China's grave demographic challenges in coming decades*

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Abstract:

This paper systematically analyzes the uncertainties of major demographic indicators from China's 2000 census, such as fertility, gender ratio at birth, and age structure, and through a probability demographic forecast gives an assessment of the situation facing the country. Research outcomes suggest that great differences exist in the estimate of China's fertility, gender ratio at birth and low-age child population. These differences directly affect China's current and future demographic uncertainties, and have implications for policy and future research. The demographic uncertainties caused by current conditions are of great value to decision-makers and the public alike.

Key words:

Uncertainty; Demographic trend; Demographic probability forecast

I. Introduction

Since the mid-1990s, some of China's major demographic indicators have been unbelievably uncertain, making it difficult to predict current and future demographic trends. Such uncertainties will, in no small measure, affect government decision-making and demographic strategies. Over the past few years, the total fertility rate (TFR) based on the 2000 census is estimated to be between 1.22 (National Bureau of Statistics, 2002a, 2002b) and 2.3 (Liang Zhongtang, 2003), which is a difference of nearly two times. Moreover, there are more than 30 estimates in this range. While it is generally agreed that China's fertility rate is already below replacement level, a considerable number of researchers insist that fertility is below the super-low level (see Ren Qiang, 2005; Zhang and Zhao, 2006).

Volatile fertility estimates of such magnitude in a short period of time are rarely seen in any country.

Fertility is only one aspect of China's demographic uncertainties, which also include gender. Gender ratio at birth based on the 2000 census is estimated between 113 (Wang Jinying, 2003) and 123 (Ma Yingtong, 2004). The discrepancy will also significantly affect the gender ratio and demographic structure of the future adult population.

The population of low-age children is subject to serious uncertainties as well. According to the 2000 census, the child population aged between 0-4 is 71 million, but the estimated value stands at 86 million for the same year (Zhang Weimin, 2004). A discrepancy of 15 million for one age group is incredible.

China's population development is characterized by several baby booms over the past 50 years.

Given the above confusions, this paper will systematically examine the uncertainties of demographic variables in predicting China's population changes. Future population is forecast by using the demographic probability method. Possible range of present and future population size and structure will be discussed. We hope the analytical perspective and results of this paper will provide a scientific demographic reference for the government and public alike.

II. Uncertainties in fertility, gender ratio and low-age population

1. Current fertility

Many researchers and institutes have re-estimated China's total fertility rate using the 2000 census data (see Table 1), as the original estimate is regarded as seriously distorted. However, the results are myriad and varied, and very few can approach the real picture. There is no sufficient evidence to prove which one is accurate. The disagreements rightly point to the degree of uncertainty in China's current fertility rate, which has never been as controversial as it is today. The published results show that the total 2000 fertility rate falls in the range of 1.22 and 2.3, and that each value was reached using respective theories, methods and even empirical judgments. The estimates are uneven: (1) total fertility rates published by institutes range from 1.7 to 1.8; (2) most total fertility rates calculated directly using census or sample survey data are below 1.5; (3) total fertility rates calculated directly using the demographic method or weighted by birth report omissions are between 1.6 and 1.7; (4) total fertility rates reached by researchers through real observations or field surveys are still above 2.0.

Although the present fertility rate is hard to calculate, we can know its temporal trends. Figure 1 shows the temporal sequence of total fertility rates estimated using five independent data groups since the 1980s. Of the same period, different survey data correspond to obvious discrepancies in fertility rates. However, after the early 1990s, all estimates are below 1.5. Experts generally agree that the low fertility rates are a result of birth report omissions, which are particularly serious in the years approaching the demographic census/survey. Evaluating the extent of omissions is one of our common challenges, given the need to find a reasonable way to adjust data and reach a reliable

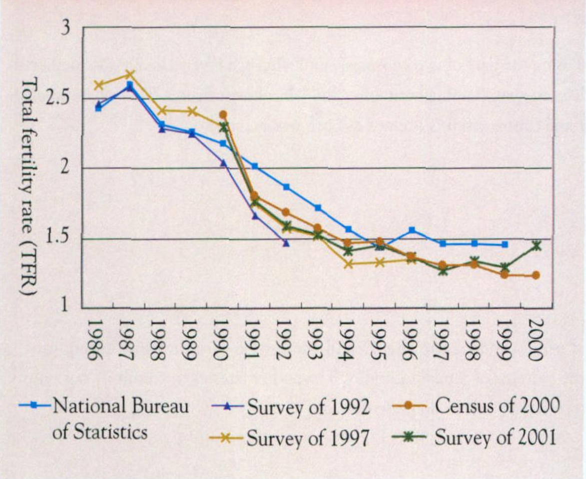
Table 1: Various estimates of Total Fertility Rate (TFR) in China Based on the 2000 census

Source	TFR	Notes
WANG Jinying (2003)	1.718(1); 1.703(2); 1.723(3)	(1) Unadjusted fertility model: calculated directly using the fertility rate by age and gender of the 2000 census, without taking omissions into account; (2) Adjusted for birth report omissions: retain the by-age fertility of the 2000 census, and then adjust for omissions; (3) Adjusted for second-child omissions: considering the serious omissions of second-child birth reports, re-estimate the fertility model adjusted for second-child omissions.
LIANG Zhongtang (2003)	2.3	Based on personal observations and experiences.
YUAN Jianhua, et al (2003)	1.71(1) 1.78(2) 1.63(3)	(1) Calculations based on national statistical yearbooks; (2) Statistics from National Family Planning Commission; (3) Estimate yearly births using the number and survival method of children aged between 0-10 from the 2000 census, presuming life expectancy is 67.767 for men and 71.15 for women in 1990, and 69.54 for men and 73.01 for women in 2000.
ZHANG Weimin, et al (2004)	1.63(1) 2.0(2)	(1) Omission rate for children aged between 0-9: 18.94%; (2) Presuming the population number for age group 10-19 is correct, omission rate for age group 0-9 is 13.68%. Presuming the omission rate of 1990 is the same with 2000, adjusted TFR is 2.0.
Zhang and Zhao (2006), Zhang (2004)	1.5-1.6	Fertility estimated using census data.
Retherford et al. (2005)	1.36(1) 1.38(2) 1.58(3)	(1) "Own children" method; (2) Birth history reconstruction method; (3) The censuses of 1990 and 2000 adjusted for comparative factors
GUO Zhigang (2004); Guo and Chen (2007)	1.23(1) 1.3(2) <1.5(3)	(1) Calculate using child-mother matching method based on the 2000 census, with 1% data; (2) Authors' view, reflect real TFR based on national survey and census; (3) According to the impact of progress effect on fertility rate, authors conclude that the fertility rate of 2000 should be near the level of policy fertility.
Cai (2006)	1.5-1.6	Fertility levels estimated using Preston and Coale's "R" variable method according to the census data of 1990 and 2000, as well as annual data natural demographic changes.
YU Xuejun (2002)	1.55(1) 1.32(2) 1.6-1.8(3)	(1) Estimated according to the census data of 2000; (2) Estimated according to child population shown by the 2000 census; (3) Estimate by the authors.
XIA Leping (2005)	1.6	Fertility levels estimated through comparison between educational statistics and demographic figures released by National Family Planning Commission and National Bureau of Statistics.
ZHANG Weimin and CUI Hongyan (2003)	1.38(1) 1.63(2) 2.0(3) 1.8(4)	(1) Only use long census tables; (2) Lower limit; (3) Upper limit; (4) Authors' estimate value.
ZHAI Zhenwu (2003), 1.8; DING Junfeng (2003), 1.35; ESCAP (2002), 1.8; US Bureau of the Census (2004), 1.7; National Family Planning Commission (2002), 1.45; Research Team of China Demographic Information Research Center (2003), 1.80; National Bureau of Statistics (2000a, 2000b), 1.22; National Family Planning Commission (2001), 1.8		

figure. This is why so many researchers and institutes are committed to researching the fertility rate around 2000, producing a myriad of total fertility estimates.

Principles and methods applied in producing the estimates are elaborated in their respective research, and we do not make further comments here. But it should be noted that recently some researchers have called for the following approach and priorities in order to clarify the puzzling fertility problem as soon as possible: prudent use of fertility measurement indicators, extensive research on current fertility, strengthened collection of demographic statistics,

Figure 1: Total Fertility Rates (TFRs) since 1980s, corresponding to different data sources



Data source: *referenced by GUO Zhigang (2004)*

Note: *NBS data are from National Bureau of Statistics (1988-2000); survey data of 1992 are from YU Jingyuan and YUAN Jianhua (1996); survey data of 1997 are from GUO Zhigang (2000); survey data of 2001 are from DING Fengjun (2003); and census data of 2000 are from GUO Zhigang (2004).*

Table 2: Gender ratio of different birth orders in China, 1989, 1994, 2000

Year	Total	First birth	Second birth	Third birth and beyond
1989	111.3	105.2	121.0	127.0
1994	115.6	106.4	141.1	154.3
2000	119.9	107.1	151.9	159.4

Note: *figures for 1989 and 2000 are from census data (NBS, 1993, 2002b); figures for 1994 are from NBS (1997)*

opening of various data sources, as well as further data collection and analysis (Guo Zhigang, 2008).

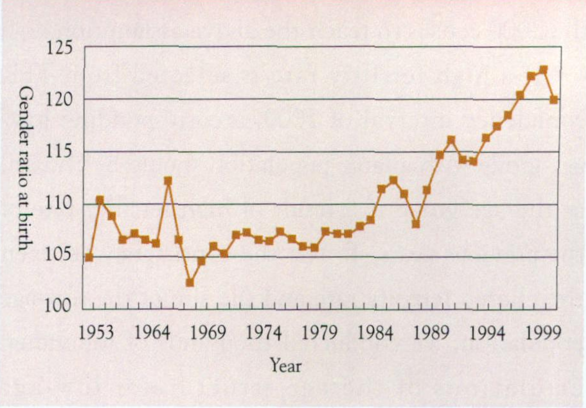
2. Gender ratio at birth

Various estimates of changing patterns of gender ratios at birth, together with gender ratios at birth reflected by the 2000 census, are shown in Table 2, Table 3 and Figure 2. Whether, or how much, the figure seriously departs from the normal range has become a focus of research in recent years. Table 2 shows that between the late 1980s and 2000, the gender ratio at birth kept rising for all birth orders. Among these, the gender ratio of first birth is in normal range, but for the second birth and beyond the ratio is seriously uneven. The higher the birth order, the more imbalanced the gender ratio is. Figure 2 shows changing patterns of the gender ratio. From 1953 to the mid-1980s, the gender ratio at birth is basically normal except for a few years (1960 and 1966). However, it began to depart from the normal range after the mid-1980s, and the departure became especially serious in the 1990s. Table 3 shows the estimates of various institutes and researchers on the gender ratio at birth reflected by the 2000 census data, which roughly fall in the range between 113 and 123. Most researchers hold that, although the report omissions of female infants partially led to the imbalanced gender ratio at birth, the real impact of killing female infants, especially the selective abortion of female fetuses, cannot be overlooked. Hence, even without considering the fact that some female infants were deliberately not reported by their parents to avoid over-birth fines, the changing patterns of data, some regional survey results, or the data consistency of different research all indicate that the reality of gender imbalance may not be so serious as specific indicators have revealed.

3. Size of low-age population

The third uncertain variable is age structure and population size of different age groups, especially low-age children. The rampant birth report omissions

Figure 2: Changing patterns of gender ratio at birth in China, 1953-2000



Source: *figures of 1960-1992 are from GU Baochang and XU Yi (1994); figures of 1993-2000 are from LÜ Hongping (2003)*

Table 3: Various estimates of gender ratio at birth of 2000

Source	Gender Ratio at Birth	Notes
WANG Jinying (2003)	113.4	Estimated using the data of two censuses, employing age reverse deduction method and supplemented with annual primary school enrolment figures. The gap between this result and census result is deemed as birth report omissions.
National Population and Family Planning Commission and China Population and Development Research Center (2003)	116.9	
MA Yingtong (2004)	≤ 122.7	Estimated using gender ratio theory and the system of indicators, taking into account the patterns of gender mortality. The author stresses the result is "not only inaccurate, but may well be an underestimate".
NBS (2002b)	116.9	
CHEN Wei and ZHAI Zhenwu (2007)	110 or so	Estimated through comparison between primary school enrolment data and census data. The gap between this result and census data is deemed as report omissions.
Banister (2002)	120	Comparison of historic data consistency; comparison of gender ratio by birth order; comparison of gender ratio of children aged between 0-14; and comparison of gender difference in infant mortality. The conclusion is that gender selection at birth is the primary reason.
ZHANG Weimin and CUI Hongyan (2003)	>115	Through comparison of same-array gender ratios of two censuses, it is confirmed that gender ratio at birth of 2000 is higher than 115. The primary reason is the omission of reporting female children and selective abortion.

mentioned before can be presumed to exist also in the size of child-age population. Their existence can be verified by the intrinsic consistency between two demographic censuses. With 1990 as the starting year, China's population between 1990 and 2000 can be forecast using various fertility rates. The forecast can then be tested by real figures of the 2000 census to reach the above assumption.

If a high fertility rate is selected from TFR confidence interval of 2000, a corresponding low-age group with a large population should be chosen, as the age group is a result of high fertility rate of the previous years. To test the consistency between the chosen fertility rate and the size of the low-age population, we conducted thousands of individual emulations of the age structure of low-age population of 2000. Our approach presumes that report omissions only affect children before school-age, and that the number of boys and girls aged seven in the census is roughly precise (of course, this method can also be applied to higher age groups until there are no child report omissions).

According to this presumption, we first set out to calculate what fertility level in 1993 could lead to the current size of child-age population.

Second, for every emulation, we randomly selected a TFR estimate of 2000 and calculated in the following way: conduct linear interpolation between estimated TFR of 1993 and the presumed value of 2000, then use the resultant TFR to forecast total births between 1993 and 2000, and obtain a new age structure of 2000 referencing a reasonable child mortality. The result is that every round of emulation could lead to a group of child age structures, which are consistent with chosen fertility rates.

Figure 3 shows China's uncertain age-structure pyramid. The grey area marks the scope of uncertain age structures estimated under different fertility scenarios.

III. Demographic forecast methods and presumptions

The above analysis shows that very big uncertainties exist in all major demographic indicators of the 2000 census figures. Although we are unclear about the exact value of each indicator, all data sources and analyses have proven the existence of such uncertainties (Guo Zhigang, 2008). With 2000 taken as the starting year, no traditional methods of demographic forecast will apply, given that age structure is not unique and fertility and gender ratio at birth are uncertain. This paper therefore employs a probability demographic forecasting method (Lutz, et al, 2004a).

Research outcomes of various scholars have provided us with a sound statistical basis for our forecasting approach. On the one hand, their research contains uncertain information of demographic indicators, which makes possible a new forecasting model that contains uncertain information. On the other hand, various estimate values of these indicators form the basis for determining the average value, median and confidence interval of initial indicators. Probability forecasting is a method of random emulation, which allows for the annual changes of fertility and mortality in a defined range. Changing patterns and presumed scope of changes share the same logic with the research of Lutz, et al (2004b).

In the following forecast sections, in order to define the uncertainty of fertility distribution around 2000, we adopt the TFR 1.5 estimated by Retherford

Figure 3: Probable distribution of China's population age structure in 2000

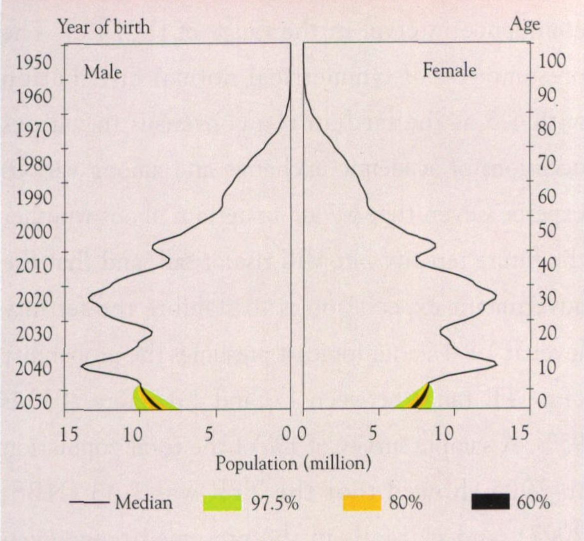


Figure 4: Probability distribution of population forecast for 2000-2050

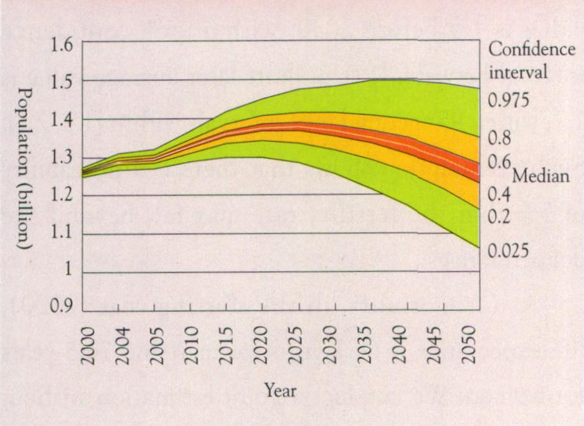
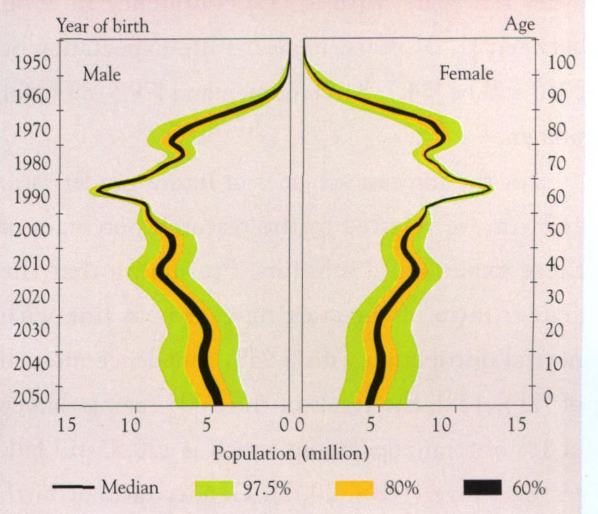


Figure 5: Probability distribution of age structure forecast pyramid till 2050



et al (2005) through own-children approach as the median value of normal distribution, with a 95% confidence interval in the range of [1.2, 1.8]. The presumption of symmetrical normal distribution with 1.5 as the median is a consensus in various occasions of academic exchange and among various experts. Given that we are uncertain about whether the future fertility rate will rise or fall, and that the government expectation is to stabilize the fertility level at 1.8-1.9, our forecast presumes the probability of a TFR range between 1.0 and 2.0 before 2030 is 95%. A sample survey of 1% of the total population in 2005 showed that the TFR was 1.33 (NBS, 2007), and still falls in the presumed range even after reevaluation. To put it simply, presuming the fertility rate is in normal distribution, its average value is 1.5 before 2030, with a 95% confidence interval between [1.0, 2.0]; its later average value is 1.7, with a 95% confidence intervals within [1.2, 2.2]. Such presumption shows that there is a probability of 5% that the fertility rate may fall beyond the defined ranges.

As for mortality, in the starting year (2000), life expectancy is 69.7 years for men and 74.5 years for women. We conduct a point estimation without considering its uncertainty. But for the future, presuming that life expectancy grows by two years every ten years, with a 95% confidence interval between [1, 3] years, it means life expectancy by 2050 will be [74.7, 84.7] for men and [79.5, 89.5] for women.

For the forecast schemes of future gender ratio at birth, we referred to the research outcomes of these experts and scholars. Presuming that the gender ratio of the starting year is in line with normal distribution with a 95% confidence interval of [113, 123], the result of the 2005 sample survey of 1% of total population, which is 120.5, still falls in this range (NBS, 2007). Gender ratio at birth will resume its normal value of 105 by 2030. Values corresponding to time points between 2000 and 2030 are estimated through linear interpolation.

In addition, the forecasted population is presumed to be a closed population, i.e. disregarding net immigration and emigration (international population migration).

IV. Uncertain future population

Figures 4-10 are our major emulation statistical results (Lutz, et al, 2007). In every independent array-element forecast, initial conditions such as fertility, gender ratio at birth and mortality are consistent with the uncertainties described above. These figures show various distribution results

Figure 6: Probability distribution of the share of population aged 65 and above between 2000 and 2050

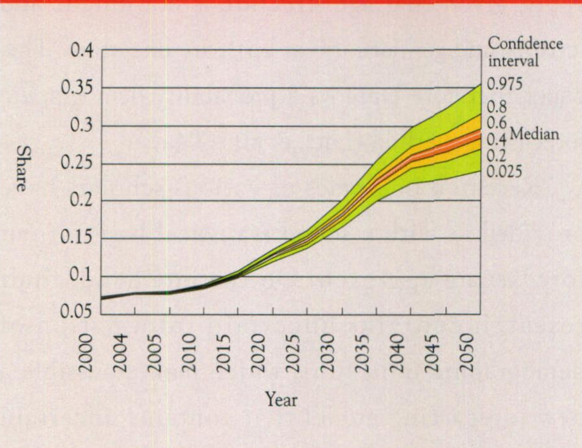
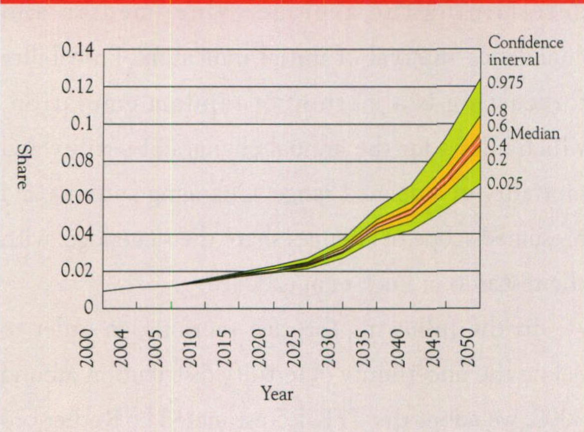


Figure 7: Probability distribution of the share of population aged 80 and above to total population between 2000 and 2050



represented by various characteristic values. The three color areas from outer to inner are 97.5%, 80% and 60% confidence intervals, with the central white or black lines marking the median.

1. Changes in population size

Figure 4 shows the uncertain distribution trends of the total population. The median value shows that the population will grow until 2020-2030 and peak at 1.38 billion, before it slowly declines. By 2050, the median will drop to 1.25 billion. However, it is predicted that the scope of uncertainties will widen as time passes. There is a 97.5% probability that the population size will continue to grow before 2035 and approach its peak of 1.5 billion. In other words, the probability that China's population will exceed 1.5 billion is only 2.5%. The probability for it to peak at 1.3 billion by 2015 is only 2.5%, i.e. there is a 97.5% probability that the population will exceed 1.3 billion. There is a 95% probability that population size will be between 1.06 billion and 1.48 billion by 2050, an 80% probability that it will fall in the range of 1.16 billion and 1.35 billion, and only a 50% probability that it will be 1.25 billion (equivalent to the current population size).

2. Age structure

Figure 5 shows China's population age pyramid with a probability distribution until 2050. All age arrays below 50 years, i.e. arrays of birth after 2000, are highly uncertain with a wide band of volatility, which results from the combined effects of uncertain fertility in 2000 and beyond. The low-age array is subjected to a broad band of uncertainty. For instance, there is a 95% probability that female children in this age group will reach 2.5 million to 7.5 million, with upper and lower limits varying by three times. The size of the population aged between 50 and 70 is less uncertain, with the smallest band of volatility. The reason is that these arrays are born population with a more or less definite size and subjected only to the impact of the current uncertain population age distribution mentioned before. What is more, these groups are below high-mortality age and therefore exempt from the impact of future uncertain old-age mortality model.

China's population development is characterized by several baby booms over the past 50 years, which will leave major traces on various stages of the future 50 years. For instance, the baby boom between 1985 and 1990 creates the largest population until 2050, which will also be the largest ageing population facing China in the 21st century. The major boom will be followed by two minor ones: 2010-2020 and 2030-2040. As shown in Figure 5, there are slight uncertainties about the size of population in the birth array between 1985 and 1990. Given uncertain mortality, the size of the oldest above 75 years of age has a broader band of volatility. It can be deduced from Figure 5 that after the mid-21st century, wild uncertainties will exist in China's population for all age groups, and in particular, the uncertain size of the ageing population will present the biggest question.

3. Ageing trend

Figure 6 shows that China's future ageing trend is definite. The ageing trend is basically free from the impact of population uncertainties before 2030, after which the impact of these factors and uncertain mortality will unfold, represented in the gradually widening uncertainty band of ageing population proportions. Before 2015, the share of the population aged 65 years and above will rise from 8% to 12%; during 2015 and 2040, it will increase at a faster rate to reach 26%; and after 2040, it will enter the second cycle of rapid growth to reach 29%. By 2050, there is a 95% probability that it will hit 24-35%, an 80% for 27-31%, and

Figure 8: Probability distribution of the share of working age population (15-64 years) to total population between 2000 and 2050

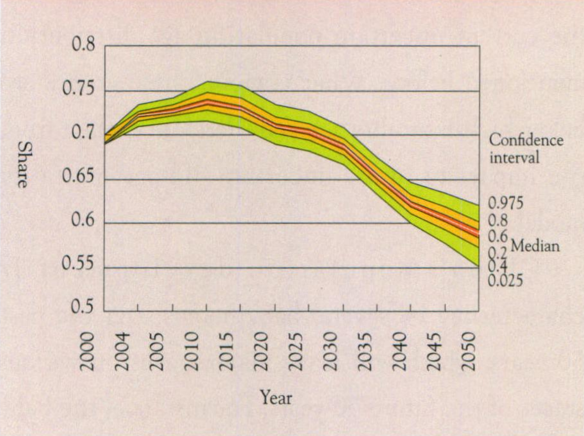


Figure 9. Probability distribution of the share of adolescent population (0-14 years old) between 2000 and 2050

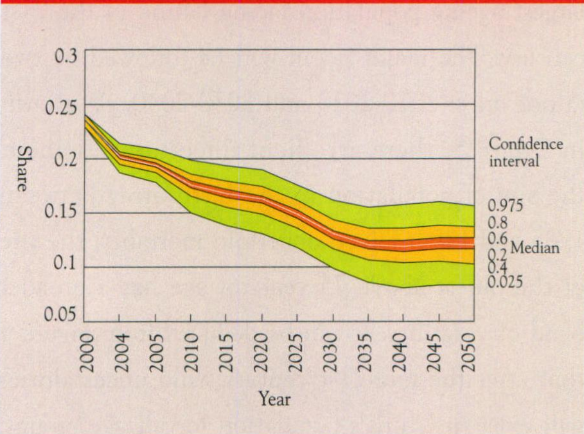
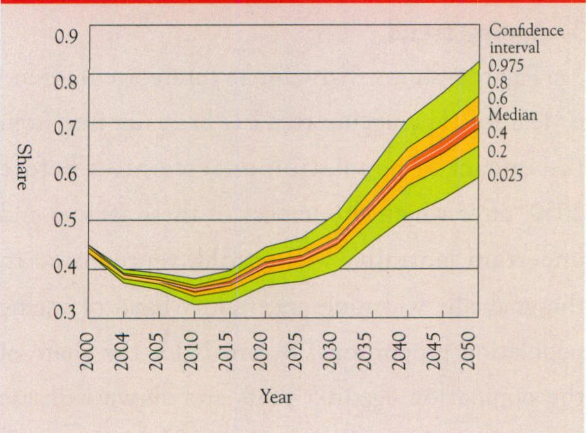


Figure 10: Probability distribution of overall dependency ratio between 2000 and 2050



a 97.5% for above 35%. In 50 years, the share of ageing population will expand by near three times.

Meanwhile, the share of the oldest population above 80 will also experience exponential growth (see Figure 7), and the share of the population aged 65 and above will grow even faster. Before 2025, it will grow slowly from 1% in 2000 to 2% or so, before it reaches 5% by 2040 and 9% by 2050, which is a nine-fold increase in 25 years. Moreover, there is a 97.5% probability that it will exceed 12% by 2050, and only a 2.5% probability that it will be under 7%. Given China's large population base, the absolute size of the oldest old will be very large indeed.

4. Changes in working age population

Figure 8 shows that the uncertainty band of the future working age population is relatively stable, as it is a living population and only subjected to the impact of the future mortality model. Changes in the curve lend credence to the view of China's "population opportunity window" expressed by many scholars. The share of working age population will further increase to the peak around 2010, before it shows a declining trend in 2015, especially an accelerated downward trend after 2025. There is a 97.5% probability that the share will exceed 75%. In the peak period, there is only a 2.5% probability that the share of working age population will be lower than 72%. By 2050, the median value of the share is 58%, and there is a 95% probability that it will fall in the range of 55-62%, as well as an 80% probability that it will exceed 60%. Judging from the trend, the share will decline at a faster rate in the second half of the 21st century.

5. Changes in adolescent population

Figure 9 shows the trend of changes in the share of the population aged below 15 years (the adolescent population). It can be clearly seen that the combination of the uncertainty in the size of low-age population and the uncertainty in current fertility leads to irregular changes in the population of this age group before 2025, after which the distribution becomes more regular and basically reflects only the uncertainty of future fertility. In comparison between this figure and the age structure pyramid of Figure 5, it is obvious that the uncertainty in the share of child population is smaller than its absolute value. The reason lies in the presumption of high fertility, which leads to the projection of a larger child population and total population. In terms of changes in the median value, the share of adolescent population will decline from 23% in 2000 to 13% in 2035 before it stabilizes at 12%. There is a 97.5% probability that it will remain at 15%. Presumably, China's incremental labor force will markedly decline in the coming 25 years, and will not substantially grow again throughout the second half of the 21st century.

6. Changes in total dependency ratio

Figure 10 shows the probability distribution of the overall dependency ratio ((adolescent population aged 0-14+ageing population of 65 years and above)/working age population aged 15-65 years.) As indicated below, the dependency burden is the smallest before 2015, with a 97.5% probability that it will not exceed 40%. This result coincides with the view of the "population opportunity window." After 2015, the overall dependency ratio will rise dramatically, with a low uncertainty. The ratio will nearly triple over 30 years. Obviously, the 95% uncertainty is confined to a narrow scope, and the reason for such a surge is the current age structure, which will not undergo substantial changes even taking into account its uncertainty. By 2050 or so, the overall dependency ratio is expected to increase by nearly three times, with a 97.5% probability of exceeding 80% and only a 2.5% probability to be under 60%. With reference to the trend of changes in the share of adolescent population in Figure 9, it can be deduced that in this period, the dependency ratio of the ageing population will grow even faster with an even narrower band of uncertainty. By 2050, the old-age dependency ratio will increase by five times, reaching 50%, with a 97.5% probability of exceeding 60% and only 2.5% probability to be under 40%.

V. Conclusions

Through the preceding statistics and analysis, this paper has shown that in the coming decades, China will witness the most dramatic demographic transition in world history. Regardless of how much uncertainty there is for the current fertility, gender ratio at birth, existing child population, future fertility rate or mortality, nothing could substantially reverse the rapid demographic transition.

This paper has shown that in the coming decades, China will witness the most dramatic demographic transition in world history.

First, the population size is highly uncertain. According to forecasts, although China's population will keep growing in the coming decades driven by a young population base, there is a 60% probability that it will drop to its current size (1.28 billion) by the middle of this century, and an 80% probability that it will drop to 1.35 billion. Forecast shows that there is a 97.5% probability that China's population will not exceed 1.5 billion. The median value shows that the peak of 1.38 billion will occur around 2025 before it begins to decline to 1.25 billion by 2050, with a 40% probability that the actual population will be under this peak level.

China is currently benefiting enormously from the low dependency ratio. Its child population is small and continues to plunge in terms of size and share, and the ageing population is not too big to afford this. The population opportunity window is one of the factors for the current economic boom, but the window will close in the foreseeable future, which will quickly bring about severe demographic burdens. Forecasts show that the overall dependency ratio will grow substantially in the coming decades, especially for old-age dependency, whose surge is certain. The consequent severe challenges to China's social and economic structures require immediate action, as such structural adjustment takes time.

The current uncertainties in population size and fertility of low-age group will cause irregular changes in the share of adolescent population before 2025, after which its changing patterns will become relatively regular, as it mainly reflects the effect of uncertainty in future fertility levels. As the source of a new labor force, the low-age group will plunge in the coming 25 years before it stabilizes at a low level (12%). This is one of the most important messages for China's future industrial restructuring. Without a continuous supply of fresh labor force, i.e. with rapid ageing of the working age population, the acceleration of industrial restructuring is the only way out. Meanwhile, adjustment of population policies is one way to ensure a new labor force supply, but the cyclical demographic changes (cycles of 20-25 years) and patterns of inertial growth must be fully taken into account.

Forecasts show that the "population opportunity window" will disappear soon, replaced by rapid declines in the share and size of the working age population. There is only an 80% probability that the share of the working age population will be kept at 60% by 2050. With China's rapid ageing process, the ageing of the working age population will also face severe challenges. Lastly, our research outcomes prove that it is feasible to take into account uncertain factors in working out initial demographic indicators, and incorporate the expertise of demographic experts into forecast models.

The consequent severe challenges to China's social and economic structures require immediate action, as such structural adjustment takes time.

Notes:

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References:

[1] Banister, Judith. 2002. "The Dearth of Girls in China Today: Origins, Geography, and Comparative Perspectives." Research Report, 28 September. Beijing: UNFPA China.

[2] Cai, Y. 2006. "An Assessment of China's Fertility Level Using the Variable–r Method." CSDE Working Paper No. 05 06, Center for Studies in Demography and

Ecology, University of Washington.
[3] ESCAP (United Nations Economic and Social Commission for Asia and the Pacific). 2002. Population Data Sheet. Bangkok, Thailand: ESCAP, Population and Rural and Urban Development Division.
[4] Guo, Z., and Chen, W. 2007. "Below Replacement Level Fertility in Mainland China," in Z. Zhao and Z. Guo .eds. Transition and Challenge: China's Population at the Beginning of the 21st Century. Oxford University Press.
[5] Lutz, Wolfgang and Joshua Goldstein, Guest Editors. 2004a. Special issue on "How to Deal with Uncertainty in Population Forecasting?" International Statistical Review 72.1&2): 1–106, 157–208.
[6] Lutz, Wolfgang, Warren C. Sanderson, and Sergei Scherbov, Eds. 2004b. The End of World Population Growth in the 21st Century: New Challenges for Human Capital Formation and Sustainable Development. London: Earthscan.
[7] Lutz, Wolfgang, et al. 2007. "China's Uncertain Demographic Present and Future." Vienna Yearbook of Population Research 2007: 37–59. Vienna, Austria: Verlag der Österreichischen Akademie der Wissenschaften.
[8] Retherford, R., et al. 2005. "Fertility in China: How Much Has It Really Declined?" Population and Development Review 31 .1: 57 84.
[9] U.S. Bureau of the Census .2004. International Data Base. Data released 4–30–2004.
[10] Zhang, Guangyu. 2004. "Very Low Fertility in China in the 1990s: An Illusion of Birth Underreporting?" Paper presented at the Annual Meeting of the Population Association of America .PAA. Boston, MA, USA, 1–3 April.
[11] Zhang, Guanyu. and Zhongwei Zhao. 2006. "Reexamining China's Fertility Puzzle: Data Collection and Quality." Population and Development Review Vol.32.2:293–321.
[12] 陈卫,翟振武. 1990年代中国出生性别比：究竟有多高？人口研究.第5期, 2007.
[13] 丁峻峰.浅析中国1991–2000年生于模式变化对生育水平的影响.人口研究.第2期,2003.
[14] 顾宝昌,徐毅.中国婴儿出生性别比综论.中国人口科学.第3期,1994.
[15] 郭志刚.从近年来的时期生育行为看终生生育水平：中国生育数据的去进度效应总和生育率的研究.人口研究.第1期,2000.
[16] 郭志刚.对中国1990年代生育水平的研究与讨论.人口研究.第2期,2004.
[17] 郭志刚.再论队列平均子女数不能作为当前总和生育率的估计.中国人口科学.第5期,2008.
[18] 国家计划生育委员会.2001年全国计划生育/生殖健康调查公报,2002.
[19] 国家计划生育委员会.计划生育统计公报（2001年第1号）,2001.
[20] 国家人口计生委发展规划司,中国人口与发展研究中心.人口和计划生育常用数据手册（2003）,第74页,2003.
[21] 国家统计局.中国人口统计年鉴, 1988–2000年,中国统计出版社,1988–2000.
[22] 国家统计局.全国1990年人口普查资料,中国统计出版社,1993.
[23] 国家统计局.全国1%人口抽样调查资料,中国统计出版社,1997.
[24] 国家统计局.2001年的中国人口,中国统计出版社,2002a.
[25] 国家统计局.中国2000年人口普查资料,第570页,中国统计出版社,2002b.
[26] 国家统计局.2005年全国1%人口抽样调查资料,中国统计出版社,2007.
[27] 梁中堂.2000年中国人口总量和妇女生育率水平研究,中国人口科学,第6期,2003.
[28] 吕红平.我国近年来出生婴儿性别比升高问题研究,全面建设小康社会人口与发展研讨会论文,（长春）,2003.
[29] 马瀛通.重新认识中国人口出生性别比失调与低生育水平的代价问题,中国人口科学,第1期,2004.
[30] 任强.当前我国的生育水平问题,马寅初人口科学论坛.市场与人口分析,第6期,2005.
[31] 王金营.1990–2000年中国生育模式变动及生育水平估计,中国人口科学,第4期,2003.
[32] 夏乐平.1979–2000年中国人口生育趋势：出生数据和教育数据的比较分析,人口研究,第4期, 2005.
[33] 于景元,袁建华.近年来中国妇女生育状况分析,蒋正华主编,1992年中国生育率抽样调查论文集,第21–34页, 中国人口出版社,1996.
[34] 于学军.对第五次全国人口普查数据中总量和结构的估计,人口研究,第3期,2002.
[35] 袁建华,于弘文,李希如,许屹,姜涛.从生育水平估计到未来人口预测,中国人口科学,第1期,2003.
[36] 翟振武.全面建设一个中等发达的社会和综合解决人口问题,人口研究,第1期,2003.
[37] 张为民,崔红艳.对2000年中国人口普查准确性的估计,人口研究,第4期,2003.
[38] 张为民,徐刚,于弘文,崔红艳.人口变动预测,田雪原,王国强主编,全面建设小康社会中的人口与发展,中国人口出版社,2004.
[39] 中国人口信息研究中心课题组.中国九十年代以来生育水平研究,内部报告,2003.