et al. 2014), while many lower-tier cities have become more accommodating. Fourth, urban problems, such as air pollution and traffic congestions, appear to have made many top tier cities less attractive to migrants (Chen et al. 2013; S. Li et al. 2014). Fifth, second-generation and whole-family migrants, who make up a growing share of the migrant population, seem more concerned about social welfare and public services (Zhu and Chen 2010; Cheng et al. 2014).

China's internal migration and rapid urbanization have attracted much scholarly attention (S. Li 2004; He et al. 2016). However, we know little about the changing spatial pattern of migrants and the relative importance of underlying factors since the early 2010s when the urban share of China's population surpassed 50% for the first

time—a major turning point of China's urbanization—and when economic transition gained momentum across the country.

Given the importance of the migrant population in China, we aim to examine three interrelated research questions: (1) To what extent have the spatial distribution of the migrant population and migration destinations changed from 2010 to 2016, compared with the period from 2000 to 2010? (2) What factors are associated with the redistribution of migrants in recent years? (3) How has the relative importance of underlying factors varied across regions and changed over time?

In the following sections, we review the literature, present our conceptual models, and discuss data and methodology used in this study. Then, we report the changing spatial patterns of migrants and carry out a longitudinal analysis of factors behind the changing patterns. Next, we examine the relationship between different types of cities and conduct a case study in two cities to cross-check our findings. We draw conclusions and provide policy recommendations in the end.

2. Literature review and conceptual framework

2.1. Theoretical background

Migration is essential to urbanization and economic development (S. Li 2004; Fan 2005; De Haas 2010). The literature suggests that internal migration is affected by uneven regional development, institutional transitions, and individual pursuits of better amenities and quality of life (Fan 1996; Vendryes 2011; Gupta 1993).

In the neoclassical and behavioral views, people migrate to maximize utility or the

overall utility of their household. The neoclassical approach emphasizes the roles of human capital, cost-effectiveness, and perceived risks in individual's migration decision (Sjaastad 1962). Everything else being equal, people migrate to places with more job opportunities, higher wages, and better living environment. Meanwhile, the behavioral approach considers migration as a complex process of decision-making (Gurak and Kritz 2000). Social networks and personal relations matter in migration decisions (Michaelides 2011). Both the neoclassical and behavioral perspectives have paid relatively little attention to macro-economic and institutional factors, some of which are unique to China (Fan 2002).

The structural method, grown from the Lewis-Fei-Ranis model (Lewis 1954; Ranis and Fei 1961), is another approach in the study of migration (Fan 1996). Researchers have highlighted the importance of labor market segmentation, uneven economic opportunities, and institutional context in migration (Fan 2002; Cai and Wang 2003). Rural-urban migration is considered a tug-of-war between the agricultural and the industrial/services sectors of the country, energized by growing agricultural productivity and wage differentials between various sectors. Rapid industrialization and urbanization in developed areas lead to more jobs and higher wages, which attract migrants from less-developed areas (Gupta 1993; Fan 2005). Furthermore, the structural approach has emphasized the role of institutional factors. State interventions have greatly affected internal migration in selected countries (Vendryes 2011; Chan and Zhang 1999).

Recent studies have also highlighted the effects of urban amenities and public

services on migration (Y. Liu and Xu 2017; Cheng et al. 2014). There has been a steady increase in "lifestyle" migration, by which the relatively affluent move for quality-of-life reasons instead of economic gains (Benson and Oreilly 2009) . One example is that many retirees in the U.S. are moving to the Sunbelt region (McHugh and Mings 1991). Finally, urban issues, including overcrowding and rising living costs, have pushed many migrants away from major cities (Yu and Myers 2007; Eimermann 2015).

2.2. Migration research in transitional China

A large body of literature has examined China's internal migration and its determinants in the past forty years (Shen 2015; Liang et al. 2014; Y. Liu and Xu 2017). Three sets of factors distinguish China's internal migration.

The first set of factors are institutional changes and state interventions, which have greatly affected the mobility and distribution of migrants in China (L. Li et al. 2010; Shen 2013). Institutional factors, such as the *hukou* system implemented in the 1950s, severely curtailed internal migration (Chan and Buckingham 2008; Chan and Zhang 1999). Later, China's central government assigned millions of skilled workers and educated youths from coastal cities to the hinterland and rural areas. Overall, self-initiated mobility was very low from the 1950s to the 1970s (Y. Liu et al. 2014). Since the 1980s, the Chinese government has gradually relaxed its control over migration (Shen and Huang 2003; Zhu 2003). There has been a massive increase in internal migration and the emergence of rural-urban migration—the

phenomenon of the floating population. Since the early 2010s, the Resident Permit (*juzhu zheng*) system, which makes local *hukou* and amenities be more accessible for migrants, has gradually replaced the Temporary Resident Permit (*zanzhu zheng*) system and made it possible for migrants to gain permanent status in cities. Since the announcement of the "Guidance on the Further Reform of the *Hukou* System" in 2014, both central and local governments have been gradually phasing out the old *hukou* system (J. Liu 2018). Because local governments have gained more control over migration policy, there has been growing regional differences in migration regulations since the early 2010s[3](J. Liu 2018). Institutional constraints still affect mobility (Chan and Buckingham 2008). It is difficult, if not impossible, for semi-/unskilled migrants—from either urban or rural sources—to "move" *hukou* to tier-1 cities, such as Beijing and Shanghai, and gain full access to public services in their migration destinations (Cheng et al. 2014). The *hukou* location and, to a decreasing extent, the *hukou* status[4] still determine one's migration choice and life opportunity in China (L. Li et al. 2010).

The second set of factors are uneven regional economic development and growing market forces (Fan 2005; Shen 2013). China's coastal regions improved their regional economy much more quickly than other parts of the country since the mid-1980s, due to their locational and institutional advantages (Wei and Ye 2009; Liao and Wei 2015). Meanwhile, agricultural productivity increased rapidly across the

[3] Please see Appendix for the requirements of household registration in cities of various urban population sizes.
[4] Please see Appendix for more information about the evolution of the *hukou* system and migration policies in China since 1949.

country and led to a large increase in surplus labor. Coupled with the *hukou* reform, the rapid economic growth in the coastal regions, such as the PRD and the YRD regions, attracted massive migration from the less-developed hinterland regions (Zhong et al. 2013; Y. Liu et al. 2014). However, since the early 2000s, the pace of economic development and urbanization has accelerated in China's central and western regions because of an improved investment environment and the support of the central government. While major cities with high productivity and wages are still appealing to migrants (Y. Liu and Xu 2017; Y. Liu and Shen 2017), many central and western cities have accelerated the pace of industrialization and adopted new policies to attract labor-intensive industries and unskilled migrants (He et al. 2016). In contrast, tier-1 cities, suffering from overcrowding and deteriorating quality-of-life, have pushed unskilled migrants away through industrial upgrading and migration regulations. Migrants who had hard time in the major cities of the coastal region are steadily migrating or returning to China's hinterland regions, generating new population agglomerations and leading to the geographic diversification of migration destinations (Liang et al. 2014).

The third set of factors are related to changing demographics and shifting preferences of migrants. China stands at a demographic turning point (Peng 2011). The one child policy implemented in the late 1970s has abruptly reduced the size of the subsequent birth cohorts (Banister 1987; Riley 2004; Zhao and Chen 2008). Each new birth cohort joining the rank of migrants is getting smaller over time. There is no longer a large pool of surplus laborers in rural China. Moreover, most

new migrants grew up in one-child families. Consequently, the newer generation of migrants is substantially different from older migrants with respect to their size and to their personal preferences. As China's economy matures and the standard of living improves, migrants seem to have paid more attention to amenities and lifestyle in their migration decisions (Wang 2011). Furthermore, young and skilled migrants seem to prefer developed urban regions that have better amenities (Fan 2005; Cheng et al. 2014; Y. Liu and Shen 2017). Family migrants have also cared more about the quality and the accessibility of public services, such as children's education and health care (Lin et al. 2019). More recently, migrants in major cities are facing new challenges, such as rising housing cost, air pollution, and traffic congestion (Zang et al. 2015). However, it is still unclear how these factors have affected the redistribution of migrants in China.

2.3. Conceptual framework for migration redistribution across urban China

Based on the literature review, we expect to see several push and pull forces that have affected the distribution of the migrant population across urban China. Figure 1 shows our conceptual framework of influencing factors on migration redistribution in the new era of China's urbanization. We focus on the role of economic transition, public policy, and urban amenities. In addition to the several factors discussed in the literature review, we examine the following variables.

(Figure 1. about here)

First, the housing sector, a pillar of China's urban economy, is closely linked to

China's internal migration. A strong local economy usually attracts migrants, which in turn elevates housing demand and attracts housing investment (Zang et al. 2015). Therefore, we expect to see that migrants are an important driver in the housing market and that housing investment—and housing prices—are positively associated with the growth of the migrant population.

Second, social welfare and public services are linked to migration. The migrant population should grow in cities with larger per capita public expenditure, which is also positively correlated with the quality of social welfare and public services. While migrants are often excluded from social welfare and public services in major cities, smaller cities tend to be more accommodating to migrants.

Third, regional differences in amenities—such as children's education, air pollution, and the availability of public transport—should also matter to migrants (Chen et al. 2013; Lin et al. 2019). Rapid industrialization and urbanization have resulted in serious environmental pollution, which may have pushed migrants away from large and heavy industrial cities (Cai et al. 2018).

To summarize, we expect to see that the growth of the migrant population is positively associated with local economies, job opportunities, the wage level, economic growth, social welfare and public services, housing investment and prices, the support of the central government, and better urban amenities. In contrast, the migrant population should grow more slowly—or even decline—in cities with strong migration controls, industrial upgrading, and greater financial burden on the local government.

3. Data and methodologies

3.1. Data sources

The population data used in this study are derived from the two recent population censuses in 2000 and 2010, and from the 1% sample population survey in 2015. We acquire the supplemental data (2011-2014, and 2016) from provincial and prefectural statistical yearbooks. These data are collected by national and local statistics bureaus, which are the most reliable source of population and migration data in China. We build our contextual variables using data from the China City Statistical Yearbooks (CCSY).

We define the migrant population (*liudong renkou*) as those who are residing in a city that is different from the city of their household registration (*hukou*) and who have stayed in the cities of destination for at least 6 months. The size of the migrant population in each city equals to the difference between the size of the *resident* population—those who have lived in the city for more than 6 months—and the size of the *registered* population—those who have local *hukou* and have lived in the city for more than 6 months[5].

There are a total of 334 cities in this sample, which include 4 centrally administered municipalities, 35 provincial capitals and specifically-designated cities, 24 county-level cities. The rest are prefecture-level cities (Fig. 2). In addition, we separately study major cities, which are centrally administered municipalities, provincial capitals, and specially-designed cities. There are a total of 63 major cities in this

[5] Temporary migrants—those who have stayed in the current location for less than 6 months—are excluded from this study.

study. There have been minor administrative changes to the boundary of the cities during our study period. We have slightly adjusted the boundary of the cities to make the data more comparable over time.

(Figure 2. about here)

3.2. Methodologies

3.2.1. Exploratory Spatial Data Analysis (ESDA)

In this study, we apply the ESDA techniques to examine the spatial heterogeneity and dependence of China's internal migration based on our spatial dataset. The Global Morans I statistic (MI) is employed to measure the spatial autocorrelation of the distribution of the migrant population across urban China. The MI can be calculated by the following equation:

$$MI = \frac{n*\sum_{i=1}^{n}\sum_{j=1}^{n} w_{i,j}(FP_i-\overline{FP})(FP_j-\overline{FP})}{\left(\sum_{i=1}^{n}\sum_{j=1}^{n} w_{i,j}\right)*\sum_{i=1}^{n}(FP_i-\overline{FP})^2} \quad (1)$$

where, FP_i and FP_j stand for the amount of the migrant population in sample city i and j, $\overline{FP}$ is the average amount of the migrant population by city. $w_{i,j}$ represents the spatial weight matrix, and n is the number of sample cities. The value of MI ranges from -1 to 1, significantly positive MI value indicates spatial agglomeration and autocorrelation of the feature.

We also use the Hot Spot Analysis tool, namely the estimation of the Getis-Ord Gi* statistic (G_i^*), to explore the spatial clusters of the growth of the migrant population. To be a statistically significant hot (cold) spot, a feature will have a high (low) value and be surrounded by other features with high (low) values as well. The G_i^* can be calculated as:

$$G_i^* = \frac{\sum_{j=1}^{n} w_{i,j} CFP_j - \overline{CFP} \sum_{j=1}^{n} w_{i,j}}{S\sqrt{\frac{\left[n\sum_{j=1}^{n} w_{i,j}^2 - \left(\sum_{j=1}^{n} w_{i,j}\right)^2\right]}{n-1}}} \quad (2)$$

where, CFP_j is the annual growth of the migrant population for city j, $w_{i,j}$ is the spatial weight matrix. n stands for the number of sample cities, and:

$$\overline{CFP} = \frac{\sum_{j=1}^{n} CFP_j}{n} \quad (3)$$

$$\mathrm{S} = \sqrt{\frac{\sum_{j=1}^{n} CFP_j^2}{n} - \left(\overline{CFP}\right)^2} \quad (4)$$

3.2.2. Empirical models and variable specifications

We also study the relative importance of factors that have affected the distribution of the migrant population across urban China since 2010. We build the following conceptual model:

$$FP_{it} = \mathrm{F}(Eco_{it-1}, Pub_{it-1}, Ame_{it-1}) \quad (5)$$

where i means the sample cities, t is the study period. FP is the dependent variable, which represents the size of the migrant population in each sample city. Eco, Pub, and Ame represent independent variables related to economic transition, public policy, and urban amenities respectively.

Table 1 reports the details of the independent variables used in this study. Researchers have considered the wage level and job opportunities as proxies for regional economic development (Y. Liu and Shen 2014). We use per capita gross domestic product (PGDP), the number of employed people (EMPL), and the average wage of the employed (WAGE) to measure the level of economic development by city. We follow previous studies and use annual growth rate of GDP (RGDP), and industrial composition (i.e. PRIM, SECO and TERT) to represent the level of

economic transition by city. Since 1980, China's agricultural productivity has increased significantly, and its share of the economy has steadily declined. In fact, the service industry has become the largest sector for employment in many major cities. Moreover, we use the annual housing investment (HOUSE) to measure the level of housing development by city. Housing prices by city are studied in the robustness check.

Based on the literature and our conceptual framework, regional differences in migration regulations should have played an important role in the redistribution of the migrant population across urban China. We introduce two dummy variables—STATE and HUKOU—as the proxies for state interventions and local migration controls respectively. Cities with better social welfare and public services are expected to attract more migrants. Meanwhile, cities that face large financial pressure should be less attractive. We use per capita public expenditure (EXPEN) and the amount of fiscal deficit (PRESS) as the proxies of social welfare services and financial pressure by city respectively.

Urban amenities perhaps have increasingly affected China's internal migration in recent years, as a new generation of migrants is paying more attention to the quality of life than older generations (Y. Liu and Xu 2017). Based on the literature, we use health care, children's education, public transport, and leisure service data to measure the level of public services by city (Y. Liu and Shen 2014). People have in recent years paid more attention to air quality in China, and governments have implemented various strategies, such as "Livable City" and "Garden City", to improve air quality

and living environment. We use the level of air pollution (AIR_P) and the availability of urban green space (GREEN) to measure the environmental conditions by city. Table 1 provides detailed information about the variables used in this study.

(Table 1. about here)

A panel regression model is used to examine the extent to which various factors have impacted the distribution of the migrant population. We use the first-lagged value of independent variables to control for the potential problem of multicollinearity and endogeneity. Table 2 shows the basic descriptive statistics of the variables used in this analysis. In order to make a consistent comparison, we standardize the data for analysis.

(Table 2. about here)

4. Changing distribution of the migrant population across urban China

4.1. Spatiotemporal patterns of the migrant population

Figures 3 and 4 show the changing spatial patterns of migrants by mapping the size of the migrant population by city and the ratio of in-/out-migration to the registered population by city in 2000, 2010, and 2016. Positive (negative) values indicate whether a given city is gaining or losing the migrant population. Clearly, the migrant population was moving to tier-1 cities (i.e. Beijing, Shanghai, Guangzhou and Shenzhen) at the beginning of the 21st century. Subsequently, the central government adopted national policies such as “Support Xinjiang and Tibet”, “Western Development”, and “Northeast Promotion” to support the less-developed regions of

China. As a result, many autonomous regions in western China had a slight increase in the migrant population. In contrast, lower-tier cities around the coastal mega-regions (i.e. the PRD, the YRD, and the Beijing-Tianjin regions) lost migrants from 2000 to 2010. Except for provincial capitals, most cities in central China also lost population to out-migration. However, there was no dramatic exodus from any given city—no cities lost more than 1 million or more than 10% of its local population over the decade.

There has been a significant redistribution of the migrant population since 2010. First, coastal mega-regions emerged as the main migration destinations, which had a net gain of more than 10% (up to 100%) of the migrant population. Cities, each of which had more than 5 million migrants in 2016, include Shanghai, Beijing, Shenzhen, Tianjin, and Dongguan. Second, provincial capitals, especially in central and western China, have attracted migrants. The migrant population has exceeded 1 million in several tier-2 cities such as Chengdu, Zhengzhou, Wuhan, and Kunming. Third, most cities in the hinterland regions and around the mega-regions lost population to out migration. Low-tier cities located in Guizhou, Guangxi, eastern Sichuan, southern Henan, western Fujian, northern Jiangsu, and northern Guangdong lost more than 20% of their local population. Moreover, the net gain of migrants in resource-based regions, such as Xinjiang and northeastern China, has slowed down.

(Figures 3 and 4. about here)

Table 3 reports the changes of global Morans I index es, which are significantly positive, from 2000 to 2016. MI indexes kept rising from 2000 to 2010, indicating

that the migrant population was increasingly concentrated in the selected destinations. In contrast, the decline of the MI indexes from 2010 to 2016 suggests not only the geographical dispersion of the migrant population, but also the reordering of migration destinations. In other words, the migrant population is dispersing to more cities and to different cities in this new era of China's urbanization.

(Table 3. about here)

4.2. Spatial restructuring of migration destinations

Figure 5 shows the clusters of migration destinations (origins) based on the relative increase (or decrease) of the migrant population. From 2000 to 2010, hot spots were in three mega-regions, namely the PRD, the YRD, and Beijing-Tianjin regions, which were the most popular destinations for migrants. In each of the three mega-regions, the size of the migrant population increased by more than 0.2 million per year from 2000 to 2010. In contrast, cold spots are mainly seen in central and western China, such as Chongqing, Sichuan, and Henan. Some lower-tier cities located in less-developed regions experienced a steady loss of population.

The spatial pattern of migration destinations and origins changed from 2010 and 2016. The hotspot analysis shows that the Beijing-Tianjin region still had a high average annual growth of in-migration from 2010 to 2016. Meanwhile, hot spots have shifted somewhat from coastal to inland regions. Specifically, many lower-tier cities in the PRD and the YRD regions had a decrease in the average annual growth of the migrant population, while several interior cities (e.g. Chongqing) witnessed a slight increase in the migrant population. On the other hand, cold spots are mainly

located in central and southwestern China (e.g. Henan, Guizhou, and Guangxi), where population has continuously declined.

Next, we look at the changes in growth, comparing the average annual growth rate of the migrant population by city during the two periods, namely 2000-2010 and 2010-2016. The results shown in Figure 4c confirm the spatial restructuring of migration destinations in China since 2010. First, cold spots are largely in the PRD, the YRD, and the Beijing-Tianjin regions. Compared with the period from 2000 to 2010, the average annual growth of the migrant population during the period from 2010 to 2016 significantly slowed in these mega-regions. In particular, the migrant population declined by 154,000 and 26,000 in Beijing and Shanghai respectively from 2015 to 2016. Second, hot spots are shown in northern Jiangsu, northern Anhui, and the upper-middle reaches of the Yangtze River—areas that used to send out large numbers of migrants. We also find that several inland cities, such as Chongqing, have slowed down the pace of population decline since 2010. Several inland provincial capitals emerged as new migration destinations. Third, several lower-tier cities in Inner Mongolia and northeast China had a decline in population likely due to fertility decline, resource exhaustion, and economic stagnation.

(Figure 5. about here)

5. Driving forces and mechanisms of the migrant population redistribution

5.1. The overall picture of the driving mechanisms

After the descriptive analysis shown above, we conduct a panel regression analysis

to study factors behind the redistribution of the migrant population across urban China from 2010 to 2016. Table 4 shows the regression results. We first report the results for all sample cities and then for major cities only. Independent variables with higher Pearson's correlation values are put into the models separately (see Models 1-3). The coefficients for PGDP, EMPL and WAGE are significantly positive in all sample cities, indicating that the size of the migrant population is positively associated with strong local economies. This finding is consistent with the neoclassical view that places with more jobs and higher wages are attractive to migrants (Michaelides 2011; Y. Liu and Xu 2017). However, the coefficients of IGDP are significantly negative, suggesting that migrants are moving away from cities with higher rate of economic growth. Many lower-tier cities, where the growth rate of GDP was high between 2010 and 2016, had a net loss of migrants to more developed cities. This finding is consistent with the structural explanation that uneven economic opportunities matter a great deal to migrants.

Our results indicate that industrial upgrading has affected the redistribution of the migrant population. The coefficients of PRIM are negative and statistically significant, showing that cities with a large agricultural sector tend to have a large out-migration. This result is consistent with a recent study that examined the effects of rising agricultural productivity on migration (Yang et al. 2016). While SECO has a negative sign, the coefficient of TERT is positive. The migrant population is growing in major cities whose economy is largely service based. Cities with a larger service sector tend to have more jobs suitable for migrants. Meanwhile,

industrial/resource-based cities that have pursued industrial upgrading pushed away low-end manufacturers and unskilled migrants. Furthermore, the coefficients for HOUSE are significantly positive, implying that housing investment is positively associated with the growth of the migrant population. Rural-urban migration has led to a growth in housing demand and investment in the migration destinations.

Different from our expectations, STATE has a negative sign, suggesting that migrants have not congregated in cities located in the National Priority Zones. Meanwhile, the coefficient of HUKOU is significantly positive, suggesting that cities with strong migration controls have still seen an increase in the migrant population. There are three possible explanations for this counterintuitive finding. First, major cities that have a large and growing migrant population are more likely to restrict migration in their effort to deal with overcrowding. Second, migration controls may have become ineffective outside tier-1 cities. It also takes time for migration controls to take effect and to affect in-migration. Third, for migrants, the lure of jobs and opportunities outweighs the effect of migration controls in major cities. Migration controls may have pushed away unskilled migrants and increased job vacancies in the short run. Wage levels will eventually increase, and more migrants will be attracted to the city until an equilibrium is reached. In sum, state interventions and institutional factors have greatly affected migration in China but may become less effective in the future.

EXPEN and PRESS have positive and negative signs, respectively. This means that cities with higher expenditures on social welfare have attracted more migrants.

In contrast, cities with a large public debt have attracted fewer migrants. These are consistent with what we have originally thought.

In addition, most coefficients for amenity variables are significantly positive. This suggests that migrants prefer places with abundant social welfare and public services. Although public services have improved across urban China, high-quality public resources are still concentrated in major cities. In addition, air pollution (AIR_P) has a significant and positive sign, which is unexpected. Migrants seem impervious to air pollution. Since the overwhelming majority of migrants are from rural China and they go to cities for jobs and opportunities, air pollution appears to be a secondary concern.

In the second stage of the analysis, we focus on major cities only. The regression results show several notable differences from those of the full sample. First, the coefficients of PGDP and EMPL become negative or no longer statistically significant. Major cities tend to have similarly high levels of economic development; migrants may not choose one major city over another based on the level of economic development. Furthermore, industrial upgrading has led to changing labor demand in major cities, where local governments have favored skilled migrants over the unskilled. Second, the coefficients for STATE and HUKOU are not statistically significant, indicating that the effects of national and local policies vary across major cities. The designation of National Priority Zones matters more to major cities than to smaller cities with respect to migration. On the other hand, tier-1 cities such as Beijing and Shanghai have implemented some of the most stringent

migrant controls to deflect unskilled migrants. Migrant regulations are less effective outside these tier 1 cities. Third, amenity variables such as DOCT, EDU, and GREEN are no longer statistically significant. This is probably because rising living costs in major cities have washed out the positive effects of amenities and quality services for migrants.

(Table 4. about here)

For major cities, the coefficient for the housing investment variable is still significantly positive. To further understand the relationship, we plot the bivariate relationship between changes in the migrant population and housing prices in major cities where housing price data are more reliable and readily available (see Figure 6). The result shows a positive correlation between the two: the growth of the migrant population is larger in cities where housing prices have increased more. In other words, migration remains an important driver of the housing market in this new era of China's urbanization. However, there are exceptions. Tier-1 cities saw a large increase in housing prices with little or no corresponding growth of migrants. These cities have the most stringent migration controls in China (S. Li et al. 2014). Even though these cities have pushed migrants away, housing demand remains very high. The bigger potential for asset appreciation has attracted much housing investment to tier 1 cities. In contrast, migrants are more likely to make compromises such as living in crowded and substandard conditions than local residents (Yu 2017). Overall, rising housing cost has not deterred migrants in major cities so far.

(Figure 6. about here)

5.2. Regional disparities in the driving mechanisms

We separately carry out the analysis in eastern and in central-western China. The results reported in Table 5 show large regional differences in factors underlying the redistribution of the migrant population. First, the coefficients for EMPL and WAGE vary between regions. The size of the migrant population is larger in eastern cities that have more jobs and higher wages. In contrast, these relationships are either muted or negative in central-western China. This is perhaps because the levels of economic development are relatively homogenous among less developed cities. Moreover, some less-developed autonomous regions have attracted migration, probably due to state interventions. Overall, these results confirm existing findings that China's eastward migration is the result of uneven regional economic development.

Second, the effects of state intervention (STATE) and financial pressure (PRESS) vary between regions. The coefficients for STATE are significantly negative for eastern cities, but positive for central-western cities. This is perhaps because most national policies have focused on supporting less-developed interior regions. Therefore, the impacts of state interventions are more apparent for inland cities. Meanwhile, the coefficients of PRESS have the opposite signs in these two areas. Surprisingly, the size of migrant population is positively associated with the level of financial pressure in eastern cities.

Third, the coefficients for some amenity variables differ between regions. In the group of central-western cities, the coefficients for EXPEN, DOCT and LEIS are

significantly positive. This signifies that the quality of social welfare and public services plays a role in attracting migrants. However, the same variables are either negative or insignificant for eastern cities, suggesting that the influences of public services are relatively muted in more developed areas. In addition, the coefficients for GREEN are negative among central-western cities. This finding is different from our original hypothesis that migrants tend to move to places with better amenities. Again, this result shows that amenities are largely a secondary concern for migrants.

(Table 5. about here)

5.3. A case study of two cities

We further conduct a case study to examine the changes of migrant flows and their driving forces in two cities, namely Beijing—a tier-1 city located in the coastal mega-region and the capital city of China—and Nanchang—a less-developed provincial capital located in central China. Figures 7 and 8 respectively show changes in the migrant population and economic structure in these two cities. As one of the most popular migration destinations in China, Beijing had net gains of more than 8 million migrants from 2010 to 2016. However, the growth rate has steadily declined in recent years. This is highly associated with the changes in the economic structure and migrant policies of Beijing. To reduce congestions and housing cost, the central and local governments plan to relocate all non-essential functions (e.g. low-end manufacturing facilities and specialized wholesale markets) from Beijing to neighboring cities. Meanwhile, the producer services and high-tech sectors have become industry leaders in Beijing (see Figure 8). There has also been a decrease in

the demand for unskilled migrants. As one of the most regulated cities in China, it is nearly impossible for unskilled migrants to gain local *hukou* and become Beijing residents. Without local *hukou*, migrants do not have access to much of the public service in Beijing. At the same time, housing prices have kept rising in Beijing. Consequently, the number of migrants has declined in Beijing for the first time in recent memory.

In contrast, the migrant population has kept increasing in Nanchang from 2011 to 2016. Although the local government has been pursuing industrial upgrading, manufacturing industries and low-end services still dominate the local economy. There have been more job opportunities for migrants. For instance, the number of jobs in the industrial sector increased by 414,500 in Nanchang from 2011 to 2016. As part of the recent *hukou* reform, the central and local governments have largely abolished the old household registration system in cities like Nanchang. It is relatively easy for migrants to acquire local *hukou* and gain access to social welfare in Nanchang. Furthermore, Nanchang has adopted preferential policies to attract skilled migrants. Coupled with a relatively cost of living and a high quality of life, abundant job opportunities and the ease of migration have attracted many migrants to Nanchang in recent years.

(Figures 7 and 8 about here)

6. Conclusion

Although there is an extensive literature on China's internal migration, we know

little about the redistribution of the migrant population and its underlying factors since 2010. This study attempts to fill this gap. We look at the changing distributions of the migrant population over time and examine the effects of push and pull factors related to economic transition, public policy, and urban amenities. We also compare different regions and carry out a case study to check the robustness of our findings.

The result illustrates that the migrant population was highly concentrated in the mega-regions, such as the PRD, the YRD and Beijing-Tianjin regions, as well as many provincial capitals before 2010. In contrast, Chongqing—the newest direct-administered municipality—and lower-tier cities in the hinterland (e.g. Sichuan, Guizhou, Henan) lost large populations to out-migration. Our findings are consistent with that of the literature (Shen 2013; Y. Liu et al. 2014).

From 2010 to 2016, there has been a significant redistribution of the migrant population. The growth of the migrant population significantly slowed in coastal mega-regions. While stringent migration controls have pushed migrants away from tier-1 cities, major cities remain very attractive to migrants. Many lower-tier cities located in central and western China have reversed the trend of population decline and, in some cases, had a modest increase in the migrant population. Several interior provincial capitals and lower-tier cities have emerged as new migration destinations. Furthermore, resource-based cities, mostly located in Inner Mongolia, Xinjiang and northeastern China, have had a steady decline in the migrant population. These results illustrate the spatial restructuring of migration destinations in China since 2010.

Our regression results show that the interactions between push and pull factors have resulted in the ebb and flow of the migrant population and that the relative importance of the influencing factors has differed across regions/cities and changed over time. As expected, regional differences in economic development, job opportunities, and wages are still the main driving forces behind China's internal migration. Migrants are skipping cities with a large agricultural sector or a declining industrial sector. Consistent with the literature, cities with better—and more accessible—amenities are attractive to migrants. The amenity effect is more salient in less-developed regions. State interventions, such as national projects and regional development plans, have had positive, but modest, impacts on population agglomeration among major cities. It is unclear whether such impacts will be long lasting. Finally, cities that have large debt obligations are less attractive to migrants, especially in less-developed regions.

We also have several unexpected findings. First, the service industry has largely replaced manufacturing in major cities and become the leading attraction for migrants. This is in contrast with some past studies which show that manufacturing expansion in urban areas has brought in migrants as cheap laborers (He et al. 2016). Industrial upgrading has reached its limit in tier-1 cities. It would be difficult for major cities with a large service sector to pursue industrial upgrading as a way to deflect migrants. Second, we find that a booming housing market, characterized by increasing housing investment and rising housing prices, has not deterred migrants. Except for tier-1 cities which have implemented stringent migration controls and deflected unskilled migrants, the growth of the migrant population is positively associated with the

increase in housing investment and prices. Migrants are perhaps primarily concerned about jobs and opportunities with the associated income. Third, except for tier-1 cities in recent years, there is a positive association between local migration controls and the spatial agglomeration of migrants. Despite migration controls and restrictive local *hukou*, people are still migrating to large cities. The *hukou* reform will likely continue to diminish the power of governments to regulate migration. Fourth, the level of air pollution is positively associated with the growth of the migrant population. Even though urban residents have complained much about air pollution in recent years, air pollution seems a secondary concern for migrants. Finally, the growth of the migrant population is negatively associated with the increase in GDP. Because of large disparities between cities, economic growth alone is not enough to keep migrants from moving to major cities.

All in all, our study has uncovered temporal and spatial redistribution of the migrant population across urban China and factors behind the redistribution since 2010—a new era of China's economic development and urbanization. Migration has been a tug-of-war not only between sectors and cities, but also between governments and between past and future. In the coming years, the growth of productivity and population will continue to slow. Migrants will have more choices in terms of migration destinations. As the migration rules become more relaxed outside tier-1 cities, there will likely be more urban migrants who seek better opportunities and living environment in other cities. Future research should pay more attention to urban migrants, to older migrants, and to the eventually integration of migrants in

cities.

There are several policy implications. From the perspective of the government, institutional reform and population regulations should be tailored to specific regions to promote regional integration and productivity. Interior cities with growing economic opportunities and relatively low costs of living have the potential to attract more migrants. Meanwhile, nationally and regionally central cities that want to attract skilled migrants can focus on industrial upgrading and fine-tuning population regulations. An important question confronting major cities is how to help migrants adapt to urban life and alleviate economic and social discrepancies between local residents and migrants.

References

Banister, J. (1987). *Chinas changing population* . Redwood City, California: Stanford University Press.

Benson, M., & Oreilly, K. (2009). Migration and the search for a better way of life: a critical exploration of lifestyle migration. *The sociological review, 57*(4), 608-625.

Cai, F., Guo, Z., & Wang, M. (2018). New Urbanisation as a Driver of China's Growth. In L. Song, R. Garnaut, F. Cai, & L. Johnston (Eds.), *China's new sources of economic growth : reform, resources and climate change. Volume 1*. Acton: ANU Press.

Cai, F., & Wang, D. (1999). Sustainability and Labor Contribution of Economic Growth in China. *Journal of Economic Research (in Chinese), 10*, 62-68.

Cai, F., & Wang, D. (2003). Migration as marketization: what can we learn from Chinas 2000 census data? *China Review*, 73-93.

Chan, K. W., & Buckingham, W. (2008). Is China abolishing the hukou system? *The China Quarterly, 195*, 582-606.

Chan, K. W., & Zhang, L. (1999). The hukou system and rural-urban migration in China: Processes and changes. *The China Quarterly, 160*, 818-855.

Chen, J., Chen, S., & Landry, P. F. (2013). Migration, environmental hazards, and health outcomes in China. *Social science & medicine, 80*, 85-95.

Cheng, Z., Nielsen, I., & Smyth, R. (2014). Access to social insurance in urban China: A comparative study of rural–urban and urban–urban migrants in Beijing. *Habitat International, 41*, 243-252.

CPC, & State Council (2014). The national plan on new urbanization (2014–2020). In C. C. o. t. C. P. o. China, & t. P. s. R. o. C. The State Council (Eds.). Beijing: The State Council.

De Haas, H. (2010). Migration and development: A theoretical perspective. *International Migration Review, 44*(1), 227-264.

Eimermann, M. (2015). Lifestyle migration to the North: Dutch families and the decision to move to rural Sweden. *Population, Space and Place, 21*(1), 68-85.

Fan, C. C. (1996). Economic opportunities and internal migration: a case study of Guangdong Province, China. *The Professional Geographer, 48*(1), 28-45.

Fan, C. C. (2002). The elite, the natives, and the outsiders: Migration and labor market segmentation in urban China. *Annals of the Association of American Geographers, 92*(1), 103-124.

Fan, C. C. (2005). Interprovincial migration, population redistribution, and regional development in China: 1990 and 2000 census comparisons. *The Professional Geographer, 57*(2), 295-311.

Freeman, R. (2015). A Labor Market With Chinese Characteristics. In G. C. Chow (Ed.), *The Routledge Handbook of the Chinese Economy*. London: Routledge.

Gupta, M. R. (1993). Rural-urban migation, informal sector and development policies A theoretical analysis. *Journal of Development Economics, 41*(1), 137-151.

Gurak, D. T., & Kritz, M. M. (2000). The interstate migration of US immigrants: Individual and contextual determinants. *Social Forces, 78*(3), 1017-1039.

He, C., Chen, T., Mao, X., & Zhou, Y. (2016). Economic transition, urbanization and population redistribution in China. *Habitat International, 51*, 39-47.

Lewis, W. A. (1954). Economic development with unlimited supplies of labour. *The manchester school, 22*(2), 139-191.

Li, L., Li, S.-m., & Chen, Y. (2010). Better city, better life, but for whom?: The hukou and resident card system and the consequential citizenship stratification in Shanghai. *City, Culture and Society, 1*(3), 145-154.

Li, S. (2004). Population migration and urbanization in China: A comparative analysis of the 1990 population census and the 1995 national one percent sample population survey. *International Migration Review, 38*(2), 655-685.

Li, S., Chan, K. W., & He, S. (2014). Migration, mobility, and community change in Chinese cities: introducing the special issue. *Eurasian geography and economics, 55*(4), 307-312.

Liang, Z., Li, Z., & Ma, Z. (2014). Changing patterns of the floating population in China, 2000–2010. *Population and development review, 40*(4), 695-716.

Liao, F. H., & Wei, Y. D. (2015). Space, scale, and regional inequality in provincial China: A spatial filtering approach. *Applied geography, 61*, 94-104.

Lin, L., Zhu, Y., Ke, W., & Wang, J. (2019). The impact of migrants access to urban public services on their urban settlement intentions: A study from the perspective of different-sized cities (in Chinese). *Acta Geographica Sinica, 74*(4), 737-752.

Liu, J. (2018). The effect, problems and countermeasures of the new round reform of household registration system (in Chinese). *Population and Society, 34*(4), 89-98.

Liu, Y., & Shen, J. (2014). Spatial patterns and determinants of skilled internal migration in China, 2000–

2005. *Papers in Regional Science, 93*(4), 749-771.

Liu, Y., & Shen, J. (2017). Modelling skilled and less-skilled interregional migrations in China, 2000–2005. *Population, Space and Place, 23*(4), e2027.

Liu, Y., Stillwell, J., Shen, J., & Daras, K. (2014). Interprovincial migration, regional development and state policy in China, 1985–2010. *Applied Spatial Analysis and Policy, 7*(1), 47-70.

Liu, Y., & Xu, W. (2017). Destination choices of permanent and temporary migrants in China, 1985–2005. *Population, Space and Place, 23*(1), e1963.

McHugh, K. E., & Mings, R. C. (1991). On the road again: Seasonal migration to a sunbelt metropolis. *Urban Geography, 12*(1), 1-18.

Michaelides, M. (2011). The effect of local ties, wages, and housing costs on migration decisions. *The Journal of Socio-Economics, 40*(2), 132-140.

ONPSS (2017). *Tabulations of the 2015 national 1% population sample survey*. Beijing: China Statistics Press.

PCOSC, & NBC (2012). *Tabulation on the 2010 population census of the People's Republic of China*. Beijing: China Statistics Press.

Peng, X. (2011). Chinas demographic history and future challenges. *Science, 333*(6042), 581.

Ranis, G., & Fei, J. C. (1961). A theory of economic development. *The american economic review*(22), 533-565.

Riley, N. E. (2004). Chinas population: new trends and challenges. *Population Bulletin, 59*(2), 3-36.

Shen, J. (2013). Increasing internal migration in China from 1985 to 2005: Institutional versus economic drivers. *Habitat International, 39*, 1-7.

Shen, J. (2015). Explaining interregional migration changes in China, 1985–2000, using a decomposition approach. *Regional Studies, 49*(7), 1176-1192.

Shen, J., & Huang, Y. (2003). The working and living space of the 'floating population'in China. *Asia Pacific Viewpoint, 44*(1), 51-62.

Sjaastad, L. A. (1962). The costs and returns of human migration. *Journal of political Economy, 70*(5, Part 2), 80-93.

Sun, M., & Fan, C. C. (2011). Chinas permanent and temporary migrants: differentials and changes, 1990–2000. *The Professional Geographer, 63*(1), 92-112.

Vendryes, T. (2011). Migration constraints and development: Hukou and capital accumulation in China. *China Economic Review, 22*(4), 669-692.

Wang, Z. (2011). Social security for Chinas migrant workers. *International Labour Review, 150*(1-2), 177-187.

Wei, Y. D., & Ye, X. (2009). Beyond convergence: Space, scale, and regional inequality in China. *Tijdschrift voor economische en sociale geografie, 100*(1), 59-80.

Wu, J., Wei, Y., Li, Q., & Yuan, F. (2018). Economic Transition and Changing Location of Manufacturing Industry in China: A Study of the Yangtze River Delta. *Sustainability, 10*(8), 2624.

Yang, J., Wang, H., Jin, S., Chen, K., Riedinger, J., & Peng, C. (2016). Migration, local off-farm employment, and agricultural production efficiency: evidence from China. *Journal of Productivity Analysis, 45*(3), 247-259.

Yu, Z. (2017). Macro effects on the household formation of Chinas young adults–demographics, institutional factors, and regional differences. *International Journal of Housing Policy, 17*(4), 512-540.

Yu, Z., & Myers, D. (2007). Convergence or divergence in Los Angeles: Three distinctive ethnic patterns

of immigrant residential assimilation. *Social Science Research, 36*(1), 254-285.

Zang, B., Lv, P., & Warren, C. M. (2015). Housing prices, rural–urban migrants settlement decisions and their regional differences in China. *Habitat International, 50*, 149-159.

Zhao, Z., & Chen, W. (2008). Changes in household formation and composition in China since the mid-twentieth century. *Journal of Population Research, 25*(3), 267-286.

Zhong, F.-n., Qing, L., XIANG, J., & Jing, Z. (2013). Economic growth, demographic change and rural-urban migration in China. *Journal of Integrative Agriculture, 12*(10), 1884-1895.

Zhu, Y. (2003). The floating populations household strategies and the role of migration in Chinas regional development and integration. *Population, Space and Place, 9*(6), 485-502.

Zhu, Y. (2007). Chinas floating population and their settlement intention in the cities: Beyond the Hukou reform. *Habitat International, 31*(1), 65-76.

Zhu, Y., & Chen, W. (2010). The settlement intention of Chinas floating population in the cities: recent changes and multifaceted individual-level determinants. *Population, Space and Place, 16*(4), 253-267.

Figure 1. Conceptual framework of migrant redistribution and its driving forces in urban China

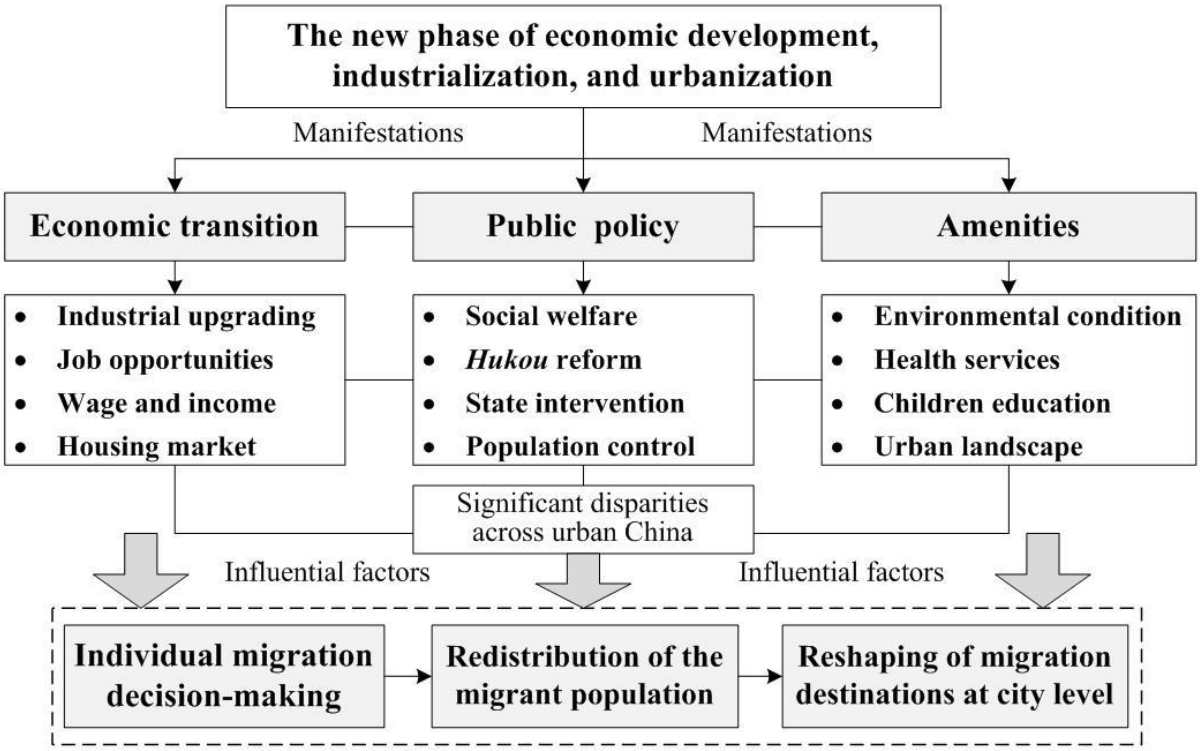
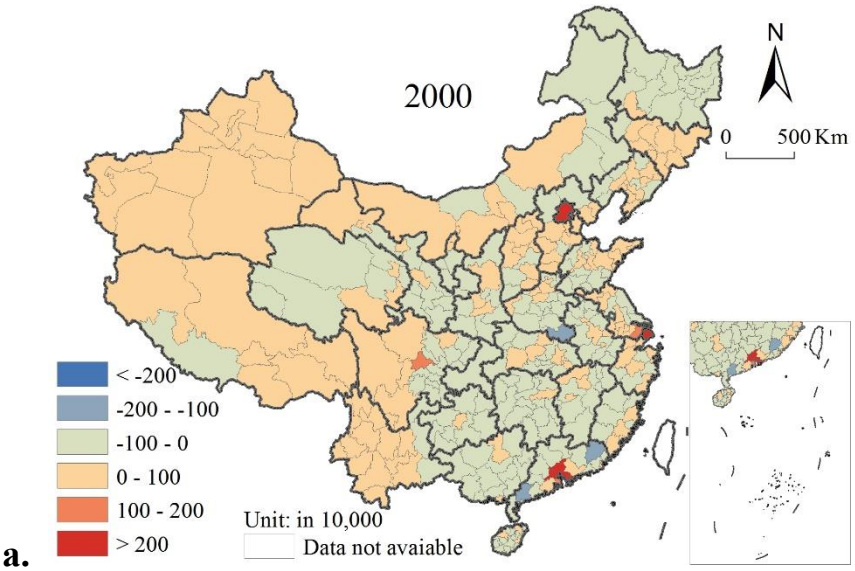


Figure 2. The sample cities and the administrative system of urban China

Figure 3. The redistribution of the migrant population across urban China in 2000, 2010, and 2016



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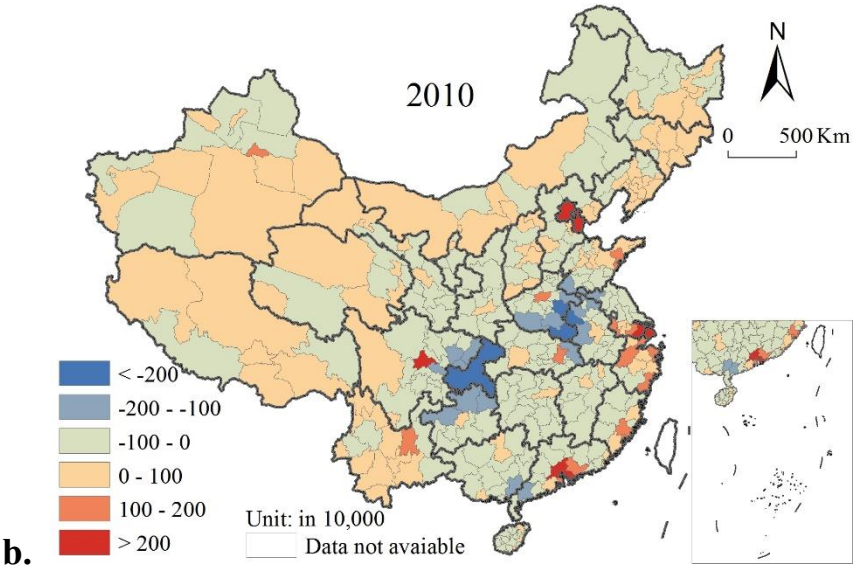

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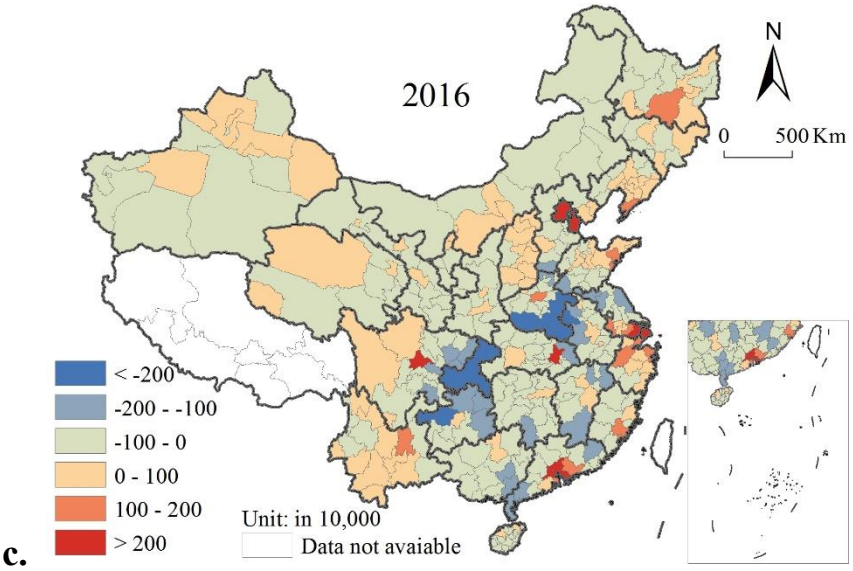
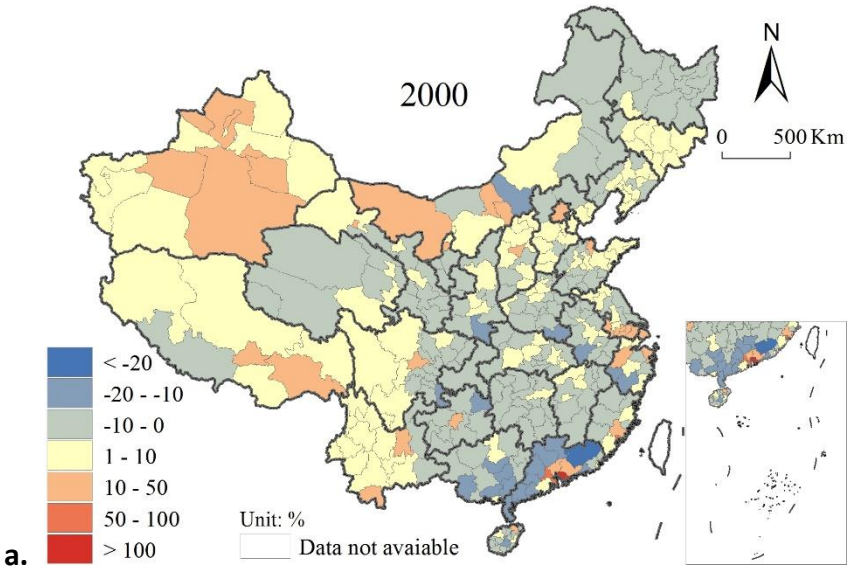


c.

Note: Positive (negative) values in these figures indicate the net inflow (outflow) of population, and the net population inflow means the increase of the migrant population at the city level.

Figure 4. The ratio of the in/out-migrant population to the local population across urban China in 2000, 2010, and 2016



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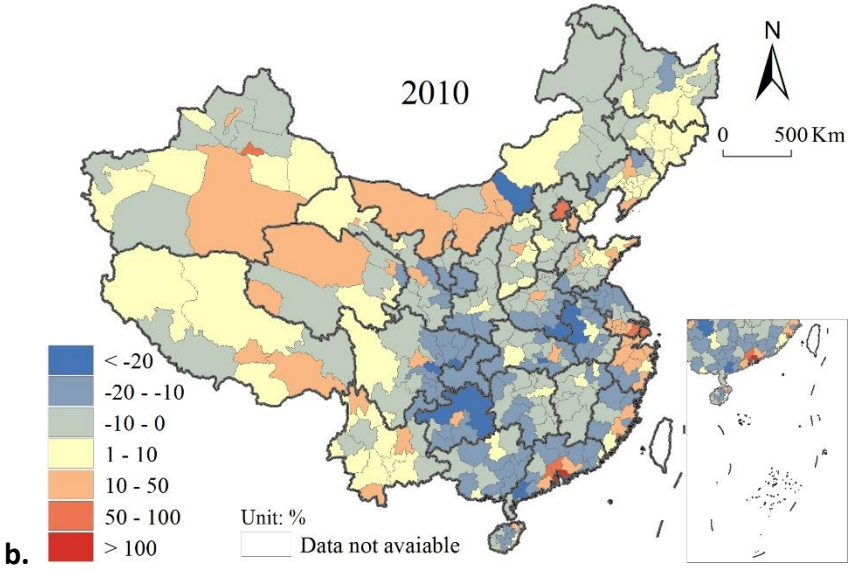

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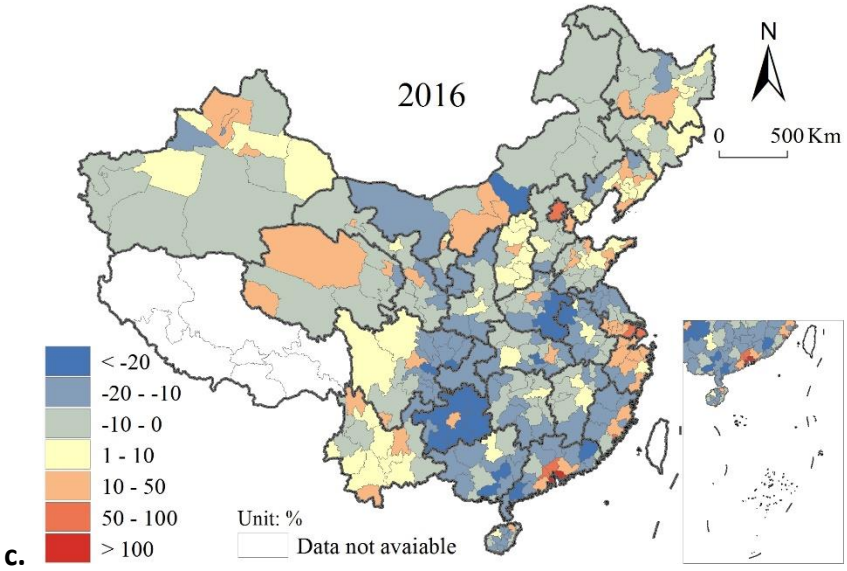

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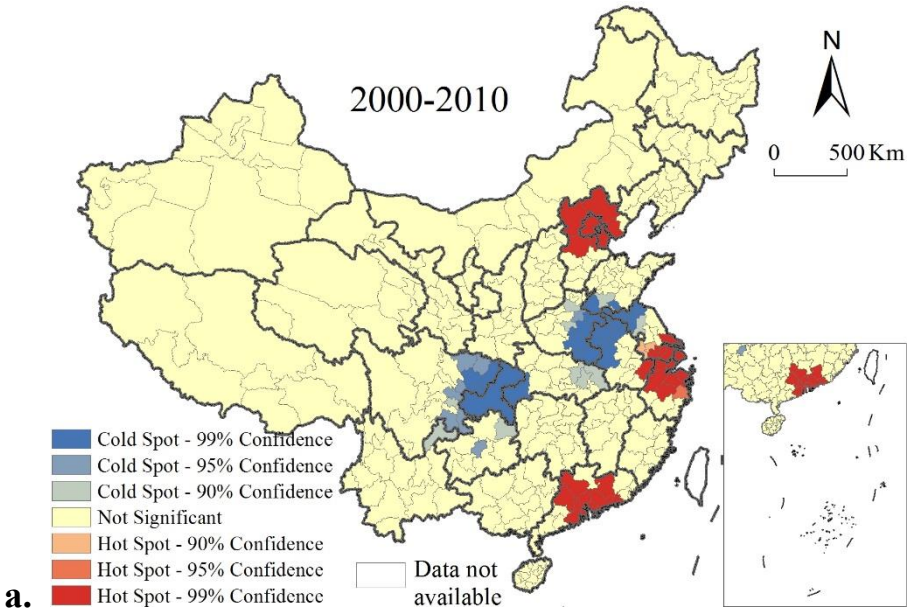
*The local population refers to those who have local *hukou* in the city of their residence and stayed there for more than 6 months. Local residents in urban areas rarely move between cities.

Figure 5. Hot/cold spots of the average annual growth of the migrant population by city: 2000-2010, 2010-2016, and annual growth differentials between the two periods



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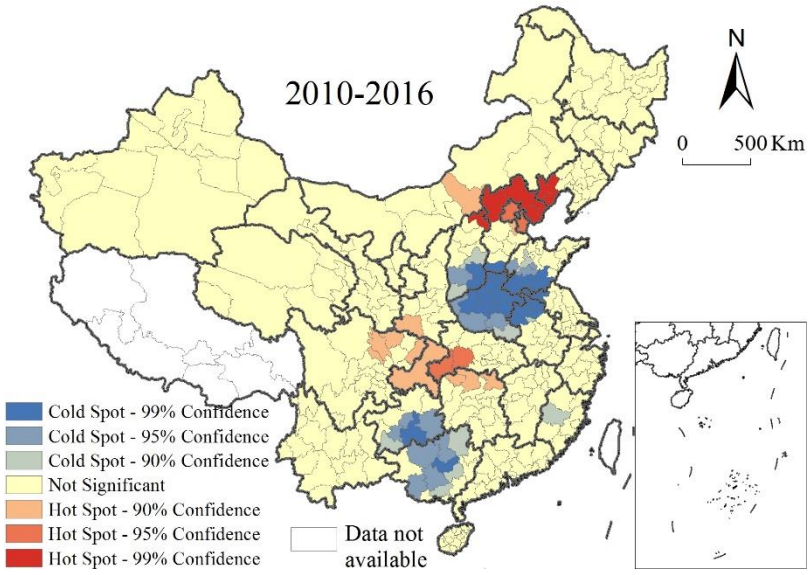

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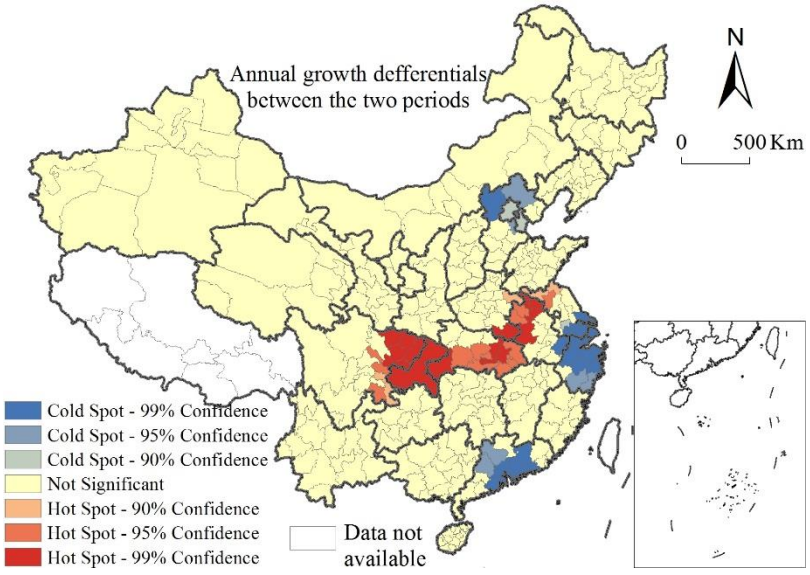

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Figure 6. The bivariate relationship between the changes of the migrant population and housing prices in major cities

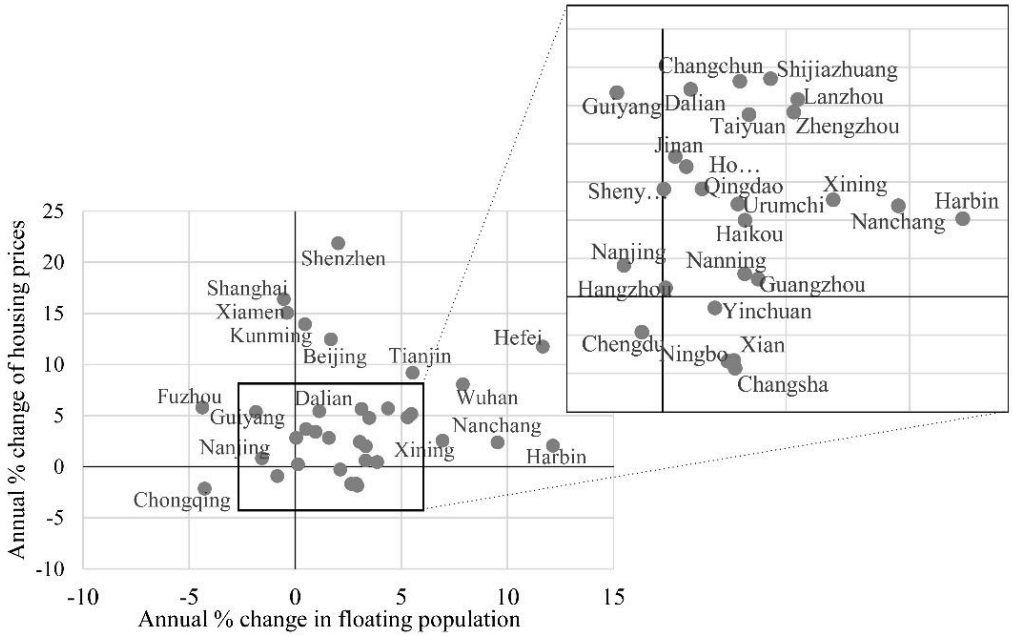
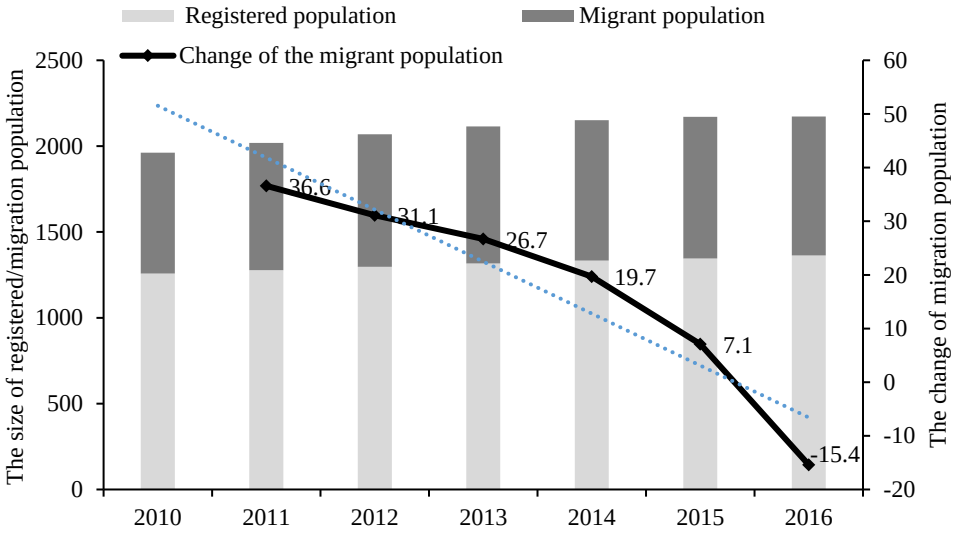


Figure 7. The changes in the migrant and local populations in Beijing (a) and Nanchang (b), 2010-2016



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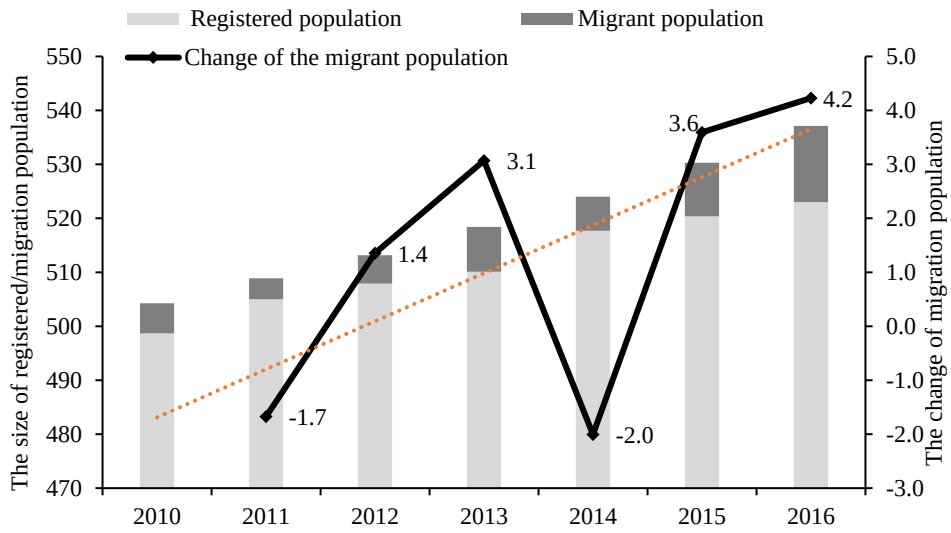

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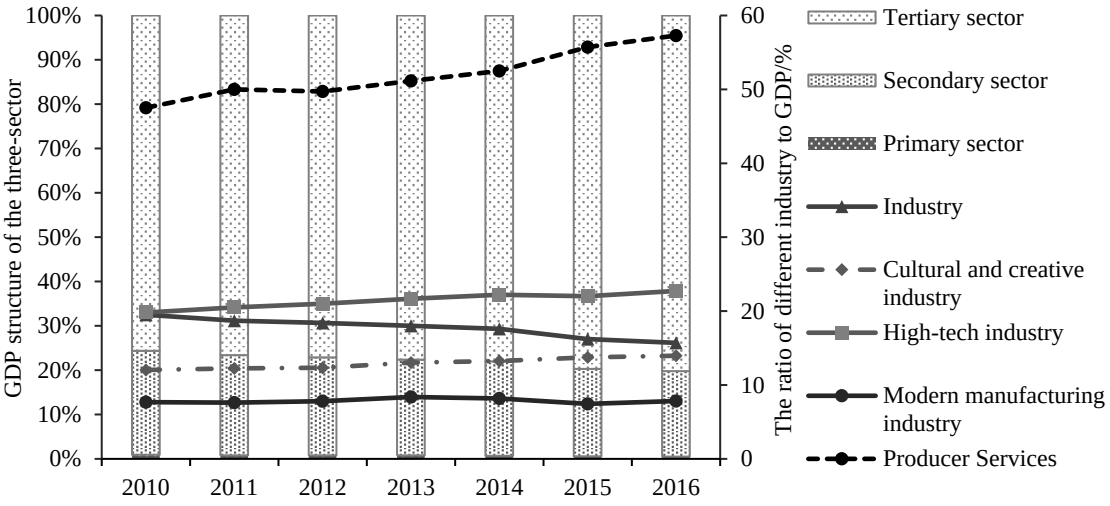
Figure 8. The changes of economic structure in Beijing (a) and Nanchang (b), 2010-2016



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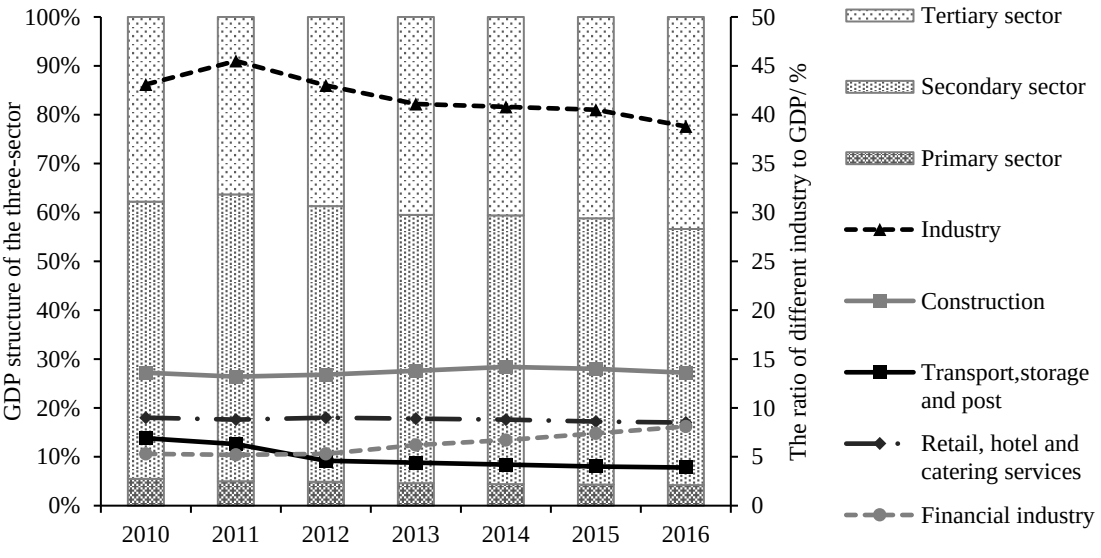

b.

Table 1. The description of the independent variables and the expected effects

Categories	Variables	Definitions and description	Abbreviation	Expected effects
Economic transition	Regional Economic development	Per capita (resident population) gross domestic product by city. (10,000 yuan)	PGDP	+
	Employment opportunities	The number of employed (year-end) by city. (10,000)	EMPL	+
	Wage levels	Average annual wage of employed workers by city. (10,000 yuan)	WAGE	+
	Economic growth	Annual GDP growth by city. (%)	IGDP	+/-
	Industrial upgrading	Changing industrial structure by city, which is calculated by the share of primary, secondary, and tertiary industry relative to the gross domestic product by city. (%)	PRIM, SECO and TERT	+/-
	Housing market development	Housing investment by city—the ratio of annual total investment (both public and private) in housing development relative to the total land area of city's administrative region. (1 million yuan per km^2)	HOUSE	+/-
Public policy	State intervention	Dummy variable. 1 for cities located in the national prioritized zone, and 0 for cities outside the zone. The central government of China defines the priority zone as the areas with high levels of economic activity and dense population.	STATE	+
	Migration control policies	Dummy variable. 1 for cities that have implemented special migration regulations such as the "points-based hukou system (*jifen luohu*)".	HUKOU	-
	Social welfare	Per capita (resident population) public expenditure by city. (yuan)	EXPEN	+
	Governmental financial pressure	The amount of fiscal deficit by city. (100 million yuan)	PRESS	-
Amenities	Health service	The number of qualified doctors per 10,000 residents by city.	DOCT	+
	Children education	The number of teachers in middle and primary schools per 1,000 residents by city	EDU	+
	Public transport	The number of public transportation vehicles per 10,000 residents by city	BUS	+
	Leisure service	The number of cinemas and theaters per million residents by city	LEIS	+
	Air pollution	Air pollution intensity—the ratio of the total emission of industrial sulfur dioxide and dust to the total land area of city's administrative region. (10,000 ton per km^2)	AIR_P	-
	Urban green space	The ratio of green space to urban built-up area by city. (%)	GREEN	+

Table 2. Summary statistics for dependent and independent variables in regression models

Variables	N	Mean	Std. Deviation	Minimum	Maximum
FP	1395	-0.44	132.08	-410.80	986.99
PGDP	1395	4.26	2.99	0.53	22.45
EMPL	1395	54.68	82.52	5.01	954.34
WAGE	1395	4.04	1.08	1.38	10.34
IGDP	1395	11.53	3.82	-19.38	25.10
PRIM	1395	12.96	8.11	0.03	49.89
SECO	1395	50.80	10.44	16.09	89.75
TERT	1395	36.24	9.11	9.76	77.95
HOUSE	1395	2.07	3.61	0.01	36.57
EXPEN	1395	6388.12	3,279.11	1,609.42	42,912.39
PRESS	1395	98.39	9.96	0.00	2,673.87
DOCT	1395	19.88	7.57	6.11	108.92
EDU	1395	2.88	1.81	0.21	18.19
BUS	1395	8.19	9.25	0.32	225.5
LEIS	1395	3.69	3.60	0.15	51.22
AIR_P	1395	3.75	8.28	0.02	254.94
GREEN	1395	39.11	7.64	6.75	71.81

Note: Two dummy variables (i.e. STATE and HUKOU) are excluded in this table.

Table 3. The global Morans I in 2000, 2010 and 2016

	2000	2010	2016
Morans I	0.304***	0.330***	0.289***
E (I)	-0.0028	-0.0028	-0.0028
Z Score	15.512	16.274	13.562
P value	0.000	0.000	0.000

Note: *** denotes statistical significance at 1% level.

Table 4. Regression results for all sample cities and major cities only, 2011-2016

Variables		All sample cities			Major cities		
		Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
	Constant	0.344***	0.197***	0.310***	1.021***	0.682***	0.581***
	PGDP	0.294***			0.031		
	EMPL	0.334***			-0.049		
	WAGE	0.114***	0.169***		0.916***	0.708***	
Economic transition	IGDP	-0.038**	-0.057***	-0.067***	-0.087*	-0.081*	-0.094**
	PRIM		-0.131***	-0.225***		-0.201***	-0.311***
	SECO	-0.124***		-0.183***	-0.204***		-0.468***
	TERT		0.198***			0.373***	
	HOUSE			0.488***			0.258***
	STATE	-0.106***	-0.179***		0.006	0.090	
Public policy	HUKOU		0.830***			0.046	
	EXPEN			0.212***			0.444***
	PRESS		-0.073***	-0.085***		-0.092***	-0.099***
	DOCT	0.009	0.013	0.028*	-0.013	-0.090***	-0.012
	EDU	0.095***	0.036*		-0.081*	-0.251***	
Amenities	BUS	0.173***	0.203***	0.078***	0.342***	0.298***	0.120***
	LEIS	0.029	0.056***	0.037**	-0.018	-0.024	0.003
	AIR_P	0.036**	0.012	0.014	0.176***	0.121***	0.107***
	GREEN	0.146***	0.115***	0.102***	-0.663*	-0.032	-0.025
Observation		1674	1674	1674	210	210	210
Adjusted R^2		0.566	0.535	0.635	0.782	0.834	0.840
F statistic		129.2***	108.0***	171.8***	45.1***	59.3***	65.9***

Note: ***, **, * denote statistical significance at 1%, 5%, and 10% level, respectively. 55 cities that did not report complete demographic data are excluded in this regression analysis. Major cities include centrally administered municipalities, provincial capitals, and specially-designed cities.

Table 5. Regression results for cities in eastern and central-western China, 2011-2016

Variables		Eastern China			Central-western China		
		Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
Economic transition	Constant	0.322***	0.432***	0.237***	-0.022	-0.167**	0.206***
	PGDP	0.100***			0.255***		
	EMPL	0.635***			-0.181***		
	WAGE	0.191***	0.496***		0.009	-0.020	
	IGDP	-0.045**	-0.055**	-0.049**	-0.023	-0.025	-0.038
	PRIM		-0.149***	-0.358***		-0.180***	-0.361***
	SECO	0.021		-0.177***	-0.132***		-0.273***
	TERT		0.154***			0.147***	
	HOUSE			0.490***			0.226***
Public policy	STATE	-0.139***	-0.153***		0.392***	0.178***	
	HUKOU		0.361***			0.902***	
	EXPEN			0.013			0.209***
	PRESS		0.127***	0.190***		-0.456***	-0.412***
Amenities	DOCT	-0.127***	-0.153***	-0.034	0.172***	0.136***	0.136***
	EDU	0.125***	0.029		0.146***	0.048***	
	BUS	0.176***	0.246***	0.092***	0.130***	0.061**	0.053**
	LEIS	-0.030*	-0.016	0.024	0.050*	0.076***	0.040
	AIR_P	0.026	0.016	0.030	0.034	0.005	0.002
	GREEN	0.187***	0.124***	0.119***	0.015	-0.005	-0.012
Observation		606	606	606	1068	1068	1068
Adjusted R^2		0.847	0.741	0.733	0.315	0.494	0.512
F statistic		198.2***	97.2***	98.6***	29.8***	58.8***	66.8***

Note: ***, **, * denote statistical significance at 1%, 5%, and 10% level, respectively. 55 cities that did not report complete demographic data during 2011 to 2016 are excluded in this regression analysis. Eastern China includes Beijing, Tianjin, Shanghai, Liaoning, Hebei, Shandong, Jiangsu, Zhejiang, Fujian, Guangdong, and Hainan. Central-western China includes Chongqing, Shanxi, Inner Mongolia, Heilongjiang, Anhui, Jiangxi, Henan, Hubei, Hunan, Shannxi, Gansu, Qinghai, Ningxia, Xinjiang, Sichuan, Yunnan, and Guizhou.

Appendix 1 The evolutionary of *hukou* system and migration policies in China since 1949

Period	Year	Key events and policies
From 1949 to mid-1950s: migrant freely	1949	"Common Program of the Chinese Peoples Political Consultative Conference", article 5: People have the right of free migration.
	1951	"Interim regulations on urban household register *(hukou)* management" has been issued by Ministry of Public Security of the PRC to ensure people's safety, and their free residence and migration.
	1954	The people's right of residence and migration freedom was stipulated by "Constitution of the PRC".
From mid-1950s to late 1970s: migration was tightly controlled by the national policies	1956	"Circular on preventing the blind outflow of rural population" was issued by the State Council of the PRC.
	1958	"Regulations on household registration of the PRC" was issued by the National Peoples Congress of the PRC, rural-urban migration was rigidly restricted due to the urban-rural dual *hukou* system.
	1964	"Provisions on handling *hukou* migration" was issued by the State Council of the PRC.
	1960s-1970s	Due to the so-called 'Third Front Projects' and the 'Up to the Mountains and Down to the Countryside' movement millions of skilled workers, educated youths had migrated to the less-developed internal regions.
	1977	The transfer of *hukou* from agricultural to non-agricultural (*nong zhuan fei*) was increasingly restricted.
From 1978 to the early 2010s: the incremental reform of *hukou* system	1978-1980	The restrictions on the transfer of *hukou* from agricultural to non-agricultural were gradually relaxed, especially for the rural-urban educated youths and skilled worker's relatives.
	1985	"Provisional regulations on the management of urban temporary resident population" and "Regulations of the PRC on the on the identity card of residents" were issued, rural-urban immigrants should apply for the temporary-residential permit (*zanzhu zheng*), and these policies have confirmed the legitimacy of migration.
	1992	The "local town resident *hukou (lanying hukou)*" system was implemented in small-towns, special economic zones and development zones, indicating that the reform of *hukou* system was featured by spatial differences in China.
	2001	"Suggestions on promoting the reform of *hukou* system in small towns", which was formulated by the Ministry of Public Security, was approved by the State Council of the PRC.
	2001-2010	Some provinces, metropolises and small and medium-sized cities started to explore the reform of *hukou* system, such as the implement of points-based *hukou* system (i.e. *jifen luohu*) in the main metropolises.
	2011	"Notice on actively and steadily promoting the reform of the household registration system" was issued by the State Council of the PRC, and the residential permit (*juzhu zheng*) system was implemented in some cities.
From 2014: comprehensively deepen the reform of *hukou* system	2014	"Opinions on further promoting the reform of the *hukou* system", and "National Plan on New Urbanization" were issued by of the State Council of the PRC.
	2014-2016	The implementation plans of the further reform of *hukou* system had introduced by 31 provinces, the distinction between agricultural and non-agricultural *hukou* will be abolished.
	2016	"Interim regulation on residential permits" was implemented by the State Council, migrants who hold the permits could apply for the local *hukou* according to the requirements for household registration in each specific city. Only cities with more than 3 million population in urban area could implement points-based *hukou* system.

Appendix 2 The requirements for household registration in cities with different urban population size

Category		The requirements for household registration
Cities or designated towns with less than 0.5 million resident population in urban area		Migrants who have stable residence could apply for local *hukou*.
Cities with 0.5 to 1 million resident population in urban area		Migrants who have stable jobs and residence, participate in urban social insurance system, and stayed in the city for a certain number of years (usually less than 3 years), could apply for local *hukou*.
Cities with 1 to 5 million resident population in urban area	1 to 3 million resident population in urban area	Migrants who have stable jobs and residence, participate in urban social insurance system, and stayed in the city for a certain number of years (usually less than 5 years), could apply for local *hukou*.
	3 to 5 million resident population in urban area	Local governments could make specific requirements based on migrants' age, job and residence. Local governments could implement points-based *hukou* system (i.e. *jifen luohu*).
Cities with more than 5 million resident population in urban area		Implement the points-based *hukou* system based on several criteria, such as migrants' age, jobs, residence, and education attainment.

Note: Information derived from the "Interim regulation on residence permits", which was implemented by the State Council of PRC.