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Metropolitan Trends and Challenges in China: The Demographic Dimension

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Contents

Abstract

Over the past century China has been transforming from a rural to an urban economy. In the course of this transition, significant regional variations have emerged in urban growth, with a gap forming between coastal and inland areas. This report focuses on China's metropolitan regions: Shanghai, Beijing, and Guangdong, which are the most socioeconomically advanced regions in China. It is the first outcome of the joint IIASA and Beijing University project on "Regional Urbanization and Human Capital Projections for China," which focuses on demographic matters, and it will analyze the following major issues: What factors have contributed to the growth of China's metropolitan areas over the last two decades? What specific urbanization patterns occur in the transformation from a rural to an urban economy? How does demography drive the speed of urbanization, in particular, in the metropolitan areas? How is IIASA's multistate method used for urbanization projections and what are its advantages and disadvantages? What challenges will China face in the near future as a result of rapid metropolitan growth? This paper suggests that the growth of Chinese mega-urban regions will have knock-on effects at the global level in the medium term.

Acknowledgments

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Metropolitan Trends and Challenges in China: The Demographic Dimension

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1 Introduction

China has been transforming from a rural to an urban economy over the past century, especially since the introduction of economic reforms in 1978. From 1978 to 2003, fast economic growth of over 9%[1] per annum (one of the highest rates in the world during that period), together with increasing globalization of the domestic economy, accelerated urbanization in China. Between 1978 and 2004, the urban population increased by a factor of 2.83 from 172 million (17% of total population) to 542.8 million (41.8% of total population), while in 2002 the share of agricultural employment decreased from 71% to 44% (National Bureau of Statistics, 2001, 2003, 2005). In the course of China's transformation from a rural to an urban economy, significant regional variations in urban growth have arisen; in particular, a gap has emerged between coastal and inland regions.

The demographic factor has been speeding up urbanization for more than 20 years following a change in China's internal migration policy that allowed farmers to seek jobs in the cities. The growing urban–rural income gap has forced millions of people from traditional agricultural societies into urban areas, increasing the land area used for urban development by 817,000 hectares during 1990–2000 (Liu *et al*., 2005).

Though urbanization is recognized as the driving force behind much-needed economic restructuring, dynamic growth, and social development in China, such rapid urbanization will present major challenges, particularly on the demographic, environmental, and energy fronts.

Given the size and the regional diversity of China, any sensible analysis must consider the regional differences in economic development, climate, and soil and water resource endowments in terms of population density. Both inside and outside China, there is a growing need for regionally disaggregated population projections for estimating regional demand both for goods and services and for labor supply.

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[1] Average economic growth of 9.4% during 1978–2003 (China Statistical Yearbook, 2004).

This report focuses on the most socioeconomically advanced regions of China: the metropolitan regions[2] of Shanghai, Beijing, and Guangdong. The report is based on recent work on urbanization and human capital projections for the three regions carried out jointly by IIASA and Beijing University in the course of the project, "Regional Urbanization and Human Capital Projections for China". The present report, emphasizing the demographic issues, is the first part of this work. The second part, addressing the demographic impacts on the development of urban sustainability, will follow later.

The report addresses the following questions:

1. What factors have contributed to Chinese metropolitan growth over the last two decades?
2. What urbanization patterns, specific to China, can be seen in China's transition from a rural to an urban economy?
3. How does demography drive the speed of urbanization, particularly in the metropolitan areas?
4. What are the advantages and challenges of IIASA's multistate population methodology for urbanization projections?
5. Will the Chinese metropolitan regions become world-class cities in the medium term from the demographic standpoint?
6. What challenges due to rapid metropolitan growth will China face in the near future?

This report is divided into four parts. The first discusses urbanization and the main driving forces behind it; the second focuses on the methods used for urbanization projections and the demographic growth scenarios for the three metropolitan regions; the third analyzes the likely path of mega-urban growth in the next three decades; the last part concludes.

2 The Unprecedented Growth of Mega-Urban Regions and the Main Driving Forces Behind It

Recent urban development in China is characterized by two notable features: (1) an unprecedented scale of urban change, as in the Shanghai, Beijing, and Guangdong regions, with the direction of urban change more strongly affected by the global economy than ever before; and (2) the formation of large mega-urban regions around economic centers in coastal areas and low rates of urbanization in inland regions. After two decades of reforms a large coastal–inland divide has emerged in terms of urbanization levels. This gap reached 14 percentage points in 2000, as against only 4 percentage points in 1982. Table 1 shows the levels of regional urbanization and economic development in China in 2000–2004, with the provinces ranked in descending order of urbanization level.

[2] We use the Organisation for Economic Co-operation and Development's classification of the metropolitan and nonmetropolitan regions of member countries (Dax, 1996).

Table 1: Regional urbanization levels, per capita GDP, and per capita FDI stock, by province, 2000–2004. Sources: Population size, per capita GDP, and per capita FDI: China Statistical Yearbook (2005). Urbanization: National Bureau of Statistics (2005).

	Population size (millions)	**Urbanization levels (%)**	**Per capita GDP (yuan)**	**Per capita FDI stock (US$)**
Shanghai	17.42	88.31	55307	313.9
Beijing	14.93	77.54	37058	146.8
Tianjin	10.24	71.99	31550	149.9
Guangdong	83.04	55.00	19707	94.2
Liaoning	42.17	54.24	16297	67.0
Heilongjiang	38.17	51.54	13897	8.4
Jilin	27.09	49.68	10932	7.0
Zhejiang	47.20	48.67	23942	105.5
Inner Mongolia	23.84	42.68	11305	3.7
Fujian	35.11	41.57	17218	74.0
Jiangsu	74.33	41.49	20705	142.1
Hubei	60.16	40.22	10500	26.1
Hainan	8.18	40.11	9450	51.5
Shandong	91.80	38.00	16925	65.5
Shanxi	33.35	34.91	9150	6.4
Qinghai	5.39	34.76	8606	4.7
Xinjiang	19.63	33.82	11199	0.8
Chongqing	31.22	33.09	9608	8.4
Ningxia	5.88	32.43	7880	3.0
Shaanxi	37.05	32.26	7757	9.0
Hunan	66.98	29.75	9117	15.2
Guangxi	48.89	28.15	7196	8.6
Anhui	64.61	27.81	7768	5.7
Jiangxi	42.84	27.67	8189	37.6
Sichuan	87.25	26.69	8113	4.7
Hebei	68.09	26.08	12918	14.2
Gansu	26.19	24.01	5970	0.9
Guizhou	39.04	23.87	4215	1.2
Yunan	44.15	23.36	6733	1.9
Henan	97.17	23.20	9470	5.5
Tibet	2.74	18.93	7779	0.0

Notes: Population size and per capita GDP data are from 2004, urbanization data from 2000, and per capita FDI data from 2003. Per capita FDI stock is created by accumulating FDI flows over time, with adjustments for inflation, and subtracting depreciation.

These data raise several questions. Why has the coastal–inland gap in urbanization levels grown? How do internal and external economic changes, other than historical factors, affect the growth of the mega-urban regions in China? Here, we intend to identify the driving mechanisms behind that growth.

2.1 Favorable Treatment in National Urban and Economic Development

Since the economic reforms began in 1978, Shanghai, Beijing, and Guangdong have again come to be seen as centers of regional and national development, with Shanghai and Guangdong in particular being recognized as the most promising regions in terms of economic growth. These three regions have benefited from preferential policies including fiscal incentives, administrative autonomy, and, most importantly, special economic zones and open development areas to attract foreign capital. As Table 1 indicates, the three mega-urban regions have the highest levels of urbanization, which is positively associated with real per capita gross domestic product (GDP).[3] Consequently, the urban land of Shanghai, Beijing, and Guangzhou (the capital of Guangdong) accounts for 61.5% of the total expanded urban land area of all 13 mega cities in China—about 65,190 ha in 1990–2000 (Liu *et al*., 2005).

For China's next phase of development, urbanization will be of great importance in both facilitating economic restructuring and driving sustained and rapid economic growth. In the national urbanization strategy for the next phase the tangent point is accelerating, and this is fostering the growth of three mega-urban regions: the Yangtze River delta around Shanghai and extending westward along the Yangtze River Valley; the Pearl River delta comprising the provincial capital of Guangzhou and other major coastal cities in Guangdong adjacent to Hong Kong and Macao; and the Round Bo-Sea Bay region, which includes the capital Beijing and the important industrial metropolises of Tianjin and Tanshan. Seven city belts will develop around these three mega-urban regions (China Population Information and Research Center, 2004). According to the 2004 City Development Report, the total GDP of the Yangtze River delta, the Pearl River delta, and the Bo-Sea Bay area was 35% of national GDP, the Pearl River delta 10%, the Yangtze River delta 18%, and the Bo-Sea Bay area 7% (China Population Information and Research Center, 2004). In the Chinese context, these three mega-urban regions will continue to remain preeminent in national and regional sustainable development in the future.

2.2 The Role of Foreign Direct Investment (FDI) in Shaping Urban Growth

China has been the largest recipient of foreign direct investment (FDI) in the developing world since 1993. Long recognized as one of the country's main engines of economic growth, FDI has played an increasingly important role in shaping the expanding urbanization and regional growth in China. Table 1 shows that larger FDI inflows seem

[3] The third-largest metropolis, Tianjin, has been the industrial center of northern China since the late 1800s. However, the speed of growth economic development in Tianjin has been behind that of Shanghai, Beijing, and Guangdong since the reforms began.

to be strongly associated with the higher urbanization levels in coastal than in inland areas. Shanghai, Beijing, and Guangdong, because of their high level of industrialization, modernizing infrastructure, and geographical position, have outpaced other regions in the race to attract FDI (see Table 1).

Moreover, to attract foreign investment and international business, several new industrial zones or districts (often called economic and technology development zones) were created in Shanghai, Beijing, and Guangdong in the early 1980s. Special concessions were granted to these special zones and districts, such as tax exemptions for a limited duration for enterprises doing business with foreign companies. The existing FDI stock has created new production space for industrial consolidation and investment promotion.

FDI seems to have enhanced China's urban growth in a special way. Because of China's abundant cheap labor and export-oriented FDI strategy, most foreign investment in China is associated with export processing and assembly plants in the manufacturing sector. Foreign affiliates thus foster local urban growth by employing formerly rural workers and by shifting the sectoral structure toward industries and services. However, as the coastal region attracts most of the FDI in China, there is an imbalance in urban growth among the regions.

2.3 Massive Net Internal Migration Directly Promoting Mega-urban Growth

According to demographers, the accelerated rate of urban growth in developing countries is the result of two driving forces: a rise in the rate of natural population increase and net urban immigration (Rogers, 1984). China differs from other developing countries in that, since 1987, its family planning policy has brought about a decline in natural population growth at the national level, particularly in urban regions. It is thus rural-to-urban migration and the transformation of rural settlements into cities that have been the most important determinants of the rapid urbanization of the past two decades.

Figure 1 shows the declining trend in Chinese population growth that began in the late 1970s. For Shanghai, negative natural population growth began in 1993, and for Beijing, which has the second lowest natural population growth in China after Shanghai, in the late 1990s. Compared with Shanghai and Beijing, Guangdong's natural population growth rate has declined slowly.

Net urban immigration has obviously directly promoted mega-urban and urban land expansion. According to the 2000 population census for China as whole, 42.42 million people had migrated across provincial boundaries.[4] Of these, 48.71% had moved to Shanghai, Beijing, and Guangdong. While, in the census year, the population of these three regions together accounted for only 9.27% of the total Chinese population, socioeconomic development and greater employment opportunities in these regions caused massive immigration, and this, in turn, has led to rapid urban growth and an increase in urban land use.

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[4] In other words, resident for more than six months in a different province from the one in which they are registered under the official household system (Hu Kou).

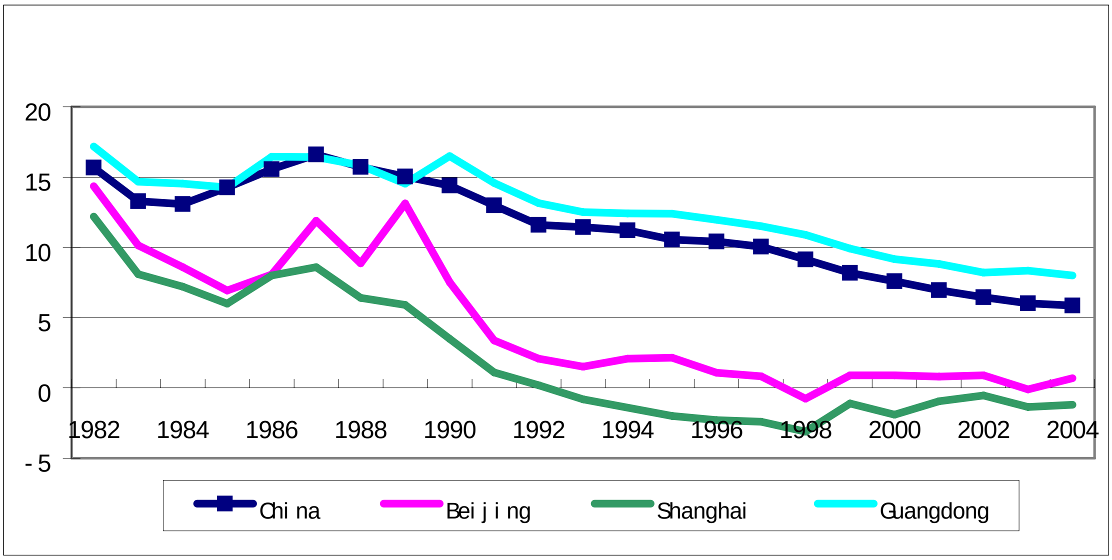

Figure 1: Natural population growth rate (in thousands), 1982–1999. Sources: Pre-1998 data: National Bureau of Statistics (1999). Post-1998 data: National Bureau of Statistics (2000, 2001, 2002, 2003, 2004); National Bureau of Statistics of Beijing (2002); National Bureau of Statistics of Shanghai (2002); National Bureau of Statistics of Guangdong (2002).

Figure 2 shows the share of inter-provincial migration for Shanghai, Beijing, and Guangdong in comparison with the other provinces of China. Figure 3 shows the share of total population of Shanghai, Beijing, and Guangdong in comparison with the other provinces of China.

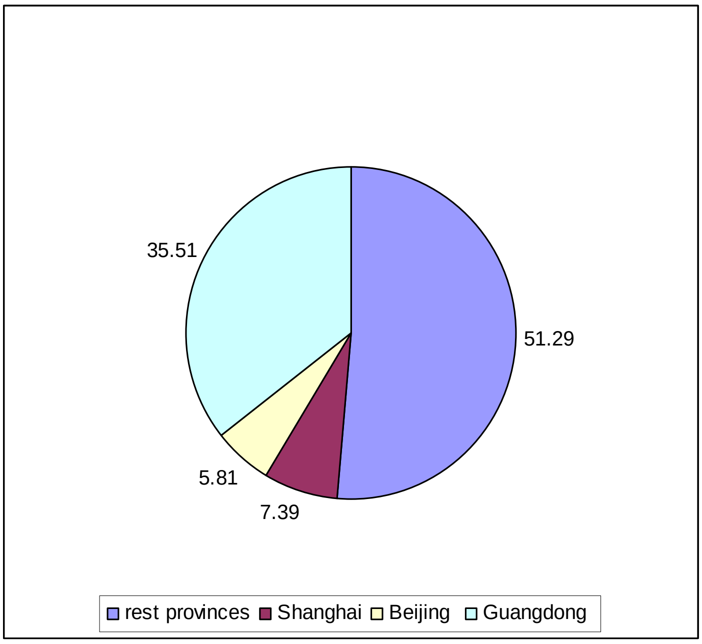

Figure 2: Share of inter-provincial migration. Source: Author's calculations based on national and provincial data from 2000 population census.

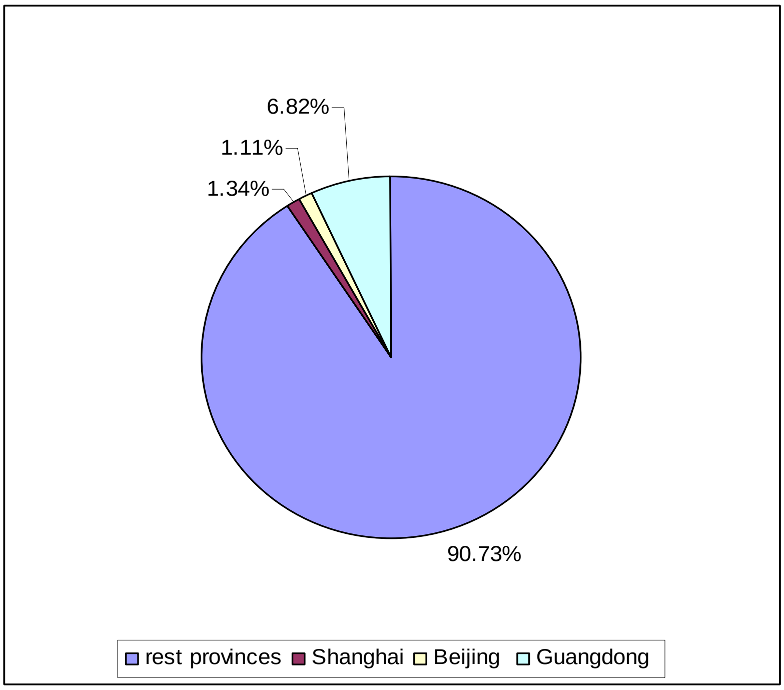

Figure 3: Share in total population in 2000. Source: Author's calculations based on national and provincial data from 2000 population census.

The unprecedented growth in the mega-urban regions of China supports the argument that urbanization in developing countries is associated with globalization in terms of the process of expansion and deepening of global markets for commodities and services. The process has resulted in the rapid integration of various parts of the world and, most notably, the linkage of large cities within global financial systems (Dicken, 1992; Beaverstock, 2001). The cities serve as centers for the control, coordination, and servicing of global capital, and in turn become central poles in the hierarchical organization of labor and migration flows.

3 Projecting the Growth of Mega-Urban Regions in the Medium Term

3.1 Method

There is a large body of literature on the analysis and projections of Chinese urbanization at the national level. For mega-urban projections, we used IIASA multistate methodology. Before discussing multistate methodology and its advantages and disadvantages in terms of regional urbanization projections, we will review the methodology used by different scholars in recent years to project Chinese urbanization.

3.1.1 Literature review of methodology used for China's urbanization projections

As far as existing research and literature pertaining to Chinese national and regional urbanization projections are concerned, three main types of simulation model have been used:

(1) Regression models, such as the linear regression model ($U_t = a_0 + a_1 * t$), the S-curve regression model ($U_t = \frac{1}{1 + C * e^{-r*(t-1982)}}$), and the logarithmic-curve regression model with GDP per capita ($U_t = b_0 + b_1 * Ln(GDP\_per_t)$) (Liu *et al*., 2002). In these regression models U_t (urbanization level in year t) is the dependent variable of the growth simulation equations.

(2) The United Nations (UN) model, which uses a parsimonious and fairly straightforward method to project the urban proportion. This method is based on a weighted average of the observed urban–rural growth difference for the most recent period available in a given country and the hypothetical urban–rural growth difference (United Nations, 1996, 2002). When the urban–rural ratio and proportion are calculated, the urban proportion is multiplied by the total population of the country. The norm of a hypothetical urban–rural growth difference is expressed as the regression equation $hrur = 0.037623 - 0.02604\ PU(to)$ (United Nations, 2002).

(3) The decomposition method, which has been used for regional urbanization projection (Toth *et al*., 2003). This method uses (1) a differentiated regional decomposition of the national population projections according to year 2000 provincial and rural–urban distribution; and (2) additional information concerning persistent long-term trends in the differences in the birth, death, and urbanization rate across the provinces. The desegregation procedure is carried out in five-year steps to match the projected national aggregated population figures. The following equation is used:

$$\bar{p}^t_{i,j,k} = (1 - d_{i,k}) * p^t_{i,j-1,k-5} * \frac{s^t_{j,k}}{\sum_i p^t_{i,j-1,k-5}} \qquad i = 1,...,31;\ j = 2,...,17;\ k = 2005,...,2030 .$$

Using the extrapolated logistic functions shown above, the regression models, and the UN method provides a picture of the future level of urbanization. However, these approaches fail to capture internal changes in rural and urban regions, as they ignore demographic characteristics, such as age and sex composition of the population, as well as migration schedules, all of which are fundamental to an understanding of urbanization processes.

The decomposition method is a pioneering approach to regional urbanization projections that uses currently available data. Although it has failed to capture the impact of migration on the changes in the age and educational composition of the population by region and by rural and urban areas, the results do show the various regional trends.

3.1.2 The multistate method of urbanization projection: Advantages and disadvantages

From the demographic standpoint, urbanization is a dynamic process generated by three factors: (1) the rural–urban differential in natural population increase; (2) the population exchange between the rural and urban sectors due to migration; and (3) the transformation of rural settlements into cities. Natural population increase and net urban immigration are core components of urbanization forecasting.

For the regional urbanization projection project, we took into account three major factors in the future evolution of the Chinese urban and rural population: (1) how a natural increase in both the urban and rural population, together with an increase in net urban immigration, contribute to urban growth in various regions; (2) how to assess the effect of net urban immigration on the changing age composition of the urban population, given the high correlation of demographic age distribution with economic output growth and the additional impact of net urban immigration on economic development, environmental quality, and public health; and (3) the impact of urban immigrants with different educational levels on the educational composition of both the urban and rural populations.

The current multistate population projection model (see Figure 4) is based on a multidimensional expansion of the life table (increment–decrement tables) and of the cohort-component projection method. The multistate model divides the population by age and sex into "states" (Lutz and Goujon, 2001). During the 1970s the multistate method was applied to multiregional projections in an international study of migration and redistribution patterns in 17 IIASA member countries (Rogers, 1983). For these multiregional projections, the multistates were conceived of as geographic units, with movement among the states being migration streams. In recent years IIASA scholars have applied multistate methodology to project two dimensions: (1) residence by rural and urban region (Cao, 2000; Cao and Lutz, 2004); and (2) level of education (Lutz *et al*., 1999; Lutz and Goujon, 2001). In those projections, the multistates represent (1) geographic units with migration between the regions; and (2) the different levels of educational attainment with educational transition rates (education tends to start at a young age and then simply moves along cohort lines).

The multistate method includes the variables of net migration and the educational status of the population in a simultaneous projection along cohort lines. It thus allows demographers to take greater account of the states of differentiated fertility, mortality, and migration patterns in population evolution. More importantly for a study of Chinese urbanization, we are able, using this method, to explicitly (1) examine the link between net migration and the growth of the urban population; (2) look at the educational differentials affected by migration; and, in particular, and (3) better understand the impact of the age and sex profile of migrants on the redistribution and composition of the rural and urban population. This is because the age profiles of rural-to-urban migration differ from those of the urban population (1) in terms of age and sex composition; (2) in their sensitivity to relative changes in dependency levels; and (3) in terms of their rate of natural population increase and mobility (Rogers, 1984).

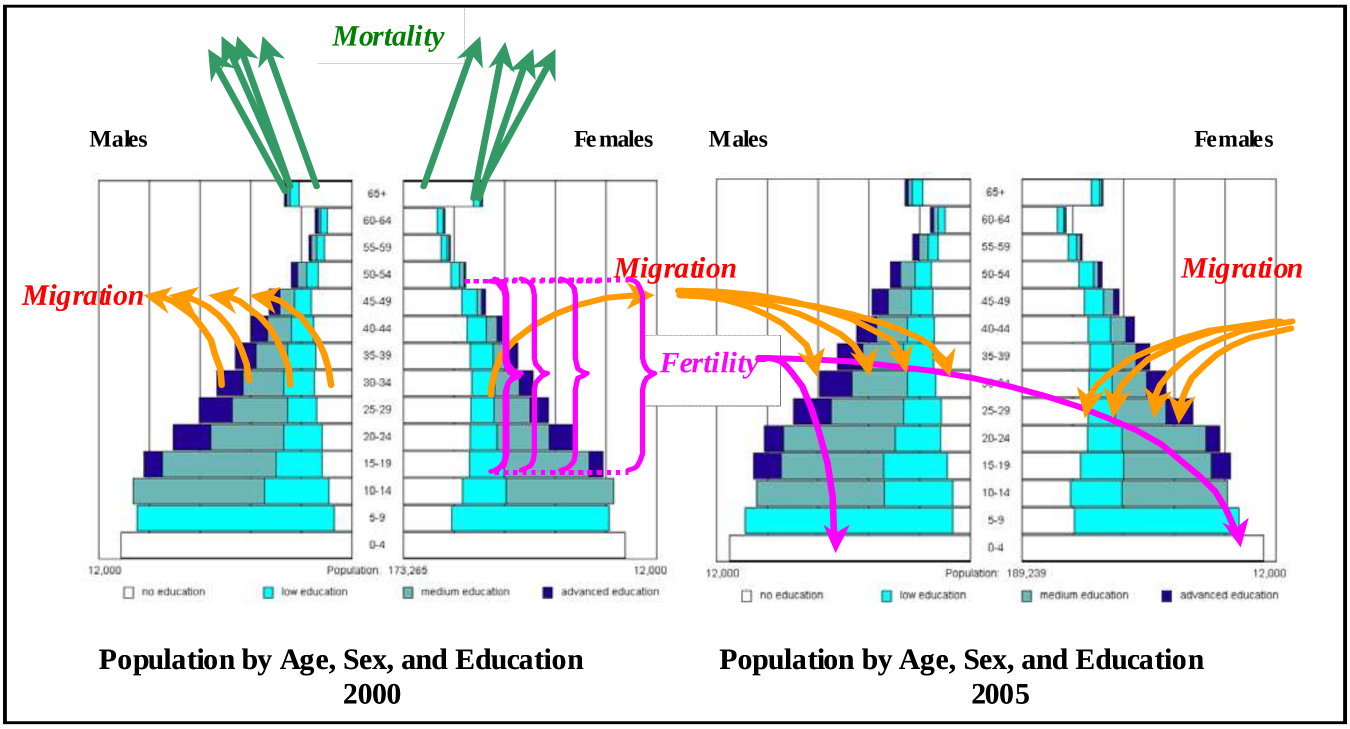

Figure 4: Specifying the educational level and migration in the multistate projection model. Source: Lutz *et al*. (2005).

However, the current multistate model is facing challenge in terms of its utility as a tool for multiregional population projection. While it is multistate, for example, by different education levels, it is not multiregional. Thus, the multistate model simulation cannot be used to project demographic variables on a multiregional basis. The distinguishing characteristic of the multiregional approach should be that all regions are projected simultaneously; in other words, the multiregional system should be projected in its entirety. The simultaneous projection of the demographic variables of each of the regions not only ensures internal consistency but also makes it possible to take greater account of regionally differentiated fertility, mortality, and migration patterns (Eichperger, 1984)

3.1.3 The multistate model applied in mega-urban region projections

As stated above, when making projections for the mega-urban regions, we can apply the model only for one region at a time using the multistate method. As every provincial population has both an urban and a rural component, we are obliged to divide each region into an urban and a rural subregion, as shown in Figure 5, and to simulate each subregion individually in terms of its own specific fertility, mortality, education, and migration development. The results are then aggregated to produce projections for the entire region.

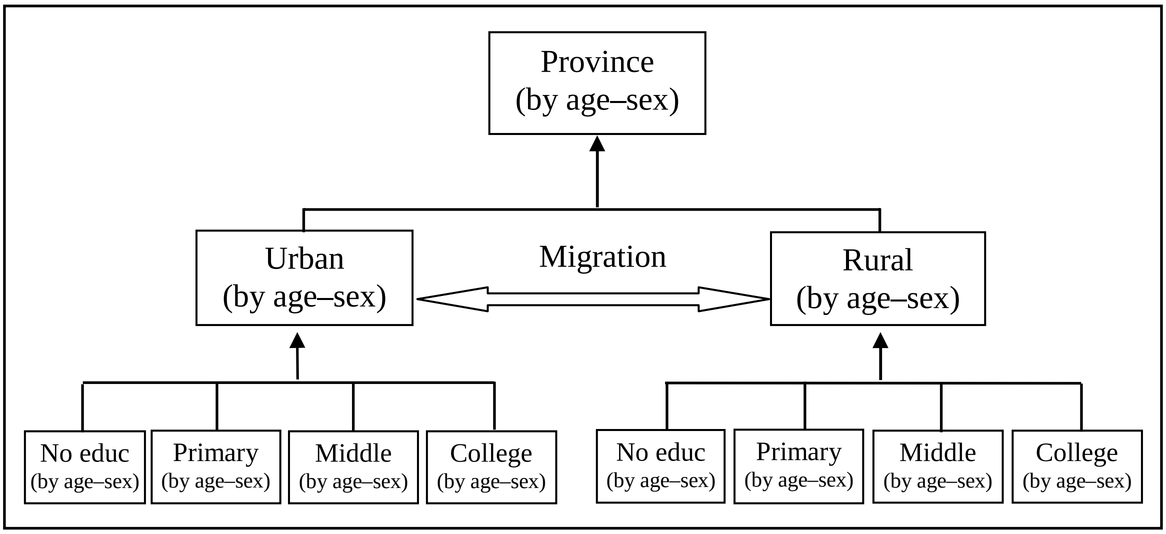

Figure 5: Framework of multistate model in mega-urban region projections.

The subregional simulation is expressed as follows:

$$P_{(i+1)U=}\ P_{iu} + N_{iu} + M_{iu} + T_i$$

$$P_{(i+1)R=}\ P_{iR} + N_{iR} + M_{iR} + T_i\ ,$$

where P_{iU} is urban population, P_{iR} rural population, N_{iU} and N_{iR} are urban and rural natural population growth, respectively, M_{iU} and M_{iR} are the net inter-provincial migration to urban and rural areas, respectively, and T_i is rural-to-urban migration within the region.

For the total regional projection, we added the subregions together to make a regional total. In the course of model simulations for each region, we had to avoid the problem of inconsistency between the total and subregional (urban/rural) population when projecting one region (province) in its entirety. To do this, we used the urban–rural growth difference (URGD) method[5] (Beijing Statistics Bureau, 2004).

3.2 Base-year Data, Variables, and Estimations

The base-year input data are rural- and urban-based. In the process of collecting the data at the provincial level we faced major difficulties: (1) underreporting both on fertility and the younger age group (0–9); (2) lack of data on net migration by age and education level; and (3) inconsistency between national and provincial data. The data have thus been adjusted to compensate for this. To avoid inconsistency between national and provincial data, we used national data and definitions or, in the event of inconsistency between national and provincial data, we adjusted our data based on the national definitions.

5

$$\frac{U_t}{R_t} = \frac{U_t}{T_t - U_t} = \frac{U_0}{R_0} e^{(u-r)t} = \frac{U_0}{R_0} e^{dt}$$

3.2.1 Basic year data in 2000

The input data consist of the following:

1. Age-, sex-, and education-specific **population distribution** by rural/urban divisions (we use five-year age groups and four education categories);
2. Age- and education-specific **fertility rates** by rural/urban divisions;
3. Age- and sex-specific **mortality rates** by rural/urban divisions;
4. Age-, sex-, and education-specific **net migration** by rural/urban divisions;
5. Age- and sex-specific **education transition rates** by rural/urban divisions.

The base-year data are derived from the following sources: National Bureau of Statistics of Beijing (2002); National Bureau of Statistics of Shanghai (2002); National Bureau of Statistics of Guangdong (2002); National Bureau of Statistics of the People's Republic of China (2002).

3.2.2 Definition of variables

Table 2 illustrates the description of variables in scenario simulation. As the definition directly affects data aggregation, base-year data are used for projections based on the following definitions:

Migration refers to those who had left their permanent residence as at 1 November 1995 for at least six months.

The four education categories are: **no education**, **primary school**, **middle school** (including junior and senior level), and **college and above**. **No education** refers to those who are illiterate or semiliterate. **Primary school** refers to those who have completed the final grade at the first level of education, which normally takes six years in China. **Middle school** refers to those who have completed the final grade at a junior and senior secondary school, vocational secondary school, or technical training school. **College and above** refers to those who have completed a degree at a university, college, or post-graduate college (including universities and colleges for adults).

Urban and rural population: According to the 2000 population census, urban population refers to those resident in towns and cities and rural population to those living in the countryside.

Table 2: Detailed description of variables in scenario simulation.

Fertility:	**Age-specific fertility rate** by sex, education and rural/urban region
Mortality:	**Age-specific mortality** by sex, education and rural/urban region
Urbanization:	**Net migration rate** by sex, education, and rural/urban region
Educational transition rate:	**Educational transition rate** by sex, age, and rural/urban region • From no school to primary school • From primary school to middle school • From middle school to college and above

3.2.3 Fertility adjustment

The under-reporting in terms of births is inherent in Chinese population statistics. According to statistical data released by the National Statistical Bureau (NSB) of China on the 2000 census, China's fertility was well below replacement level in 2000, with the total fertility rate (TFR) for the whole of China being 1.22, rural TFR 1.43, and urban TFR 0.95 (National Bureau of Statistics, 2002). For the mega-urban regional projections, we modified the base-year fertility for each region based on Wang's adjustment (Wang *et al*., 2004; see Table 3):

$$TFR_k(.) = \frac{B(K_{,\bullet})}{\sum_{x=15}^{49} f_k(x) W(k,x)} \quad ,$$

where $TFR_k(.)$ is the adjusted total fertility rate of the province, $B(K_{,\bullet})$ is the estimated number of births in the province, $W(k,x)$ is the number of childbearing women in the province, and $f_k(x)$ is adjusted age-specified fertility rate.

Table 3: Adjusted total fertility rate Beijing, Shanghai and Guangdong, 2000. Source: Wang *et al*. (2004).

	TFR 2000 census	TFR adjusted	Difference
Beijing	0.688	0.845	0.157
Shanghai	0.69	0.765	0.075
Guangdong	0.944	1.443	0.499

For Shanghai, Beijing, and Guangdong, we disaggregated the adjusted total fertility into four levels of education and into urban and rural regions based on the age- and education-specific profile of the female fertility level in 2000.

As the birth rate was underreported, we have correspondingly assumed that the number of births is also significantly underreported. The adjustment for births is taken from Wang's adjustment (see Table 4).

Table 4: Estimated births from 1 November 1999 to 1 November 2000. Source: Wang *et al*. (2004).

	2000 census birth	Estimated birth	Under-reported rate %
Beijing	81381	96610	23.15
Shanghai	71487	98673	24.32
Guangdong	945044	1919238	51.11

3.2.4 The net migration calculation

Collecting the migration data of Shanghai, Beijing, and Guangdong was a difficult task, as the multistate model requires the base-year inputs for migration to be classified not only according to sex and age, but also to three other factors: (1) education levels; (2) in–out migration between rural and urban areas within the region; and (3) in–out migration between provinces. There is also a lack of migration data by education level at the provincial level (see Figure 6).

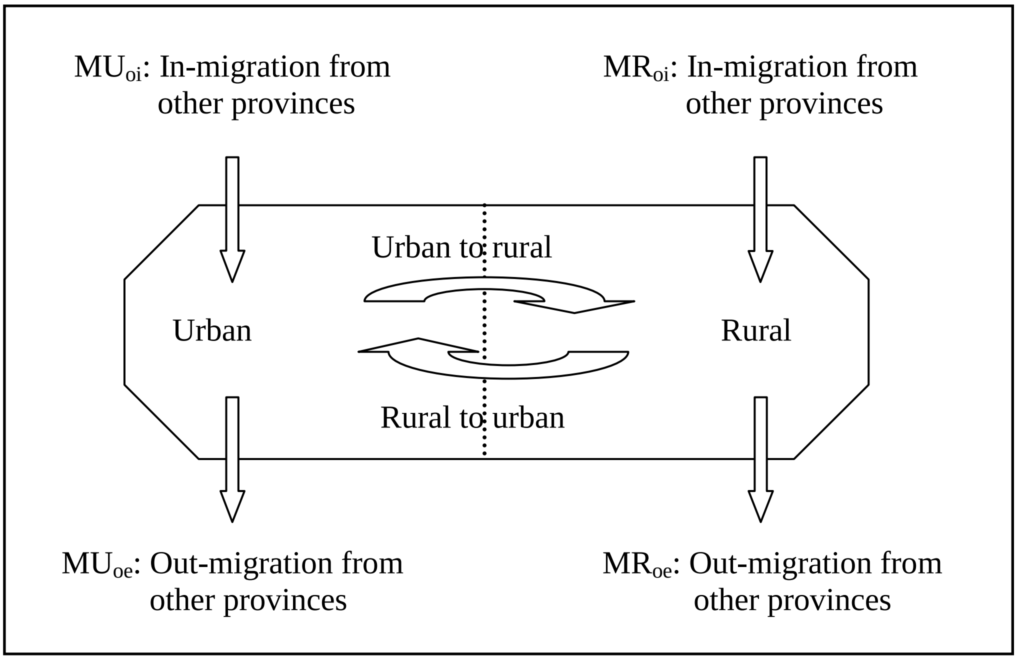

Figure 6: Framework of migration calculation.

As shown in Figure 6, the equation used to calculate net migration is: $M_n = M_i - M_e$, where M_n is net migration, M_i is in-migration, M_e is out-migration.

Urban net migration: $MU_n = (MUr_i + MUo_i) - (MUr_e + MUo_e)$

$MUr_{i:}$ Urban in-migration from rural in same province.

$MUo_{i:}$ Urban in-migration from other provinces.

$MUr_{e:}$ Urban out-migration to rural in same province.

$MUo_{e:}$ Urban out-migration to other provinces.

(MUr_i+ MUo_i): Urban in-migration within the same province plus in-migration from other provinces.

(MUr_e+ MUo_e): Urban out-migration within the same province plus out-migration to other provinces.

Rural net migration: $MR_n = (MRu_i + MRo_i) - (MRu_e + MRo_e)$

$MRu_{i:}$ Rural in-migration from urban in the same province.

MRo_i: Rural in-migration from other provinces.

MRu_e: Rural out-migration to urban in the same province.

MRo_e: Rural out-migration to other provinces.

(MRu_i+ MRo_i): Rural in-migration within the same province plus in-migration from other provinces.

(MRu_e+ MRo_e): Rural out-migration within the same province plus out-migration to other provinces.

3.3 Urban Growth Scenarios for Shanghai, Beijing, and Guangdong to 2030

3.3.1 Migration in formulating scenarios

When identifying the scenario of growth for the three mega-urban regions, one essential question of concern are the population growth limits of the three regions. If we follow urban growth trends for the last 10 to 20 years and, in particular, the increase in migration, then population growth in these three regions may already be well beyond the point of sustainable development. If population growth is under control, what are reasonable alternative population sizes and growth speeds for these three regions? To define these, we must carefully study the literature on the three regions, including the scientific debates and the official regional strategies that have been proposed (Wang, 2000; Zeng and Zhang, 2004; Guangdong Government Economic and Social Development Center, 1994; Yang *et al*., 2000; Gustafsson and Li, 2004).

Regarding the population development of Shanghai and Beijing, Shanghai's natural population growth has been negative since 1994 and Beijing's at around zero for five years. As the population growth of both Beijing and Shanghai has mainly been caused by net migration, migration will obviously be pivotal for the future population growth of both provinces.

Although Guangdong's experience has not mirrored that of Shanghai and Beijing, the province has a relatively higher fertility rate. However, from the point of view of absorbing migrants, Guangdong is ranked first among the 31 Chinese provinces in terms of accepting migrants, especially rural-to-urban migrants, since economic reforms began in 1978.

Without any doubt, the future growth of these three regions will be strongly associated with migration policy. Migration trends over the last 20 years have shown that these regions will continue to play an important role in absorbing migrants from all parts of China in the near future. Although migration policy, particularly that affecting rural-to-urban migration, has changed from rigid to relaxed since 1978, migration will still be somewhat controlled under the Shanghai and Beijing governments' development plans (Beijing Statistics Bureau, 2004; Wang, 2000).

Given that the Olympic Games will be held in Beijing in 2008 and the World Trade Exhibition in Shanghai in 2010, the size of the population in the near future is a major concern for the regional development planners. To provide policy alternatives, we have decided to follow three lines in developing regional population growth scenarios: (1) natural growth, which combines various levels of fertility and mortality without new migration; (2) limited growth, which combines natural growth with new migration based on government growth plans; and (3) high growth, which combines natural growth with migration based on past migration trends or on a relatively relaxed migration policy. These scenarios are shown in the matrix in Table 5.

Table 5: Scenario matrix.

	Low fertility	Medium fertility	High fertility
Natural growth	N1	N2	N3
Limited growth	L1	L2	L3
High growth	H1	H2	H3

In scenario setting, natural growth is a basic scenario assumption. The limited and high growth scenarios are based on national growth differentials with the addition of various new net migration statistics.

Natural growth (N1, N2, and N3) refers to low, medium, and high fertility levels, combined with mortality and the educational transition rate, without new migration**.** **Limited growth** (L1, L2, and L3) means different natural growth rates combined with controlled net migration based on government growth plans. **High growth** (H1, H2, and H3) implies various combinations of different natural growth rates and migration trends following past trends for Beijing and Guangdong and the relatively relaxed migration policy for Shanghai.

Table 6 describes a detailed scenario setting for Beijing, Shanghai, and Guangdong. As there is a lack of literature and documentation on the Guangdong government plan, we decided to produce only two sets of scenarios for Guangdong's population growth.

Table 6: Migration scenarios in Beijing, Shanghai, and Guangdong.

Beijing:	**Natural growth**: Natural population growth based on low, medium, and higher fertility and mortality, without new migration **Limited growth:** The same as for natural growth, but based on government growth plan with controlled new migration; urban population will be about 18 million in 2020, and then following the same path to 2030. **High growth**: Natural growth for both urban and rural populations, but with a more liberal migration policy.
Shanghai:	**Natural growth**: Natural population growth based on low, medium, and higher fertility and mortality, without new migration **Limited growth:** The same as for natural growth, but based on government growth plan, with controlled new migration; regional population could be 23 million in 2030. **High growth:** The same as for natural growth, with somewhat relaxed policy of new migration; for whole region, maximum population should be around 25 million by 2030.
Guangdong:	**Natural growth**: Natural population growth based on low, medium, and high fertility and mortality, without new migration **High growth**: The same as for natural growth, with migration based on the trend of last five years and liberal migration policy.

3.3.2 Natural population growth assumptions

The natural population growth scenarios for population projections for Shanghai, Beijing, and Guangdong combine the demographic components of fertility, mortality, and education. These scenarios provide the basic assumptions for our analysis of the impact of projected net migration in these regions.

Fertility is a critical component and difficult to estimate, especially when it is cross-classified with education categories and regions. There are large differences in the fertility level among the 31 provinces of China. In projections for the three mega-urban regions, there are three fertility assumption variants: low, medium, and high. The mortality component has only one variant. For education transition, meaning the proportion moving to the next level of education, the base-year input was estimated based on the distribution by levels of educational attainment in the base year (2000). The assumptions regarding migration depend on whether the limited or high regional population growth alternatives are taken into account.

The summarized assumptions in Tables 7–9 present the basic scenarios of natural population growth for Beijing, Shanghai, and Guangdong to 2030.

For Beijing, we assume that in N1 fertility by different educational category will remain constant both in rural and urban regions, that is, at the same level as in the base year 2000, until the end of the projection. In N2 the TFR is expected to increase gradually to the level foreseen by policy makers—which could be 1.37 in rural areas and 1.04 in urban regions up to 2010—rather than continue to increase to 1.63 and 1.23 in 2020, and then remain constant to 2030. In N3 the fertility rate in both rural and urban areas will increase, more or less reaching the current European Union level by 2030.

The education scenario assumptions for "no education–primary" school for both rural and urban regions remains constant at the 2000 level. For urban "primary–middle" school, the transition rate remains constant, while the rural rate for the 10–14 age group increases to match the urban level in 2000. For the urban high assumptions, educational transition rates will increase to the developed country level for the year 2000.

The total fertility rate of Shanghai has been even lower than that of Beijing, in addition to which, according to the 2000 census, there was no difference in fertility between rural and urban regions. We thus assume that the fertility levels converge in rural and urban Shanghai. In N1 fertility by different educational category will remain constant at the same level, as in the base year 2000, until 2030. In N2 the TFR is expected to gradually increase to the level foreseen by policy makers, reaching 1.06 by 2010 for rural urban areas then remaining constant to 2030. In N3 the fertility rate in both rural and urban regions will gradually increase to 1.35 in 2030, when the fertility level will reach the current European Union level. Regarding educational assumptions, we expect Shanghai development trends to be the same as those of Beijing.

The total fertility rate of Guangdong was higher than that of Beijing and Shanghai, but it is not the highest fertility region in China. We assume that in N1 the TFR will continue to drop to 1.51 in rural areas and 1.15 in urban regions in 2010 and remain constant to 2030, with the TFR reaching the level envisaged by policy makers. In N2 we assume that the fertility rate will remain at the 2000 level during the projection period. In N3 we assume that the TFR will increase slightly to 2.01 for rural areas and 1.63 for urban areas by the end of projection period; at the regional level, the TFR is aggregated to around 1.85.

Regarding the education hypothesizes for Guangdong, we assume that significant improvements in higher education (college and above) will take place in both urban and rural regions by the end of the projection period. Regarding the transition rate for primary to middle school, by 2030 the rural region will reach the level of urban areas in 2000; the urban middle-school level will be constant at the year 2000 level; while for the transition rate of no education to primary, both regions will be at the year 2000 level.

Table 7: Basic year inputs and scenario assumptions of natural growth for Beijing.

Fertility	**2000***	**N1 Low**	**N2 Medium**	**N3 High**
Urban	0.7656	0.7656 (2000–2030)	1.04 (2001–2010) 1.23 (2010–2030)	1.418 (2000–2030)
Rural	0.9672	0.9672 (2000–2030)	1.37 (2001–2010) 1.63 (2010–2030)	1.831 (2000–2030)

Mortality (Life Expectancy)	**2000**	**2030**
Urban male	75.4	77.53
Urban female	78.49	80.35
Rural male	71.91	73.82
Rural female	75.14	76.64

Educational Transition Rate

Transition from	**No education–primary (5–9)**		**No education–primary (10–14)**	
	2000	**2030**	**2000**	**2030**
Urban male	0.7772	0.7772	0.4985	0.4985
Urban female	0.7815	0.7815	0.4809	0.4809
Rural male	0.7895	0.7895	0.5659	0.5659
Rural female	07866	0.7866	0.5393	0.5393
	Primary–middle (10–14)		**Primary–middle (15–19)**	
	2000	**2030**	**2000**	**2030**
Urban male	0.4998	0.4998	0.8045	0.8045
Urban female	0.5177	0.5177	0.7829	0.7829
Rural male	0.4307	0.4998	0.9025	0.8545
Rural female	0.4576	0.5177	0.8947	0.8330
	Middle–college and above (15–19)		**Middle–college and above (20–24)**	
	2000	**2030**	**2000**	**2030**
Urban male	0.1759	0.4000	0.3292	0.3800
Urban female	0.1958	0.4000	0.3353	0.3800
Rural male	0.0296	0.1759	0.0758	0.3000
Rural female	0.0321	0.1958	0.0990	0.3000

* Modified total fertility rate for 2000.

Table 8: Basic data and scenario assumptions of natural growth for Shanghai.

Fertility	**2000***	**N1 Low**	**N2 Medium**	**N3 High**
Urban	0.86	0.86	1.06 (2010–2030)	1.35 (2010–2030)
Rural	0.86	0.86	1.06 (2010–2010)	1.35 (2010–2030)

Mortality (Life Expectancy)	**2000**	**2030**
Urban male	76.4	79.08
Urban female	79.52	81.69
Rural male	76.92	80.56
Rural female	80.67	83.52

Educational Transition Rate

Transition from	**No education–primary** (5–9)		**No education–primary** (10–14)	
	2000	**2030**	**2000**	**2030**
Urban male	0.7718	0.7718	0.9880	0.9880
Urban female	0.7728	0.7728	0.9892	0.9892
Rural male	0.7954	0.7954	0.9702	0.9702
Rural female	0.7728	0.7728	0.9824	0.9824
	Primary–middle (10–14)		**Primary–middle** (15–19)	
	2000	**2030**	**2000**	**2030**
Urban male	0.7275	0.7275	0.9497	0.9497
Urban female	0.7490	0.7490	0.9290	0.9290
Rural male	0.5385	0.7275	0.8866	0.9497
Rural female	0.7490	0.7490	0.9290	0.9290
	Middle–college and above (15–19)		**Middle–college and above** (20–24)	
	2000	**2030**	**2000**	**2030**
Urban male	0.2332	0.3800	0.1420	0.3800
Urban female	0.2441	0.3800	0.1462	0.3800
Rural male	0.0124	0.1655	0.0433	0.3000
Rural female	0.0112	0.1702	0.0291	0.3000

* Modified total fertility rate in 2000.

The educational profiles of migration are different among these mega-urban regions. The proportion of in-migrants with higher education in Beijing and Shanghai is higher than in Guangdong. However, in terms of quantity, Guangdong ranks first in China in terms of absorbing job-seeking rural migrants.

Table 9: Basic year inputs and scenario assumptions of natural growth for Guangdong.

Fertility	**2000***	**N1 Low**	**N2 Medium**	**N3 High**
Urban	1.23	reaches 1.15 in 2010, then constant	as 2000 level	1.63 to 2030
Rural	1.85	reaches 1.51 in 2010, then constant	as 2000 level	2.01 to 2030

Mortality (Life Expectancy)	**2000**	**2030**
Urban male	72.91	75.91
Urban female	79.14	82.14
Rural male	69.9	74.40
Rural female	71.19	75.69

Educational Transition Rate

Transition from	**No education–primary (5–9)**		**No education–primary (10–14)**	
	2000	**2030**	**2000**	**2030**
Urban male	0.7187	0.7187	0.7140	0.7140
Urban female	0.7199	0.7199	0.7110	0.7110
Rural male	0.7167	0.7167	0.7908	0.7908
Rural female	0.7095	0.7095	0.8083	0.8083
	Primary–middle (10–14)		**Primary–middle (15–19)**	
	2000	**2030**	**2000**	**2030**
Urban male	0.2837	0.2837	0.9049	0.9049
Urban female	0.2861	0.2861	0.8944	0.8944
Rural male	0.2061	0.2837	0.8581	0.9049
Rural female	0.1868	0.2861	0.7938	0.8944
	Middle–college and above (15–19)		**Middle–college and above (20–24)**	
	2000	**2030**	**2000**	**2030**
Urban male	0.0309	0.1114	0.1073	0.2509
Urban female	0.0221	0.1138	0.0728	0.1969
Rural male	0.0032	0.0309	0.0212	0.1073
Rural female	0.0022	0.0221	0.0123	0.0728

* Modified total fertility rate for 2000.

4 Analysis of Results

4.1 Alternative Growth and Size of Mega-urban Regions

4.1.1 Natural growth without migration

Figures 7, 8, and 9 show the possible paths of population growth during the projected period under the different fertility levels combined with mortality and educational transition rates for Beijing, Shanghai, and Guangdong.

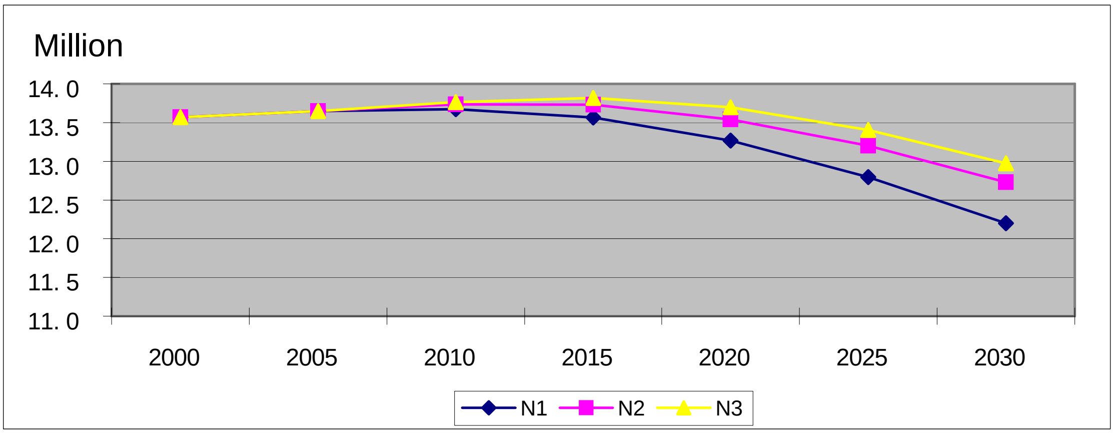

Figure 7: Natural population growth at different fertility levels, Beijing.

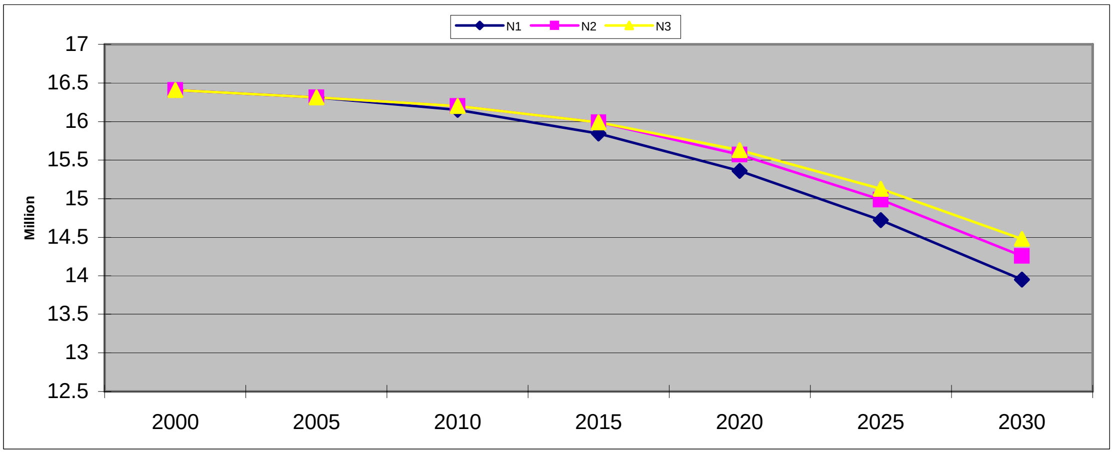

Figure 8: Natural population growth at different fertility levels, Shanghai.

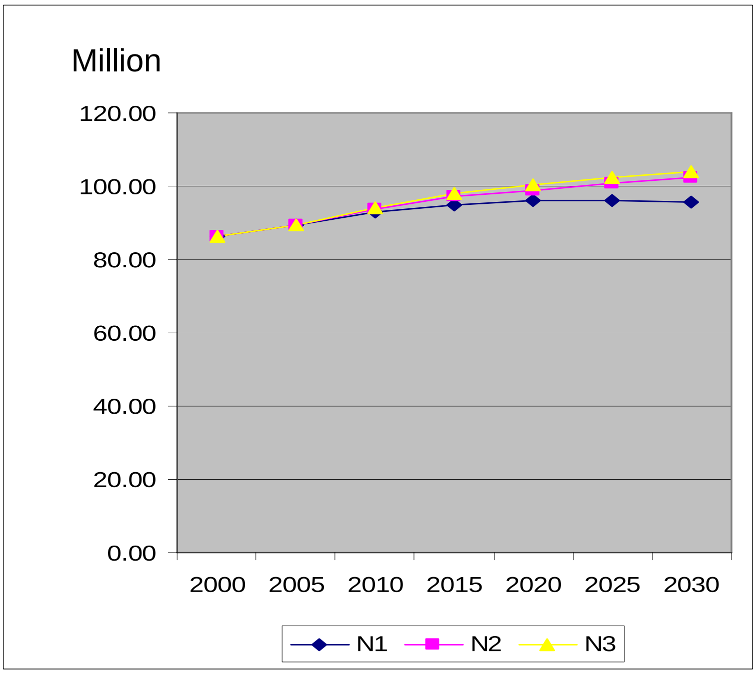

Figure 9: Natural population growth at different fertility levels, Guangdong.

Beijing's population evolution will reach the point at which negative population growth will begin during the next 30 years. The simulation results show that if fertility remains at the year 2000 level (N1), the population will undergo almost zero growth up to 2010 before entering into negative growth; under N2, where the fertility level increases to 1.23 (urban) and 1.63 (rural), negative growth will begin soon after 2010; if fertility increases to 1.42 (urban) or 1.83 (rural) as expected under N3, then negative growth will likely be postponed until 2015. Under the scenarios of low, medium, and high fertility, population is expected to reduce from 13.57 million to 12.20, 12.73, and 12.98 million, respectively.

In the next 30 years the population of Shanghai is expected to decrease from 16.41 million to 13.95, 14.26, and 14.48 million under the scenarios of low, medium, and high fertility, respectively.

The population evolution trends of Guangdong are different from those of Beijing and Shanghai; Guangdong's population will certainly increase. According to the N1, N2, and N3 scenarios, the population in 2030 will be between 96.62 and 103.71 million, an increase of between 11.39 and 18.48 million. Although Guangdong's total fertility rate is assumed to be the same as in 2000 (N2), its population is expected to grow by 17.3 million.

4.1.2 Alternative population sizes under the different migration scenarios

As discussed previously, net migration and the transformation of rural settlements into cities will be important determinants of population growth in these three mega-urban regions over the next three decades. Table 10 presents the plausible alternative sizes of future population under the scenarios of natural population growth combined with migration. The results show that Beijing, Shanghai, and Guangdong, if they are able to retain their preeminence in the Chinese context, will have the best prospects of all the East Asian urban regions of becoming global centers in the future. As these three regions are, and have been, the engines of Chinese economic growth, their crucial period for population growth is between 2000 and 2030, when urbanization in China will continue to make rapid progress.

In the limited migration scenarios (L1, L2, and L3), in which migration is controlled, Beijing's population is expected to reach between 17.52 and 18.75 million, an increase of 30–38% from 2000; Shanghai's population will increase to 23 million until 2030, a 40% increase from 2000.

In the high migration scenarios (H1, H2, and H3), there is a more liberal immigration policy for Beijing, Shanghai, and Guangdong. The results indicate that Beijing's population will increase to between 20 and 21.16 million, by 47–56% from 2000 to 2030; Shanghai's population is expected to increase to between 25.30 and 25.40 million, by 54–55% from 2000 to 2030; Guangdong's population will reach its peak at between 115.76 and 121.25 million.

It should be noted that, according to our results, in the coming decades, irrespective of whether Beijing and Shanghai apply the limited or the liberal migration policy, both cities will figure among the 10 largest urban agglomerations in the world, ranked by population size. These projection results are much higher than the United Nations projections for Beijing and Shanghai (United Nations, 2002, 2006), as the United Nations' projection does not take into account the migration factor.

Table 10: Projected Population size for Beijing, Shanghai, and Guangdong to 2030 (in millions).

Beijing			
2030	**No migration**	**Limited migration**	**Higher migration**
Low fertility	12.20	17.75	20.00
Medium fertility	12.73	18.49	20.81
High fertility	12.98	1875	21.16

Shanghai			
2030	**No migration**	**Limited migration**	**Relaxed migration**
Low fertility	13.95	23.25	25.35
Medium fertility	14.26	23.26	25.37
High fertility	14.48	23.28	25.38

Guangdong		
2030	**No migration**	**Relaxed migration**
Low fertility	96.62	115.76
Medium fertility	102.53	119.87
High fertility	103.71	121.25

4.1.3 Urban population and share in the total population

Over the next three decades, Beijing, Shanghai, and Guangdong will continue to develop and urbanize, as the Chinese government has begun to promote the advancement of key metropolises into regional or global hubs by granting them economic, cultural, and information technology functions. Table 11 presents the urbanization trends of the projected regions. It shows urbanization is increasing from 77.55% in 2000 to 84.08% in 2030 under the L2 assumption and urbanization in Shanghai increasing from 88.31 % in 2000 to 94.95% in 2030 under L2.

Compared with Beijing and Shanghai, where net migration contributes greatly to urban population growth, Guangdong's results indicate that fertility is still an important factor in terms of urban growth. We can clearly see that the lower fertility scenario is associated with a higher urbanization level, as there is a rather large difference between the urban and rural fertility level (see Table 12).

4.2 Migration Trends of Mega-urban Regions

Migration is an important factor for Beijing, Shanghai, and Guangdong, as the higher the assumed population growth, the more migrants are needed in the projected regions. Figures 10, 11, and 12 show how population growth is associated with net migration.

Obviously, we can clearly see the large differences when the population growth under N2 (no migration), L2 (limited migration), and H2 (higher migration) are compared.

Table 11: Urban population and urban share in the total population: Beijing and Shanghai.

	Natural growth (N) million	**Share in total** %	**Limited migration (L)** million	**Share in total** %	**High migration (H)** million	**Share in total** %
***Beijing* 2000**	**10.52**	**77.55**	**10.52**	**77.55**	**10.52**	**77.55**
2030						
Low fertility	9.42 (N1)	77.23	14.82 (L1)	83.46	17.07 (H1)	85.32
Medium fertility	9.79 (N2)	76.93	15.51 (L2)	84.08	17.87 (H2)	85.89
High fertility	9.96 (N3)	76.73	15.81 (L3)	84.34	18.22 (H3)	86.12
***Shanghai* 2000**	**14.48**	**88.31**	**14.48**	**88.31**	**14.48**	**88.31**
2030						
Low fertility	12.49 (N1)	89.53	21.92 (L1)	94.63	24.09 (H1)	95.63
Medium fertility	12.77 (N2)	91.04	21.95 (L2)	94.95	24.10 (H2)	94.95
High fertility	12.97 (N3)	91.04	21.99 (L3)	94.55	24.10 (H3)	94.96

Table 12: Urban population and urban share in the total population, Guangdong.

Guangdong urbanization under N and H assumptions

	Natural growth (N)	**Share in total %**	**Higher migration (H)**	**Share in total %**
2000	**474.32**	**55.66**	**474.32**	**55.66**
2030				
Low fertility	54.06 (N1)	55.95	79.86 (H1)	68.99
Medium fertility	55.57 (N2)	54.20	79.99 (H2)	66.73
High fertility	55.86 (N3)	53.86	80.02 (H3)	65.98

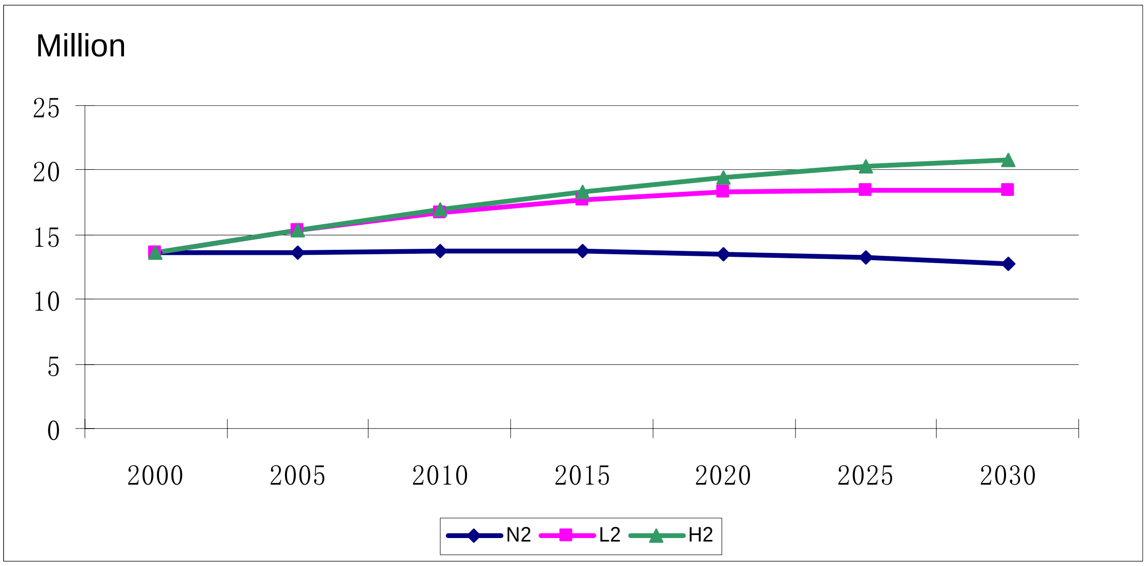

Figure 10: Population growth under N2, L2, and H2 assumptions, Beijing.

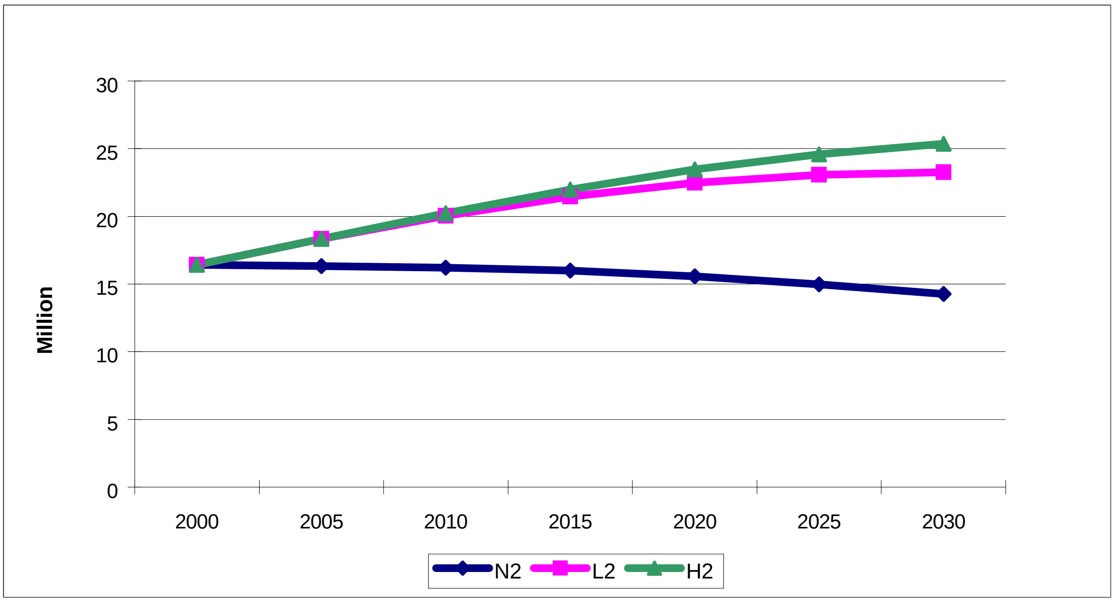

Figure 11: Population growth under N2, L2, and H2 assumptions, Shanghai.

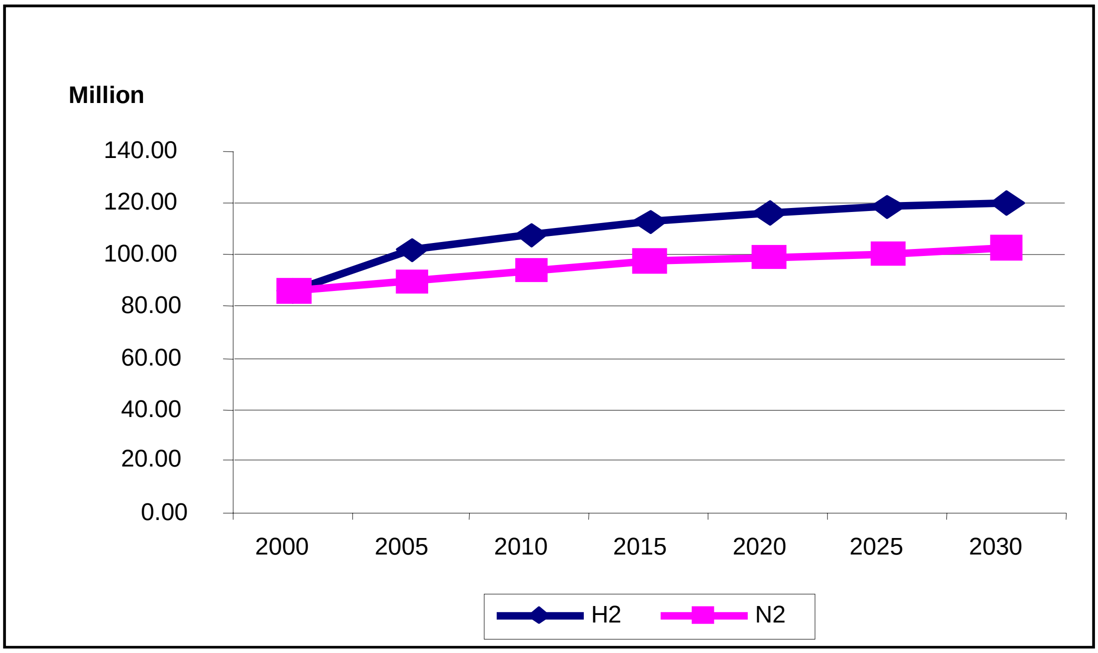

Figure 12: Population growth under N2, L2, and H2 assumptions, Guangdong.

In the past 20 years, the mega-urban regions, especially Shanghai and Beijing, have relied on migration to meet the needs of economic growth and labor force requirements. In the future, the decline in the numbers in the labor force will continue to be offset by an increasing volume of migrant workers.

Table 13 shows how many net migrants will be needed based on the limited and high population growth scenarios. Beijing, Shanghai, and Guangdong will continue to be magnets for a massive number of job and rural migrants in the next 30 years. Under the limited population growth scenario, Beijing needs about 5.53–6.92 million migrants and Shanghai about 7.24–8.17 million. Under the high growth assumption, Beijing needs 8.04–8.98 million migrants and Shanghai about 9.02–10.07 million. Total migration for Guangdong will be around 15.87–19.92 million in the next 30 years.

Table 13: Expected total migration during 2000–2030 under different growth scenarios (millions)

	L1	L2	L3	H1	H2	H3
Beijing	6.92	6.46	5.53	8.98	8.74	8.04
Shanghai	8.17	7.64	7.24	10.07	9.49	9.02
Guangdong				19.92	18.28	15.87

4.3 Labor Force and Aging

Population aging in China first appeared in the population age distribution figures in the mid-1970s. Since the 1980s it has steadily increased along with a significant decline in fertility and a stable increase in life expectancy; in the 1990s it became more serious. Based on the central assumption of IIASA projections (Cao and Lutz, 2004), China's working population will experience a downward trend in 2020. The working population will diminish before there is a reduction in the total population. Moreover, the population is likely to become significantly older in the coming decades (see Table 14). In terms of population aging, Shanghai and Beijing ranked uppermost among China regions, with Shanghai in particular about 20 years ahead of the national trend.

Table 14: China's population by age group under the central scenario. Source: Author's calculations.

	Total population of China (millions)	0–14 (%)	15–59 (%)	60–79 (%)	80+ (%)
2000	1275.13	24.85	65.04	9.20	0.90
2005	1321.46	21.91	67.32	9.79	0.99
2010	1362.30	20.17	67.61	11.01	1.20
2015	1399.68	19.18	66.05	13.29	1.47
2020	1428.75	18.34	64.89	15.06	1.71
2025	1448.14	17.53	62.74	17.77	1.96
2030	1458.60	16.61	59.77	21.07	2.55

In tandem with the massive increases in net migrants under the different growth scenarios, Beijing, Shanghai, and Guangdong will profit from their demographic window of opportunity, in the sense that that working population dependency ratio (young and old) will decline. The projection results confirm that the demographic window of opportunity for Beijing, Shanghai and Guangdong will manifest itself in two ways: (1) the decline in the workforce based on natural growth will be offset by an increasing volume of migrant workers; (2) the accelerated aging process will slow, as migration, with its large proportion of young males and females, is age-selective (see Tables 14–17 and Figures 13–14). When we compare for Beijing and Shanghai the scenarios regarding the share of the working population under N2 (no migration) and under L2 (with migration), the shares in the L2 assumption in 2030 are significant higher than in N2, while the share of the elderly aged 60 and above declines significantly in the L2 scenario, the difference being 10.84% for Beijing and 15.01% for Shanghai. Moreover, the projection results show clearly that Beijing, Shanghai, and Guangdong will have a higher-than-average share of the working population than China as a whole in the coming decades (see Tables 14–17).

Table 15: Beijing population by age group under the N2,L2, and H2 scenarios.

	Total (millions)	**0–14 (%)**	**15–59 (%)**	**60–79 (%)**	**80+(%)**
N2					
2000	13.57	13.59	73.87	11.56	0.98
2005	13.65	10.85	75.59	12.41	1.15
2010	13.73	11.13	73.45	13.83	1.59
2015	13.73	11.96	68.44	17.35	2.25
2020	13.54	11.62	63.91	21.75	2.72
2025	13.20	10.33	59.21	27.69	2.77
2030	12.73	8.97	55.50	32.09	3.44
L2					
2000	13.57	13.59	73.87	11.56	0.98
2005	15.30	10.39	77.37	11.21	1.03
2010	16.67	11.00	76.03	11.64	1.33
2015	17.73	12.52	71.87	13.85	1.77
2020	18.31	13.19	67.99	16.77	2.05
2025	18.49	12.38	64.75	20.83	2.04
2030	18.45	10.73	62.91	23.91	2.46
H2					
2000	13.57	13.59	73.87	11.56	0.98
2005	15.30	10.39	77.37	11.21	1.03
2010	16.92	10.94	76.27	11.48	1.31
2015	18.38	12.41	72.48	13.41	1.71
2020	19.49	13.15	69.07	15.85	1.93
2025	20.25	12.65	66.28	19.19	1.87
2030	20.81	11.40	64.92	21.48	2.20

Table 16: Shanghai population by age group under the N2, L2, and H2 scenarios.

	Total (millions)	0–14 (%)	15–59 (%)	60–79 (%)	80+(%)
N2					
2000	16.41	12.55	71.87	13.70	1.88
2005	16.31	10.06	73.37	14.40	2.17
2010	16.20	9.99	70.67	16.98	2.68
2015	15.99	10.56	64.84	22.21	3.30
2020	15.57	10.08	59.35	28.71	3.24
2025	14.99	8.73	55.55	33.92	3.57
2030	14.26	7.29	52.73	36.78	5.40
L2					
2000	16.41	12.55	71.87	13.70	1.88
2005	18.35	9.59	75.58	12.90	1.93
2010	20.04	10.02	73.97	13.89	2.17
2015	21.46	11.53	69.53	16.80	2.46
2020	22.48	12.22	65.57	20.33	2.25
2025	23.06	11.36	63.80	22.74	2.34
2030	23.26	9.73	63.14	23.86	3.31
H2					
2000	16.41	12.55	71.87	13.70	1.88
2005	18.35	9.59	75.58	12.90	1.93
2010	20.23	9.99	74.18	13.78	2.15
2015	21.99	11.50	70.07	16.44	2.40
2020	23.47	12.24	66.50	19.55	2.17
2025	24.59	11.57	65.08	21.47	2.20
2030	25.37	10.19	64.74	22.09	3.05

Table 17: Guangdong population by age group under the N2 and H2 scenarios.

	Total (millions)	0–14 (%)	15–59 (%)	60–79 (%)	80+(%)
N2					
2000	86.20	24.97	65,35	7.68	1.00
2005	89.42	21.78	69.27	7.93	1.02
2010	93.62	20.06	70.92	8.68	1.16
2015	97.27	20.51	70.09	10.33	1.43
2020	99.95	19.49	70.68	12.25	1.59
2025	101.63	17.78	70.33	15.85	1.67
2030	102.63	16.23	68.62	20.34	2.14
H2					
2000	86.20	24.97	66.35	7.68	1.00
2005	101.84	20.42	71.67	7.01	0.89
2010	107.66	19.89	71.54	7.48	1.00
2015	112.86	20.77	69.41	8.63	1.19
2020	116.53	20.80	67.93	9.98	1.29
2025	118.63	18.52	67.45	12.71	1.32
2030	119.87	16.16	65.89	16.30	1.65

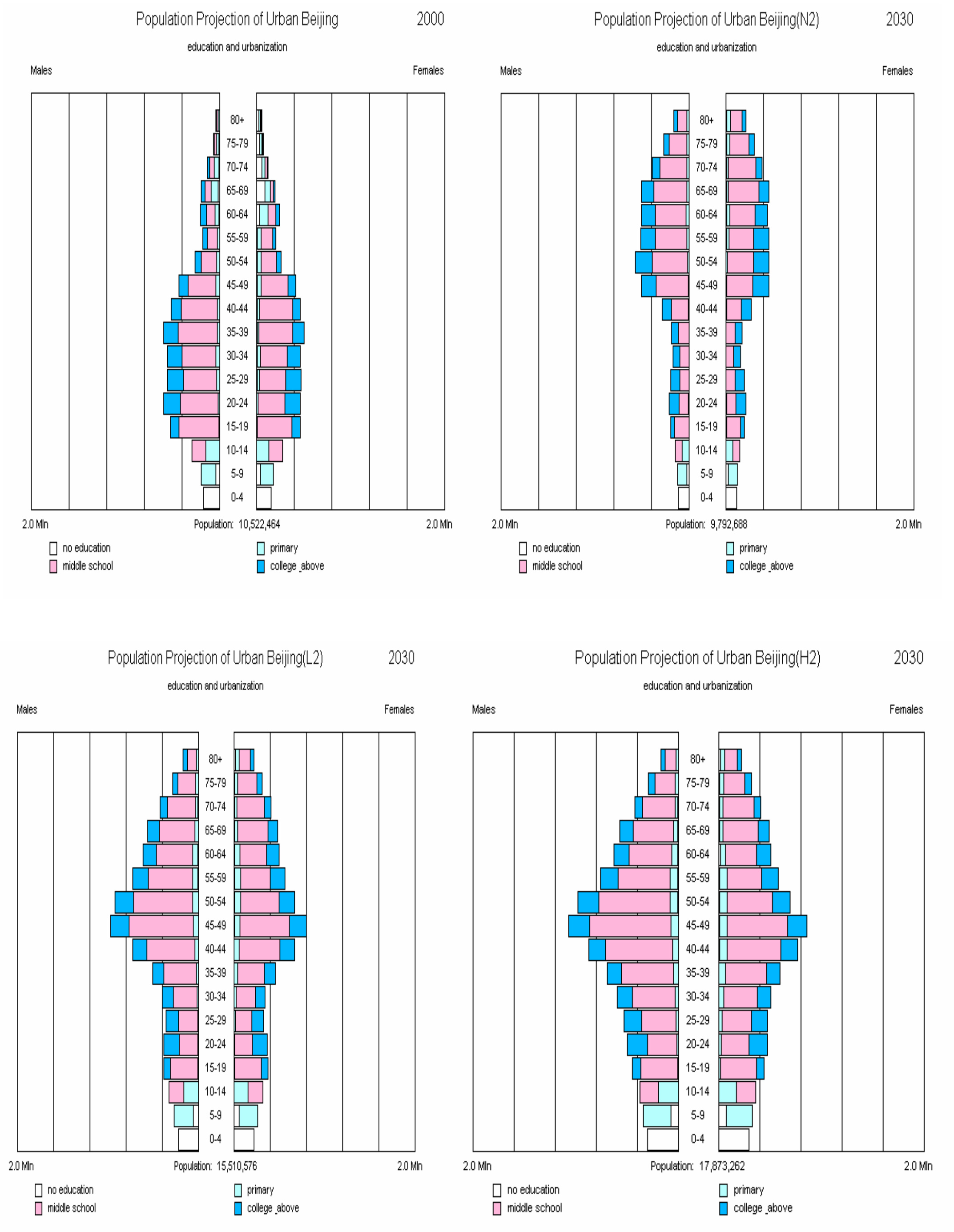

Figure 13: Comparing the age pyramid of Beijing in 2000 and 2030 under N2, L2, and H2 scenarios.

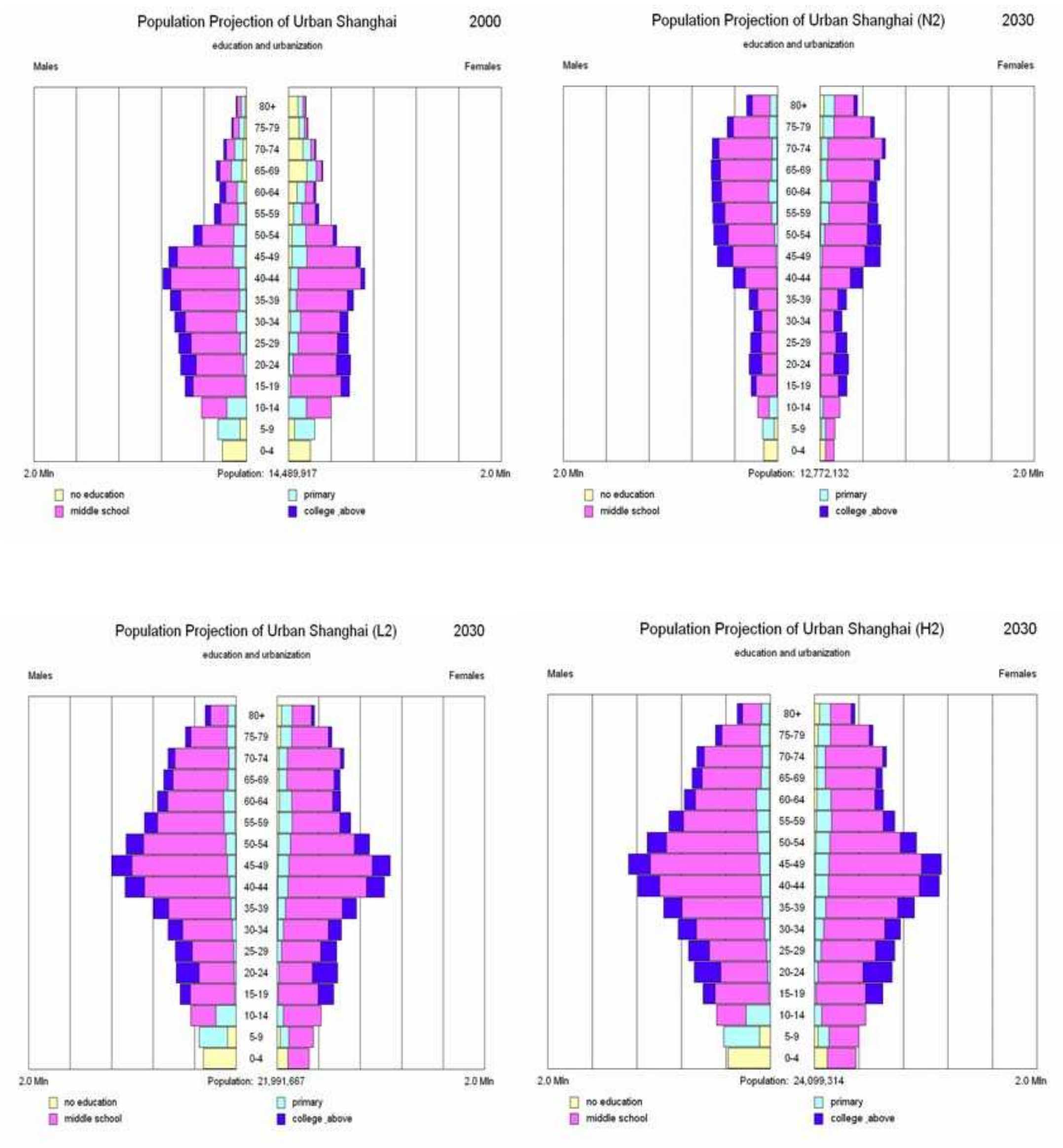

Figure 14: Comparing the age pyramid of Shanghai in 2000 and 2030 under N2, L2, and H2 scenarios.

4.4 Human Capital Trends

As accelerating technological innovations and growing specialized service functions are features of the economies of these three mega-urban regions, the labor force needs a good basic education and skills. For more than 20 years the regions have needed to attract new, young talented personnel, with a college or tertiary education from other parts of China.

Table 18 and Figures 15–17 provide a picture of population trends by educational composition for Beijing, Shanghai, and Guangdong from 2000 to 2030. An important finding from the multistate projection is that the middle-school level will increase considerably over the next decades in all these regions, in particular, in Guangdong; the percentage of the population attending middle school will increase from 49.60% in 2000 to 65.37% in 2030.

Table 18: Projected population by educational composition for Beijing, Shanghai, and Guangdong.

	No education	Primary	Middle school	College and above
Population of Beijing under the L2 scenario				
2000	8.65	16.96	57.55	16.84
2005	7.82	14.45	60.66	17.07
2010	7.88	13.74	61.06	17.33
2015	7.65	13.76	61.15	17.44
2020	6.61	13.70	61.75	17.95
2025	5.40	12.85	62.62	19.13
2030	4.55	11.55	63.19	20.70
Population of Shanghai under the L2 scenario				
2000	11.39	20.65	58.13	9.82
2005	9.70	17.91	61.83	10.56
2010	7.86	16.69	64.30	11.16
2015	6.83	15.38	66.28	11.51
2020	5.55	14.58	67.84	12.02
2025	4.37	13.64	68.86	13.14
2030	3.69	12.42	69.07	14.82
Population of Guangdong under the H2 scenario				
2000	13.72	33.13	49.60	3.56
2005	12.21	28.76	54.30	4.74
2010	11.36	25.97	57.10	5.57
2015	10.07	24.49	59.10	6.34
2020	8.60	22.78	61.56	7.06
2025	7.32	20.91	63.70	8.07
2030	6.63	18.96	65.37	9.04

These results also imply that the proportion of the population at college level and above in these three mega-urban regions will substantially increase; the percentage of the population with high-school education will reach 20.7 in Beijing and 14.82 in Shanghai by 2030 according to L2, which would be around the level of European Union countries in 2000.

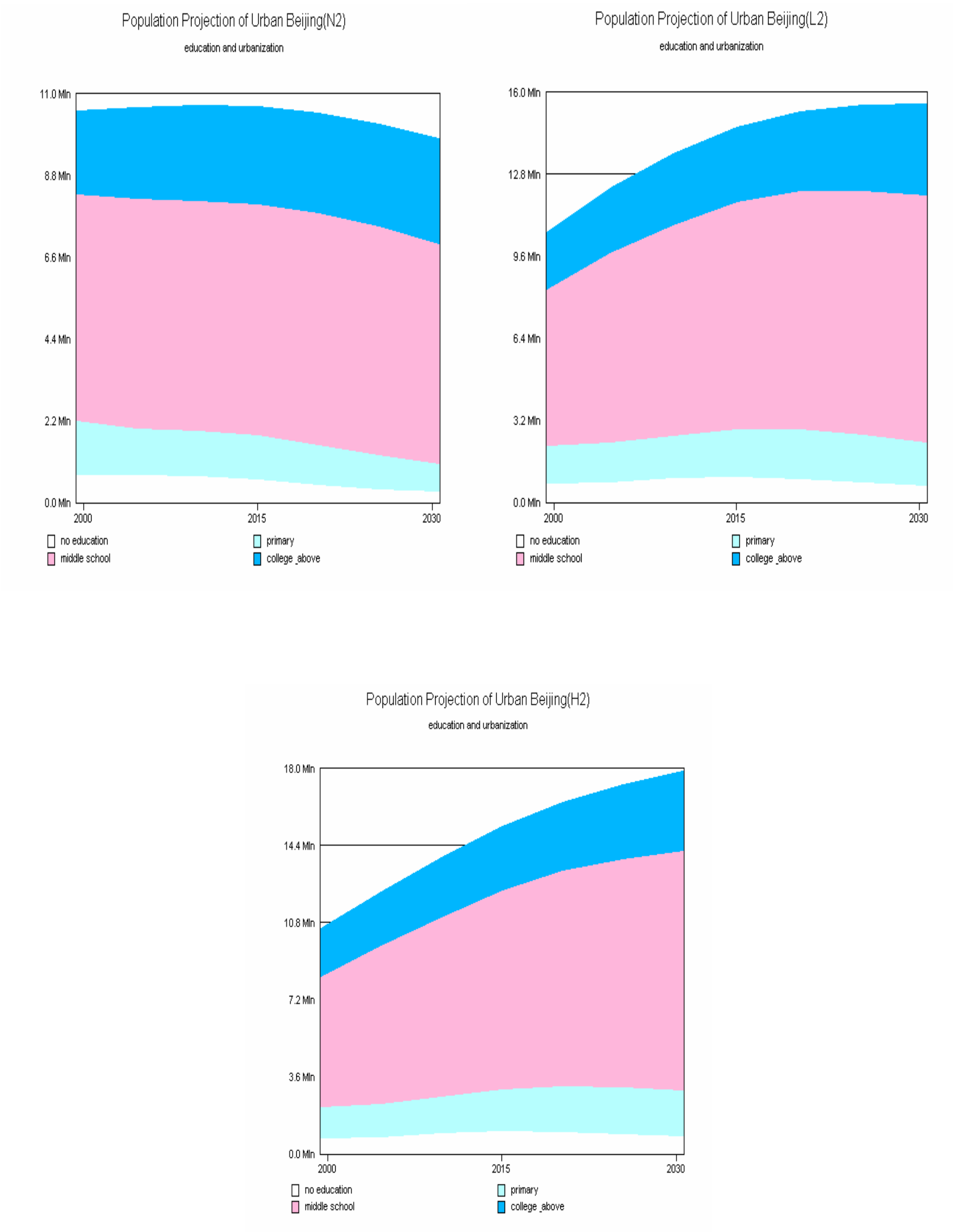

Figure 15: Trends in educational composition under N2, L2, and H2: Urban Beijing.

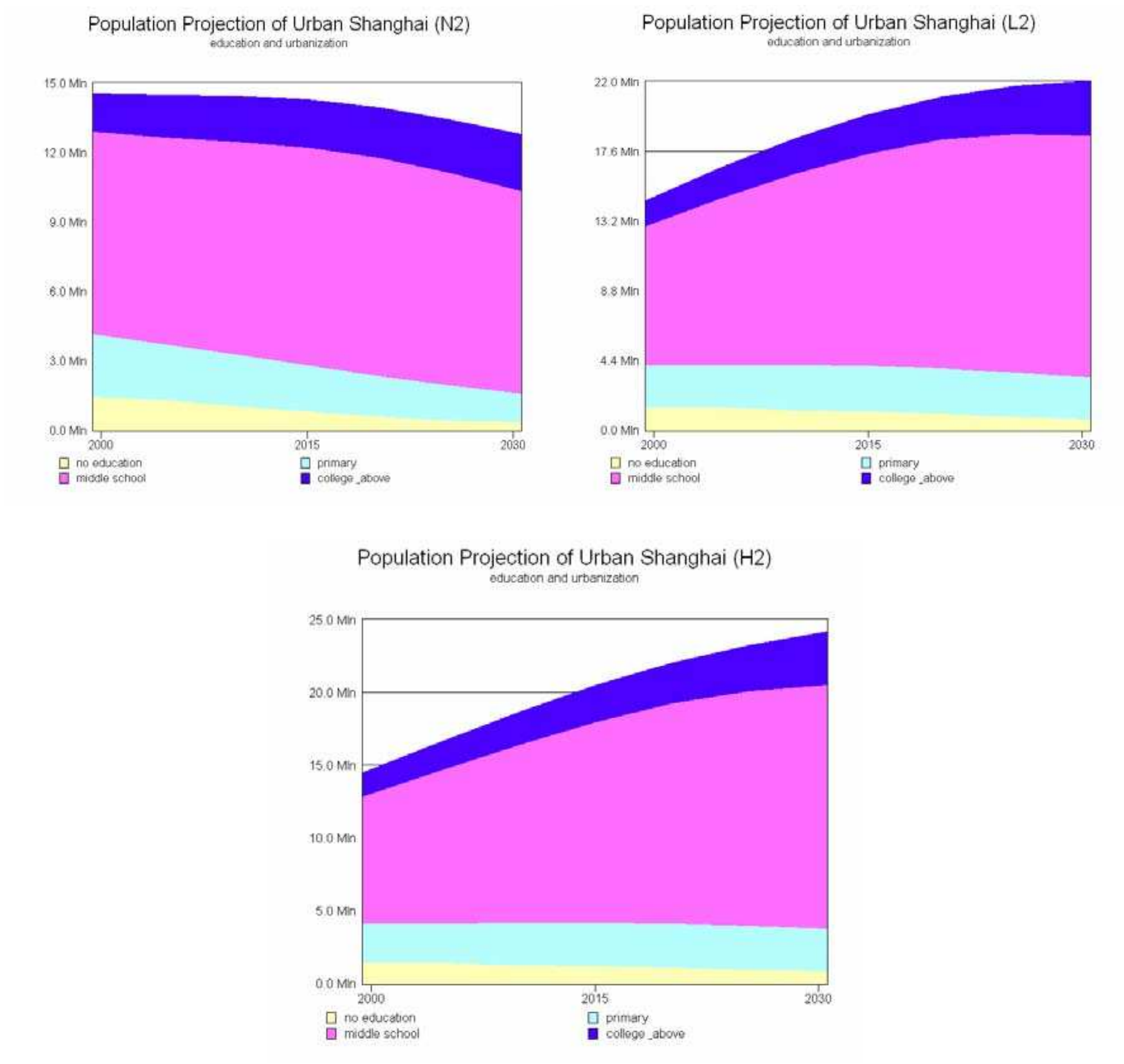

Figure 16: Trends in educational composition under N2, L2, and H2: Urban Shanghai.

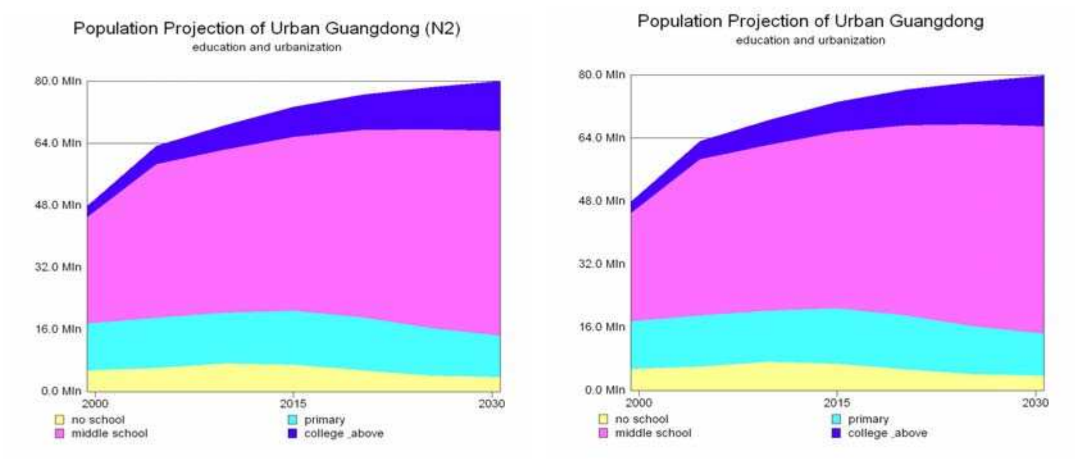

Figure 17: Trends in educational composition under N2 and H2: Urban Guangdong.

5 Conclusions

Recent urban development in China is characterized by two notable features: (1) an unprecedented scale of urban change, as in the Shanghai, Beijing and Guangdong regions, with the direction of urban change more strongly affected by the global economy than ever before; (2) the formation of large mega-urban regions around economic centers in coastal areas and low rates of urbanization in inland regions. A large coastal–inland divide in terms of urbanization has emerged after two decades of economic reforms.

The mega-urban regions of Shanghai, Beijing, and Guangdong will continue to play a major role in achieving sustainable development at the national and regional levels. We have thus have tried in this report to provide a picture of demographic evolution in those regions in the medium term. Our projections indicate that demographic trends for the mega-urban regions may be quite different from those of other Chinese regions: (1) From 2000 to 2030 is a crucial period for population growth, as the mega-urban regions will continue to be the engines of strong economic growth in China; (2) There will be a significant requirement for labor force migration to meet the anticipated economic growth; (3) The regions will continue to develop and urbanize, even in the limited migration scenario; (4) Compared with the other regions of China, the expected massive net migration will slow down the fast population aging of all three regions, with the latter benefiting from the subsequent demographic window of opportunity; (5) The proportion of the population with higher education will increase substantially during the next three decades.

The future demographic trends of Beijing, Shanghai, and Guangdong will have the potential to significantly alter the outlook for socioeconomic and environmental development in the coming decades, not only in the mega-urban regions but in China as a whole. On the one hand, these three regions are recognized as a driving force of Chinese economic restructuring and rapid economic growth; on the other hand, because of the pre-eminence of these three regions, their demographic trends represent a challenge to strong socioeconomic and environmental development in the China as a whole. How then should Beijing, Shanghai, and Guangdong as well as China as a country prepare for the challenges inherent in the process of urbanization and rapid population growth caused by massive net migration?

Compared with other urbanization projection methods, the multistate method captures the internal changes occurring in rural and urban regions and assesses how net migration affects the changing age and education composition of the population. However, the current multistate model is facing challenges in terms of its use as a tool for multiregional population projection because it is multistate in terms of, for example, different education levels, but not multiregional. A multistate model simulation cannot be used to produce multiregional projections simultaneously. The current multistate method thus needs to be improved.

China's economy will continue to enjoy strong economic growth and, in common with governments across the world, the Chinese government will continue to promote its key metropolises so that they gain some or all of the attributes of regional or global hubs. The mega-urban regions of Beijing, Shanghai, and Guangdong have achieved respectable levels of growth in a short space of time; if they remain pre-eminent in the Chinese context, they have the best prospects of all East Asian mega-urban regions of becoming global centers in the future.

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