Province-specific mortality in China, 1990-2000

Simona Bignami-Van Assche

Harvard University Initiative for Global Health

104 Mt Auburn St

Cambridge, MA, USA

E-mail: simona_bignami@harvard.edu

Abstract

This paper uses data from the two most recent population censuses of the People's Republic of China to estimate province-specific mortality levels and trends from 1990 to 2000. I estimate completeness of death reporting at the province level by modifying the General Growth Balance method to account for inter-province migration flows, which have increasingly affected Chinese provinces in the last decade. These estimates permit calculating adjusted life tables by province for the intercensal period 1990-2000 as well as for the period 1999-2000. The results of the analysis suggest significant provincial variation in the declining trend of mortality that China as a whole has experienced since the late 1960s.

Introduction

China is an arithmetic average of disparate components—and those disparities also appear in the realm of health (Wolf et al., 2003: 49). Much detailed and accurate information has been published on the subject in reports and papers on the censuses taken in 1982 and in 1990 (Population Census Office, 1987; Hao, Arriaga and Banister, 1988; Calot and Caselli, 1989; State Statistical Bureau, 1995a, 1995b; Zhang and Li, 1997; Peng, 1997). However, little in the way of research has been done on mortality disparities across Chinese provinces for recent years, mostly because of the lack of available data. In this paper, data from the two most recent population censuses of the People's Republic of China are used to estimate province-specific mortality levels and trends from 1990 to 2000.

Differential completeness of census enumeration, completeness of death reporting relative to population counts and intercensal migration represent important sources of bias when using census data to estimate mortality. Hill's General Growth Balance Method (GGB) permit evaluating and correcting for incompleteness of the death rates as well as inferring the relative completeness of the censuses for non-stable populations that are closed to migration (Hill, 1987). The GGB has been used to estimate levels and trends of mortality in China at the national level between 1964 and 2000 (Banister and Hill, 2004), as international migration for China as a whole is negligible and the country can be considered closed to migration. However, this assumption is problematic for mortality analyses at the sub-national level, as most Chinese provinces have been affected by substantial net migration during the past decade (Liang and White, 1996; Liang, 2001; Sun, 2003).

When data on intercensal migration or a standard pattern of migration are available, the GGB can be easily generalized (Bhat, 2002). When this information is not available, Hill and Queiroz (2004) have suggested a two-step iterative approach in which the GGB is first used to estimate net migration rates using the Rogers-Castro model of age-specific migration, and then to adjust the death rates for that migration. In this paper, these two approaches are used in combination with migration data for the five years preceding the 2000 census[1] to estimate China's province-specific mortality by accounting for inter-province migration flows. These estimates permit calculating adjusted life tables by province for the intercensal period 1990-2000 as well as for the period 1999-2000.

The results of the analysis suggest significant provincial variation in completeness of death reporting, as well as in the declining trend of mortality that China as a whole has experienced since the late 1960s.

China provincial mortality and population data

Information on deaths in China is gathered from a variety of sources, but the most complete mortality data to date have been collected from all households in the three most recent nationwide censuses of 1982, 1990, and 2000. The 1982 census, with a reference date of 1 July 1982, collected information about deaths in calendar year 1981. The 1990 census, with a reference date of 1 July 1990, collected information about deaths occurred during the calendar year 1989 and from January to June 1990. The data are published for

[1] China's 2000 census data include information on the number of net migrants by sex and province, and on the age pattern of migration for the country as a whole, which was collected for a sub-sample of the population (with a sampling ratio of 9.5%) through the long form census questionnaire.

three separate 6-month periods: January–June 1989, July–December 1989, and January–June 1990. The 2000 census, with a reference date of 1 November 2000, collected information about deaths in the 12 months before the census, i.e., the period November 1999–October 2000. The classification of deaths in the 1990 and 2000 censuses is particularly useful as it permits to create groupings of deaths consistently for the 12-month preceding both censuses (Banister and Hill 2004: 57).

[Table 1 about here]

On the basis of the tabulated census figures, in Appendix basic mortality statistics for China's provinces are presented for the periods 1990-2000 and 1999-2000 (Table A1 and Table A2). These figures do not take into account underregistration of deaths, perhaps the most relevant source of bias in the calculation of mortality rates and life tables from census data. At the national level, Banister and Hill (2004: 60) find that for the period 1990-2000 death reporting of adult males improved to become 90 percent complete, while for females it remained essentially constant at 85 per cent. At the province level, by comparing the crude death rate calculated on the basis of the unadjusted census figures with the average of the crude death rates for 1999 and 2001 as reported in the China Statistical Yearbook (Table 1), it seems that, at least at the aggregate level, the completeness[2] of death data recorded by the 2000 census is quite high.[3] However, as it is

[2] The *China Statistical Yearbook* does not report the annual number of deaths by province, only the crude death rate (CDR) and population size at year-end as estimated by means of the annual Survey of Population Change. Completeness of death reporting in Table 1 is therefore calculated by dividing the number of deaths reported in the 2000 census by the number of deaths *implied* by the reported values of CDR and population size in 1999 and 2001. For this reason, the crude estimates of completeness in Table 1 result highly dependent on the accurateness of the underlying population estimates.

[3] In few cases (Chongqing, Guangdong, Hebei, Jilin, Shandong, Shanghai, Tibet) implied completeness of death registration is above 100 percent, which suggests that either deaths were overreported in the census

discussed below, these findings mask differential underreporting of deaths across Chinese provinces, especially those most affected by net migration. In the next sections underregistration of adult and child deaths is evaluated in detail, and the adjustments necessary to construct accurate life tables for Chinese provinces are discussed.

Estimating the completeness of death reporting above age 15

There are three broad groups of methods for evaluating data quality or otherwise estimating adult mortality: (1) death distribution methods that assess the completeness of death recording relative to census recording, (2) methods based on intercensal survival, and (3) methods that convert indicators of mortality levels based on survival of close relatives into standard life table functions. Where the necessary data exist, death distribution methods are the method of choice because they provide age-period specific estimates of mortality rates (Hill, 2001). These methods compare the distribution of deaths by age with the age distribution of the living and provide age pattern of mortality in a defined reference period. Standard methods require two population censuses (or large sample surveys) to provide age distributions of the living and their changes over time, plus enough information to calculate an age pattern of deaths for the intercensal period. If the completeness of death recording relative to population recording can be estimated, any differential in completeness can be adjusted for, and unbiased death rates and standard life table functions calculated.

2000 for these provinces, or that in 1999 and/or 2001 population size was underestimated. The latter possibility is the most likely one, since it is well-known that internal migration and the "floating population" have introduced large margins of error in the vital statistics collected by means of the household registration system (Lavely, 2001; Scharping, 2001).

Recent death distribution methods (Bennett an Horiuchi, 1981; Hill, 1987) are particularly useful to analyze completeness of death reporting for China because they do not assume that the underlying population is demographically stable, and because they are well-suited for census intervals that are not multiples of five. The method proposed by Hill (known as the General Growth Balance method, or GGB) is generally preferred over the Bennett-Horiuchi method because it also allows estimating the relative completeness of the two censuses. In addition, although the GGB method assumes that the underlying population is essentially closed to migration, it can be extended to allow "discounting" the effect of migration by using an observed (Bhat, 2002) or theoretical (Hill and Queiroz, 2004) age pattern of migration. In this section, we apply both extensions of the GGB method to China's province-level mortality data from the 1990 and 2000 censuses.

The General Growth Balance (GGB) method

Brass (1975) first proposed the Growth Balance method, deriving from stable population equations the intuitively-necessary relationship that, for any open-ended age segment $a+$ of a closed population, the entry rate into the segment is equal to the growth rate of the segment plus the exit (death) rate of the segment. In a stable population, the growth rate is constant for all segments, so the entry rate and the death rate must be linearly related:

$$\frac{N(a)}{N(a+)} = r + \frac{D(a+)}{N(a+)} \qquad (1)$$

where $N(a)$ and $N(a+)$ are the number of entries into and the population of the age group a and over respectively, r is the stable population growth rate, and $D(a+)$ is the deaths at ages a and over.

If the entry rate is calculated from a population age distribution alone using fairly simple approaches such as obtaining *N(a)* as one-fifth of the average of the five-year populations under and over age *a*, any coverage error that is invariant with age cancels out, whereas the death rate, calculated from both deaths by age and population by age, will be affected by any differential coverage between population and deaths. The slope of the line relating the entry rate to the exit rate will estimate the completeness of population recording relative to death recording and provide a potential adjustment factor for the deaths:

$$\frac{N(a)}{N(a+)} = r + \frac{1}{c} \cdot \frac{D(a+)}{N(a+)} \qquad (2)$$

where *N(a)/N(a+)* is the entry rate, *D(a+)/N(a+)* is the reported death rate, *r* is the stable population growth rate, and *c* is the completeness of deaths recording relative to population recording assumed constant by age.

This simple method can be generalized for non-stable populations when two or more census enumerations are available (Hill, 1987). In this case, the growth rate of each segment can be calculated from the census counts, and the assumption of stability is no longer needed. The relationship of the entry rate minus the growth rate to the death rate estimates (1) an intercept that captures any age-invariant change in census coverage between the two censuses and (2) a slope that estimates the coverage of death recording relative to an average of the coverage of the two censuses:

$$\frac{N(a)}{N(a+)} - r(a+) = k + \frac{1}{c} \cdot \frac{D(a+)}{N(a+)} \qquad (3)$$

where $r(a+)$ is the observed growth rate of the population a and over, and k is the error in the growth rate (assumed constant across ages), arising for instance from a systematic change in census coverage between the first and the second census.

In order to apply the GGB method to China's thirty provinces[4], I used information on deaths by age, sex and province from the 1990 and 2000 census data[5] to calculate age-specific mortality rates, backdating the census population using age-sex-specific growth rates for the intercensal period 1990-2000.[6] I calculated and averaged age-specific mortality rates for the 12 months before the 1990 and 2000 census, and then applied the age-specific mortality rates to the estimated exposure time for each age group for the intercensal period (see Table A3 in Appendix).

[Table 2 about here]

The results of the application of the GGB method to provincial data from the 1990 and 2000 censuses of China are reported in Table 2. Values of the slope close to one indicate that the fit of the observations to a straight line are remarkably good, and values of the intercept close to zero indicate highly consistent coverage between the 1990 and 2000 censuses. Three provinces show a particularly large slope (greater than 1.2) for both males

[4] China has added one provincial-level administrative unit since the 1990 census: Chongqing Municipality, which was carved out of eastern Sichuan to form the 31st province. In order to maintain consistency, only results for Sichuan province are presented here, which are obtained by combining the data for Chongqing and Sichuan.

[5] The tabulations of the 1990 census data do not include the distribution of deaths by age, sex and province, but only the distribution of deaths by age and sex at the national level, and the distribution of deaths by sex and province. In order to calculate the combined distribution of deaths by age, sex and province, I therefore assumed that the distribution of deaths by age and sex in each province was the same as that at the national level.

[6] The population data used here include the servicemen of the PRC's army. These data were allocated to each province proportionately to the share of the province's enumerated population to the national enumerated population.

and females: Beijing, Guangdong and Shanghai. These provinces are also those where the intercept is furthest from zero, thus suggesting lower relative coverage of the 2000 census compared to the 1990 census.

[Figure 1 about here]

These findings are consistent with the explanation that these provinces are severely affected by migration. Indeed, when the GGB results are presented graphically (see Figure 1 for an example) the series of birth rates above age *x* exhibit a curvilinear, rather than linear, trend. This is because a population destabilized by recent, intense migration does not experience the same rate of increase in different segments of the age distribution, in ways that depend on the age pattern and level of mortality among migrants.

[Table 3 about here]

Internal migration has indeed increased dramatically in China since the late 1980s, especially towards the large metropolitan areas of Beijing and Shanghai (Liang and White, 1996; Liang, 2001; Sun, 2003). This can be seen in Table 3, which contains figures on net inter-province migration for the five years preceding the 1990 and the 2000 censuses.

When the 2000 census figures on net migration are plotted versus the GGB estimates presented in Table 2, three patterns of interest emerge. First, a higher volume of net migration seems to be positively correlated with higher underreporting of deaths (i.e. GGB>1.0; see Figure 2). Second, in provinces characterized by net immigration, it seems that the higher the share of migrants in the total population, the more deaths seem over-registered relative to population (Beijing, Guangdong and Shanghai, where the GGB estimates are almost close to two, have the largest share of net immigration; see Figure 3a).

Third, in provinces characterized by net emigration, the higher is the share of migrants in the total population, the more deaths seem over-registered relative to population (i.e. GGB<1.0; see Figure 3b).

[Figure 2 and Figure 3 about here]

These patterns are consistent with the progressive disruption of the China's household registration system (*hukou*) since the 1980s. The *hukou* system, established as a permanent system in 1958 (Ministry of Public Security, 1984), was one of China's important institutions to create and maintain a certain social and economic configuration in the post-Mao era, and as such served mainly the function of migration control.[7] Although official policies regarding rural-to-urban migration remained largely intact throughout the 1980s, controlling de facto migration has become increasingly difficult as China's transition to a market-oriented economy progresses (Goldstein, Goldstein and Guo, 1991; Liang and White forthcoming). Openings for granting urban *hukou* to certain categories of people have increased substantially, especially covering workers in a wide range of industries and occupations, and the 'temporary population' in urban areas has also increased. On the other hand, economic reforms since the late 1970s have changed the previous multi-layered control structure in which the *hukou* system was an integrated part, thus weakening the effectiveness of the *hukou* system on monitoring and controlling the mobility of the population. Under the economic reforms, job openings and the distribution of daily necessity control are no longer monopolized by the state. There are many jobs in

[7] The designation of *hukou* registration place and status for a person is inherited from that of his or her mother. Change of the *hukou* registration (either the registered place or the registered status or both) has to go through a process of seeking approval from the government.

the non-state sector, and almost all daily necessities are amply available on the market today. State-subsidized welfare for urban people has been reduced. The ongoing economic reforms and *hukou* system reforms have generated a series of new dilemmas in the administration of population distribution and rural-urban migration with many important consequences. One of them is that the death of emigrants might be reported in the province where they were registered, and not in the province where they migrated to, especially in the case of temporary migrants without an urban *hukou*.

The General Growth Balance (GGB) method applied to a population open to migration

The GGB method assesses the completeness of a recorded schedule of deaths by comparison with the recorded age distribution through age-specific growth rates under the assumption of no migration. As Bhat (2002) shows, it is straightforward to adapt this method for the effects of migration if the magnitude and age distribution of net migration are known. This can be done by modifying the left-hand side of equation 3 as follows:

$$\frac{N(a)}{N(a+)} - u(a+) + nm(a+) = k + \frac{1}{c} \cdot \frac{D(a+)}{N(a+)} \qquad (4)$$

where $u(a+)=r(a+)-r(0+)$ is the partial growth differential, and $nm(a+)$ is the net migration rate of the population a and over. This should ideally be calculated from information on intercensal migration as:

$$nm(a+) = \frac{M(a+)}{N(a+)} \qquad (5)$$

where $M(a+)$ is the net of in-migrants and out-migrants of age a and over during the intercensal period. If data on net migration by age are not available, Bhat (2002) suggests

the use of a standard pattern of migration by age and sex, $m_s(a+)$, and information on the total net migration rate, $m(0+)$, to calculate $nm(a+)$ as: $nm(a+)=m(0+)m_s(a+)$

When even a standard pattern of migration is not available, Hill and Queiroz (2004) propose a two-step iterative procedure where the GGB method is first used to estimate net migration rates as follows:

$$r(a+)+\frac{D(a+)}{N(a+)}-\frac{N(a)}{N(a+)}=k_{nm}+q_{nm}\cdot nm^{s}(a+) \qquad (6)$$

where: $nm^{s}(a+)=\sum {}_5nm_x^s\cdot {}_5PYL_x / \sum {}_5PYL_x$, and where ${}_5nm_x$ is a set of model net migration rates; ${}_5PYL_x$ is the average annual person-years lived by the population aged x to $x+5$; q_{nm} is a constant that relates the quantum of migration in the standard rate set to the quantum of migration in the actual population; and k_{nm} is a constant. The slope of the relationship in Equation (6) estimates q_{nm}, and any systematic error in the population growth rate or death rate will result in a non-zero intercept term related to the change in census coverage and relative coverage of deaths. The second step involves substituting the adjusted values of $nm^{0}(a+)=k_{nm}^{0}+q_{nm}^{0}\cdot nm^{s}(a+)$ in equation (4):

$$\frac{N(a)}{N(a+)}-r(a+)+nm^{0}(a+)=k+\frac{1}{c}\cdot\frac{D(a+)}{N(a+)} \qquad (7)$$

The procedure should be repeated until q_d converges to a fixed value.

These two methods were applied to China's mortality analysis. First, Bhat's method was applied using the observed standard pattern of migration by age and sex at the

national level, and net migration rates by province from the 2000 census data.[8] Then, Hill-Queiroz's method was applied using two age patterns of migration: the Rogers-Castro model of labor force mobility, and the observed national pattern calculated from the 2000 census data.[9] It is important to note that both methods assume prior knowledge on the direction (and, in Bhat's case, also the magnitude) of the net migration flow in each province. However, according to the 1990 and 2000 census data, it seems that during the early 1990s the direction of the migration flow changed in few provinces (see Table 3). For example, Tibet, Yunnan and Zhejiang, which were characterized by net out-migration in the mid-1980s, became provinces of net in-migration since the mid-1990s. The opposite is true for Hubei and Qinghai. As it is not possible from the census data to identify in which year between the 1990 and 2000 censuses this direction shift occurred, in order to take this issue into account when adjusting the GGB method for migration I calculated and averaged the in-migration and out-migration correction factors for these provinces.

[Table 4, 5, and 6 about here]

The results are presented in Table 4-6. It can be seen that the fit of the adjusted models improves considerably as compared to the unadjusted GGB method. The consistency of the parameters of the fitted lines in the tables also suggests that the method has worked well. As it can be seen when the results are represented graphically (Figure 4), the best fitting is obtained, with few exceptions, with the last model, where Hill and Queiroz's iterative procedure is used in combination with the national age pattern of

[8] The national pattern of relative migration risk at ages *a* and over derived from the 2000 census is presented in Table A5 in Appendix. Table A6 in Appendix contains the provincial net migration rates per annum during the intercensal period 1990-2000.
[9] Rogers-Castro age-specific migration rates are presented in Table A5 in Appendix.

migration derived from the 2000 census data. This adjustment achieves better results than Bhat's model because it does not rely on the estimates of annual net migration rates by province from the 2000 census data, which probably misrepresent the trend in migration flows during the intercensal period. The two models do, however, produce similar age patterns of net migration rates above each age (see Figure 5 for an example).

[Figure 4 and 5 about here]

According to the final model presented in Table 6, adult deaths are severely underreported (20-30% for males and 30-40% for females) in Jilin, Heilongjiang, Zhejiang, Henan, Hubei, and Anhui (for females). In all other provinces death underreporting is within the national average, being less than 10% for males and between 10 and 15% for females. The results also indicate that census coverage has improved in most provinces, but worsened in Shanghai, Beijing, and Guangdong, probably because of the large migration flows that have affected these provinces during the past decade.

The slope coefficients presented in Table 6 were used as adjustment factors that were applied to the observed age-specific mortality rates for the periods 1990-2000 and 1999-2000 to calculate adjusted life tables. Although the adjustment factors are based on experience above age 15+, they were also applied to mortality rates for ages 5-15 years.

Estimating the completeness of death reporting under age 5

The techniques considered in the previous section are conventionally limited to the evaluation of death registration beyond childhood, since completeness of death records for

infants or young children is often different from the completeness of records for deaths at older ages. It has long been understood that infant mortality is always, or almost always, significantly underreported in China (Banister 1987, pp. 98–110; Zhou et al. 1989; Zhai 1993, p. 11; Tu and Liang 1994; Poston 1996). Mortality from age 1 to age 4 is also usually underreported.

[Table 7 about here]

Infant mortality rates (IMR) by province calculated directly from the 2000 census data are presented in Table 7, together with the corresponding figures from the previous two censuses.[10] It is evident that for most provinces the IMR calculated on the basis of the 2000 census data are too low to fit the declining trend of infant mortality started in the early 1980s, thus suggesting strong underreporting of infant deaths. For few other provinces (Anhui, Gansu, Guangdong, Guizhou, Hebei, Henan, Jiangxi, Shaanxi and Yunnan), the observed IMR for females imply a substantial increase in infant mortality between 1990 and 2000, which is an anomaly most likely due to significant underreporting of female births.

[Table 8 about here]

Internal consistency checks and other demographic methods confirm that, although there was an improvement in infant mortality between the 1990 and 2000 censuses, a certain amount of underreporting exists in the 2000 census data. First, infant mortality rates calculated trough indirect estimation techniques are all higher than those derived from the

[10] Note that the figures presented in Table 7 are calculated directly from the census data without adjustments, and therefore refer to the period between November 1, 1999 and October 30, 2000.

census data. For instance, by using the Johnson technique (Johnson 1982), based on the number of births one year prior to the census date and the population aged less than one year on the census date, the infant mortality rates are 20-30% higher than the figures derived directly from the census data on infant deaths and number of live births (Table 8).[11] Indirect estimation techniques based on children ever born (CEB) and children surviving (CES)—such as the Brass method (Brass et al., 1968)—could not be applied here because the 2000 census data do not include tabulations of CEB and CES by age of the mother and by province.[12] Second, a comparison between the infant mortality derived from census data and figures from other sources also prove the existence of underreporting. For instance, a study using monitoring data of live births, infant deaths and stillbirths in Beijing municipality during the period 1992-2000 found that the IMR for both sexes was 6.46‰ in 2000 (Wang et al. 2001), and a study of infant and child mortality in Sichuan province found that the IMR had decreased from 15.58‰ in 1994 to 10.98‰ in 1998 (Liu et al. 2000). However, the values of the IMR for Beijing and Sichuan were 3.7 and 19.8 per thousand, respectively, according to the unadjusted census data.

Given these considerations, estimates of ${}_5q_0$ were calculated by applying the same adjustment factors presented in Table 6 to the observed age-specific mortality rates under-5

[11] The Johnson technique produces absurd estimates for the provinces that have suspiciously high female IMR (i.e. Anhui, Gansu, Guangdong, Guizhou, Hebei, Henan, Jiangxi, Shaanxi and Yunnan). This is most likely because for these provinces the assumption that the proportion dead among reported births is the same as among unreported births is violated. In addition, for several provinces (Heilongjiang, Shanghai, Beijing, Tianjin, Zhejiang, Jiangxi, Hubei, Hunan, Hainan, Ningxia and, especially, Tibet, Qinghai and Xinjiang) even the IMR estimated by means of the Johnson technique imply gains in infant mortality that are too substantial to fit the historical trend depicted in Table 7. This is most likely because the population under 1 year of age (which forms the basis for the application of the Johnson technique) is subject to the same degree of underreporting as infant deaths (which forms the basis for the calculation of infant mortality rates). Ultimately, this implies that in these provinces a large number of children (especially females) are reported not being born and subsequently dead.

[12] The 2000 census data include only the total number of children ever born and children surviving to women aged 15-50 in each province.

years of age. This procedure results in good agreement with the trends in infant and child mortality rates documented since the early 1980s, and has the additional advantage of maintaining a consistent adjustment procedure for both periods 1990-2000 and 1999-2000.

[Table 9 and 10 about here]

Summary indicators from the adjusted life tables for the periods 1990-2000 and 1999-2000 are presented in Table 9 and Table 10 (full life tables for 1999-2000 are presented in Appendix). When compared to the unadjusted figures (see Table A2 and A3 in Appendix), in both periods adjusted life expectancies at birth are, on average, 0.7 years lower for males and 1.3 years lower for females. For males, the greatest difference between unadjusted and adjusted figures is found in Qinghai, Jilin, Zhejiang and Heilongjiang; for females, in Henai, Anhui, Zhejiang, Hubei and Hunan.

Patterns and trends of mortality in China, 1990-2000

With its socio-economic development, China has achieved great success since the 1960s in improving the life conditions of its population, as it is evident in the decrease in mortality that the country has experienced. According to estimates by Banister and Hill (2004), life expectancy at the national level has increased about 11 years over the course of four and a half decades (from about 60 years in 1964 to about 71 years in 1999–2000).

[Table 11 about here]

The advances that characterize this overall development picture mask large differences in mortality at the sub-national level. Adequate data to permit evaluating the

magnitude and patterns of these differences first became available with the 1973-75 Cancer Epidemiology Survey, a nationwide survey of deaths intended to provide figures for causes of death and age-specific mortality for China and its provinces.[13] In 1981, an analysis of mortality data from the cancer survey presented figures on life expectancy at birth separately for 24 of China's 29 provinces (Table 11, left panel). According to these figures, the lowest life expectancy in China was found in Guizhou, Sichuan and Yunnan Province, and was about ten years lower than that of the "healthiest" provinces (i.e. Tianjin, Heilongjiang, Shanghai, Liaoning and Beijing). Although the reported data indicate that life expectancy among China's province was roughly uniform in the range 59-73 years, Banister (1987: 94-95) argued that this lack of variation "is so pronounced as to invite suspicion", and suggested that life expectancies at birth by province more likely ranged from 45-50 years in Tibet to 65-70 years in developed municipalities. Provincial life tables based on the 1982 census data (Hao, Arriaga and Banister, 1988) revealed an average increase of 3 years in life expectancy at birth among Chinese provinces, but the same geographical pattern as in the 1973-75 cancer survey (Table 11, central panel). The greatest improvements were registered in the most backward provinces, such as Ningxia and Guizhou. As of 1982, China's healthiest region (Shanghai) enjoyed a life expectancy at birth roughly 15 years higher than its least healthy province (Xinjiang). In 1990, Shanghai remained China's healthiest province and maintained a difference of about 15 years in life expectancy at birth with the least healthy province (Tibet) for both sexes (Table 11, right panel). However, most provinces experienced small increases in life

[13] Reported mortality data before the 1970s were highly unreliable, and rarely included sub-national figures (Banister 1987).

expectancy between the 1982 and 1990 census (on average, one year for males and one and half year for females).

The results of the present analysis reveal a strong improvement in mortality in most provinces during the past decade. When estimates for 1999-2000 are compared to estimates for 1989-1990 (Table 11, right panel), it can be noticed that the largest improvements have been experienced, for both males and females, by the most backward provinces, namely Qinghai, Xinjiang, Sichuan, Ninxia and Tibet (more for males than females).[14] Beijing, Shanghai and Liaoning follow with mortality improvement of approximately 4 years for males and 3 years for females. Because of these trends, the gap between Shanghai and Tibet, which remain China's healthiest and least healthy province, has narrowed for males (from 15 to 12 years), but remained almost stable for females.

Life expectancy at birth for females in both periods 1990-2000 and 1999-2000 remains about 3 years higher than that for males. However, in two-thirds of the provinces the sex differential in mortality between males and females widened between 1990 and 2000, and only marginally narrowed in the other provinces. In general, within a region where the life expectancy is low, the sex difference in life expectancy at birth remains low; whereas in an area where the life expectancy is high, the sex difference is also high.

In the periods 1990-2000 and 1999-2000, regional mortality patterns are also highly consistent with the regional pattern of socioeconomic development. The regions with low mortality levels are mainly those coastal provinces in the east with higher

[14] The magnitude of these improvements in Qinghai and Xinjiang arises the suspicion that they might have been inflated by an incorrect adjustment for death underreporting at infant and child ages (both provinces had historically very high infant mortality rates, see Table 7). In absence of additional data sources on infant and child mortality it is not possible to evaluate the extent to which the present analysis underestimates mortality in these provinces.

development levels, while the high-mortality regions are the ones located in the northwest and southwest and characterized by backward socio-economic development and high proportions of minority nationalities. The regions with mid-level mortality are mostly those located between the coastal and west regions with mid-level development.

5. Conclusions

This paper uses data from the two most recent population censuses of the People's Republic of China to evaluate province-specific mortality levels and trends from 1990 to 2000. Different adjustment procedures are applied to Hill's General Growth Balance method to evaluate completeness of death reporting at the province level accounting for inter-province migration flows, which have increasingly affected Chinese provinces in the last decade, and best estimates are arrived at.

The results of the present analysis indicate that, although at the national level adult death reporting improved during the period 1990-2000 to become 85-90 percent complete (Banister and Hill, 2004), at the sub-national level adult deaths remained severely underreported in at least few provinces (i.e. Jilin, Heilongjiang, Zhejiang, Henan, Hubei, and Anhui), and more so for females than for males (death underreporting is, respectively, 30-40 and 20-30 percent in these provinces). The results also indicate that, in the context of a general improvement in census coverage, in Shanghai, Beijing, and Guangdong census coverage has worsened, probably because of the large migration flows that have affected these provinces during the past decade.

Mortality patterns and trends between 1990 and 2000 have remained consistent with previous periods. The largest improvements in mortality were experienced by the most backward provinces (Qinghai, Xinjiang, Sichuan, Ninxia and Tibet), although the gap between China's healthiest province, Shanghai, and China least healthy province, Tibet, has remained approximately the same since 1990. Consistently with trends at the national level (Banister and Hill, 2004), sex differential in mortality have also increased in two-thirds of all provinces, and only marginally decreased in the other provinces. Finally, in the periods 1990-2000 and 1999-2000, regional mortality patterns have remained highly consistent with the regional pattern of socioeconomic development, as in previous periods (Hao, 2000).

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Table 1: *Comparison of crude death rates from unadjusted 2000 census figures and the average for 1999 and 2001, by province*

Province	CDR for 2000 [a]	Average of CDR for 1999-2001 [b]	Implied completeness in death reporting for 2000
Anhui	5.77	6.18	0.87
Beijing	5.26	5.45	1.00
Chongqing	7.05	6.92	1.01
Fujian	5.01	5.69	0.88
Gansu	6.17	6.44	0.94
Guangdong	4.69	5.26	1.02
Guangxi	5.59	6.50	0.77
Guizhou	7.30	7.46	0.92
Hainan	4.53	5.50	0.77
Hebei	6.46	6.22	1.04
Heilongjiang	4.86	5.49	0.84
Henan	6.01	6.31	0.92
Hubei	5.52	6.22	0.88
Hunan	6.08	6.92	0.84
Inner Mongolia	5.94	5.94	0.99
Jiangsu	6.03	6.78	0.89
Jiangxi	6.03	6.54	0.86
Jilin	5.52	5.42	1.02
Liaoning	6.37	6.58	0.97
Ningxia	4.69	5.25	0.89
Qinghai	5.90	6.61	0.83
Shaanxi	6.02	6.36	0.92
Shandong	6.63	6.26	1.07
Shanghai	5.94	6.24	1.02
Shanxi	5.97	5.99	1.00
Sichuan	6.80	6.91	0.94
Tianjin	6.00	6.34	0.95
Tibet	7.20	6.95	1.05
Xinjiang	4.70	6.33	0.75
Yunnan	7.27	7.70	0.93
Zhejiang	6.20	6.30	1.00
National	5.98	6.36	0.93

Notes: [a] Population moved at year-end 2000. Total deaths for 2000 calculated by doubling the death count recorded by the 2000 census for the period January 1 – June 30, 2000. [b] State Statistical Bureau 2000, 2002.

***Table 2**: Results of the application of GGB method (ages 15+ to 65+) to data from the 1990 and 2000 censuses of China, by province*

	Males			Females		
Province	Slope	Intercept	Completeness	Slope	Intercept	Completeness
Anhui	1.57	–0.0136	0.869	1.65	–0.0132	0.873
Beijing	1.37	–0.0052	0.948	1.38	–0.0049	0.951
Fujian	1.24	–0.0025	0.974	1.31	–0.0023	0.976
Gansu	1.20	–0.0014	0.986	1.27	–0.0013	0.987
Guangdong	1.09	–0.0015	0.985	1.02	0.0001	1.001
Guangxi	1.16	–0.0022	0.978	1.17	–0.0013	0.986
Guizhou	1.15	–0.0049	0.950	1.14	–0.0029	0.971
Hainan	1.13	0.0013	1.014	1.17	0.0023	1.024
Hebei	1.73	–0.0162	0.846	1.83	–0.0156	0.851
Heilongjiang	1.16	–0.0021	0.979	1.29	–0.0033	0.966
Henan	1.21	–0.0037	0.962	1.26	–0.0028	0.972
Hubei	0.96	0.0044	1.047	1.14	0.0013	1.014
Hunan	1.06	–0.0022	0.978	1.15	–0.0021	0.978
Inner Mongolia	0.97	0.0018	1.018	1.05	0.0000	1.000
Jiangsu	1.11	–0.0020	0.980	1.19	–0.0022	0.978
Jiangxi	1.08	0.0019	1.020	1.20	0.0008	1.008
Jilin	1.19	–0.0033	0.967	1.28	–0.0028	0.972
Liaoning	1.04	0.0001	1.001	1.09	–0.0002	0.998
Ningxia	1.39	–0.0106	0.896	1.66	–0.0109	0.893
Qinghai	0.95	0.0052	1.055	1.00	0.0040	1.042
Shaanxi	1.05	0.0016	1.016	1.38	0.0005	1.005
Shandong	0.76	0.0328	1.404	0.81	0.0317	1.388
Shanghai	0.87	0.0030	1.031	0.90	0.0024	1.025
Shanxi	0.95	–0.0031	0.968	0.93	–0.0004	0.996
Sichuan	0.89	0.0012	1.012	0.94	0.0005	1.005
Tianjin	1.10	0.0005	1.005	1.06	0.0013	1.014
Tibet	0.98	0.0021	1.022	0.97	0.0018	1.019
Xinjiang	0.71	0.0111	1.121	0.79	0.0086	1.093
Yunnan	0.96	–0.0004	0.996	0.90	0.0010	1.011
Zhejiang	1.15	–0.0065	0.935	1.02	–0.0024	0.975
National	1.11	0.0012	.988	1.17	0.0013	.987

Table 3: *Net migration (immigrants minus emigrants) during the five years preceding the 1990 and 2000 censuses, by sex and province*

Province	Net migration, 1990 census	Net migration, 2000 census	Net migration 2000 as % of total enumerated census population
Anhui	–195,625	–5,430,526	9.2
Beijing	540,514	3,611,242	13.3
Fujian	12,657	1,519,389	4.5
Gansu	–81,519	–751,958	3.0
Guangdong	1,007,014	23,290,674	13.7
Guangxi	–446,384	–3,264,589	7.4
Guizhou	–122,378	–2,043,095	5.8
Hainan	44,124	185,432	2.5
Hebei	–125,317	–215,368	0.3
Heilongjiang	–240,057	–1,344,463	3.7
Henan	–111,793	–3,871,705	4.2
Hubei	84,847	–3,376,842	5.7
Hunan	–256,812	–6,102,274	9.6
Inner Mongolia	–48,823	–243,305	1.0
Jiangsu	170,632	1,404,989	1.9
Jiangxi	–68,907	–5,146,674	12.7
Jilin	–118,239	–579,684	2.2
Liaoning	246,379	789,368	1.9
Ningxia	35,303	87,158	1.6
Qinghai	13,678	–97,347	2.0
Shaanxi	–47,761	–623,853	1.8
Shandong	74,590	54,484	12.9
Shanghai	532,964	4,220,821	12.9
Shanxi	88,554	103,495	0.3
Sichuan	–846,173	–9,392,147	8.3
Tianjin	172,413	816,211	8.3
Tibet	–54,582	74,400	2.8
Xinjiang	64,306	1,948,211	10.6
Yunnan	–27,168	704,421	1.7
Zhejiang	–296,437	3,673,537	8.0

Sources: Population Census Office (1993), vol. 4, p. 152-331; Population Census Office (2002), vol. 7, p. 1813.

***Table 4**: Results of the application of GGB method to data from the 1990 and 2000 censuses of China, by province (adjusted for inter-province net migration with Bhat's method)*

	Males			Females		
Province	Slope	Intercept	Completeness	Slope	Intercept	Completeness
Anhui	1.08	0.0152	0.86	1.31	0.0053	0.95
Beijing	1.10	0.0072	0.93	1.10	0.0048	0.95
Fujian	1.00	0.0052	0.95	1.09	0.0061	0.94
Gansu	1.03	0.0098	0.91	1.02	0.0109	0.90
Guangdong	0.90	0.0056	0.95	1.08	0.0086	0.92
Guangxi	1.05	0.0037	0.96	1.11	0.0043	0.96
Guizhou	0.92	0.0023	0.98	0.94	0.0051	0.95
Hainan	1.03	0.0027	0.97	1.32	0.0056	0.95
Hebei	1.25	0.0121	0.89	1.33	0.0033	0.97
Heilongjiang	1.18	0.0060	0.94	1.22	0.0048	0.95
Henan	1.14	0.0081	0.92	1.27	0.0070	0.93
Hubei	1.29	0.0067	0.93	1.40	0.0068	0.93
Hunan	1.19	0.0111	0.89	1.26	0.0090	0.91
Inner Mongolia	1.11	0.0055	0.95	1.04	0.0067	0.93
Jiangsu	1.13	0.0037	0.96	1.27	0.0042	0.96
Jiangxi	1.13	0.0075	0.93	1.25	0.0066	0.94
Jilin	1.18	0.0045	0.96	1.18	0.0050	0.95
Liaoning	1.13	0.0014	0.99	1.14	0.0036	0.96
Ningxia	0.94	0.0265	0.77	0.88	0.0169	0.84
Qinghai	0.76	0.0079	0.92	0.83	0.0076	0.93
Shaanxi	1.12	0.0169	0.84	1.09	0.0125	0.88
Shandong	1.11	0.0038	0.96	1.19	0.0064	0.94
Shanghai	1.17	0.0116	0.89	1.15	0.0114	0.89
Shanxi	1.19	0.0121	0.89	1.27	0.0111	0.90
Sichuan	1.01	0.0031	1.03	1.08	0.0059	1.06
Tianjin	1.26	0.0071	0.93	1.26	0.0082	0.92
Tibet	0.97	0.0120	0.89	1.15	0.0129	0.88
Xinjiang	0.99	0.0164	0.85	0.89	0.0161	0.85
Yunnan	0.93	0.0158	0.85	0.89	0.0167	0.85
Zhejiang	1.07	0.0161	0.85	1.11	0.0153	0.86

***Table 5**: Results of the application of GGB method to data from the 1990 and 2000 censuses of China, by province (adjusted for inter-province net migration with Hill and Queiroz's method and Rogers-Castro age pattern of migration)*

	Males			Females		
Province	Slope	Intercept	Completeness	Slope	Intercept	Completeness
Anhui	1.04	0.0003	1.00	1.28	-0.0034	0.97
Beijing	1.08	0.0039	1.04	1.12	0.0032	1.03
Fujian	0.98	0.0013	1.01	1.02	0.0024	1.02
Gansu	1.02	0.0000	1.00	1.02	-0.0004	1.00
Guangdong	1.00	0.0052	1.05	1.05	0.0076	1.08
Guangxi	1.04	0.0010	1.01	1.13	-0.0005	1.00
Guizhou	1.00	-0.0040	0.96	1.02	-0.0035	0.97
Hainan	0.98	0.0047	1.05	1.09	0.0089	1.09
Hebei	1.06	0.0059	1.06	1.08	0.0063	1.07
Heilongjiang	1.23	-0.0036	0.96	1.30	-0.0030	0.97
Henan	1.17	-0.0022	0.98	1.37	-0.0056	0.95
Hubei	1.19	-0.0034	0.97	1.29	-0.0030	0.97
Hunan	1.10	-0.0025	0.98	1.19	-0.0037	0.96
Inner Mongolia	1.17	-0.0054	0.95	1.06	-0.0016	0.98
Jiangsu	1.04	0.0029	1.03	1.07	0.0038	1.04
Jiangxi	1.05	-0.0023	0.98	1.13	-0.0033	0.97
Jilin	1.27	-0.0107	0.90	1.26	-0.0076	0.93
Liaoning	1.04	0.0033	1.03	1.04	0.0035	1.04
Ningxia	0.93	0.0014	1.01	0.82	0.0046	1.05
Qinghai	0.74	0.0102	1.11	0.80	0.0082	1.09
Shaanxi	1.19	-0.0037	0.96	1.12	-0.0009	0.99
Shandong	1.02	0.0022	1.02	1.04	0.0029	1.03
Shanghai	1.11	0.0041	1.04	1.13	0.0031	1.03
Shanxi	1.05	0.0059	1.06	1.07	0.0069	1.07
Sichuan	0.99	0.0042	0.96	1.01	-0.0028	0.97
Tianjin	1.08	0.0066	1.07	1.09	0.0057	1.06
Tibet	0.98	0.0005	1.00	1.19	0.0000	1.00
Xinjiang	1.01	0.0001	1.00	0.94	0.0017	1.02
Yunnan	0.95	-0.0001	1.00	0.93	0.0024	1.02
Zhejiang	1.22	0.0034	1.03	1.27	0.0042	1.04

***Table 6**: Results of the application of GGB method to data from the 1990 and 2000 censuses of China, by province (adjusted for inter-province net migration with Hill and Queiroz's method and observed national age pattern of migration)*

	Males			Females		
Province	Slope	Intercept	Completeness	Slope	Intercept	Completeness
Anhui	1.05	-0.0033	0.97	1.27	-0.0057	0.94
Beijing	1.04	0.0180	1.20	1.13	0.0120	1.13
Fujian	0.98	0.0039	1.04	1.03	0.0044	1.04
Gansu	1.03	-0.0018	0.98	1.02	-0.0015	0.98
Guangdong	0.97	0.0168	1.18	1.05	0.0148	1.16
Guangxi	1.05	-0.0022	0.98	1.12	-0.0025	0.97
Guizhou	1.01	-0.0098	0.91	1.02	-0.0064	0.94
Hainan	0.97	0.0070	1.07	1.10	0.0124	1.13
Hebei	1.05	0.0131	1.14	1.10	0.0108	1.11
Heilongjiang	1.24	-0.0075	0.93	1.30	-0.0058	0.94
Henan	1.18	-0.0055	0.95	1.37	-0.0085	0.92
Hubei	1.19	-0.0034	0.97	1.29	-0.0031	0.97
Hunan	1.10	-0.0047	0.95	1.18	-0.0055	0.95
Inner Mongolia	1.17	-0.0084	0.92	1.05	-0.0025	0.98
Jiangsu	1.03	0.0072	1.07	1.07	0.0073	1.08
Jiangxi	1.06	-0.0056	0.95	1.13	-0.0049	0.95
Jilin	1.28	-0.0153	0.86	1.25	-0.0100	0.90
Liaoning	1.03	0.0078	1.08	1.05	0.0062	1.06
Ningxia	0.92	0.0029	1.03	0.83	0.0064	1.07
Qinghai	0.74	0.0104	1.11	0.81	0.0082	1.09
Shaanxi	1.19	-0.0072	0.93	1.11	-0.0021	0.98
Shandong	1.01	0.0057	1.06	1.05	0.0055	1.06
Shanghai	1.06	0.0207	1.23	1.14	0.0132	1.14
Shanxi	1.04	0.0120	1.13	1.08	0.0110	1.12
Sichuan	1.00	-0.0088	0.92	1.01	-0.0045	0.96
Tianjin	1.05	0.0165	1.18	1.10	0.0116	1.12
Tibet	0.98	0.0005	1.00	1.19	0.0000	1.00
Xinjiang	1.00	0.0051	1.05	0.94	0.0037	1.04
Yunnan	0.95	0.0022	1.02	0.93	0.0037	1.04
Zhejiang	1.22	0.0090	1.09	1.27	0.0075	1.08

***Table 7**: Infant mortality rates, by sex and province: Mainland China, 1981, 1990 and 2000[*]*

	1981 [a]		1990 [b]		2000*	
Province	Males	Females	Males	Females	Males	Females
Anhui	*33.7*	*35.3*	*26.6*	*29.7*	21.7	33.9
Beijing	*17.5*	*15.2*	*12.2*	*10.7*	3.6	3.7
Chongqing	---	---	---	---	20.6	20.8
Fujian	*27.1*	*26.8*	*23.5*	*27.9*	14.5	21.4
Gansu	*46.7*	*42.5*	*32.2*	*32.3*	35.2	47.9
Guangdong	*26.8*	*26.1*	*17.0*	*17.8*	11.1	18.6
Guangxi	*44.5*	*44.8*	*33.1*	*55.4*	17.8	31.8
Guizhou	*99.1*	*97.9*	*63.0*	*59.1*	50.7	63.8
Hainan	---	---	*37.7*	*36.1*	12.7	23.7
Hebei	*25.2*	*21.6*	*17.4*	*15.4*	15.0	20.6
Heilongjiang	*39.4*	*31.4*	*34.2*	*27.2*	9.5	8.5
Henan	*24.0*	*23.8*	*19.0*	*22.2*	15.7	24.8
Hubei	*45.0*	*39.2*	*31.5*	*30.2*	14.8	19.3
Hunan	*58.9*	*54.0*	*43.8*	*44.2*	19.9	27.2
Inner Mongolia	*46.8*	*41.0*	*39.7*	*37.2*	26.7	30.0
Jiangsu	*38.7*	*39.8*	*21.2*	*22.4*	10.9	12.9
Jiangxi	*55.3*	*58.2*	*42.2*	*52.2*	25.9	60.2
Jilin	*23.1*	*20.3*	*26.2*	*23.3*	15.6	16.0
Liaoning	*25.5*	*22.0*	*21.4*	*18.8*	9.4	9.8
Ningxia	*77.6*	*64.6*	*52.6*	*42.1*	22.8	22.1
Qinghai	*101.7*	*88.9*	*91.0*	*76.7*	37.5	40.0
Shaanxi	*50.8*	*48.8*	*31.7*	*30.8*	23.2	35.2
Shangdong	*23.0*	*21.7*	*16.1*	*17.6*	12.7	15.7
Shanghai	*25.5*	*19.3*	*15.1*	*12.2*	4.1	4.4
Shanxi	*34.3*	*33.5*	*24.8*	*23.9*	15.2	18.0
Sichuan	*69.2*	*69.2*	*45.5*	*47.4*	19.4	20.3
Tianjin	*22.0*	*18.9*	*15.1*	*13.6*	4.0	4.0
Tibet	---	---	*102.6*	*84.0*	37.8	36.7
Xinjiang	*155.4*	*137*	*100.2*	*84.6*	28.2	25.0
Yunnan	*106.9*	*96.4*	*74.6*	*66.1*	52.2	66.7
Zhejiang	*37.2*	*41.8*	*22.2*	*25.7*	10.1	11.8
National	***45.3***	***43.3***	***32.4***	***33.5***	**20.5**	**28.4**

***** Refers to the period between November 1, 1999 and October 30, 2000.

Note. Figures in *italics* are adjusted infant mortality rates.

Sources: [a] Hao, Arriaga and Banister (1988), Table 1, p.4; [b] Zhang and Li (1997), Table 1, p.1331.

***Table 8**: Comparison between observed and estimated (according to Johnson technique) infant mortality rates, by sex and province, 2000*[*]

	Observed (O)		Estimated (E)		Difference (O–E)	
Province	Males	Females	Males	Females	Males	Females
Anhui	21.7	33.9	23.2	39.3	-1.5	-5.4
Beijing	3.6	3.7	3.0	2.8	0.6	0.9
Chongqing	20.6	20.8	20.6	20.7	0.0	0.1
Fujian	14.5	21.4	14.6	22.6	-0.1	-1.2
Gansu	35.2	47.9	39.3	58.5	-4.1	-10.6
Guangdong	11.1	18.6	11.1	19.6	0.0	-1.0
Guangxi	17.8	31.8	18.3	35.8	-0.5	-4.0
Guizhou	50.7	63.8	59.5	86.2	-8.8	-22.4
Hainan	12.7	23.7	13.0	25.7	-0.3	-2.0
Hebei	15.0	20.6	15.8	22.6	-0.8	-2.0
Heilongjiang	9.5	8.5	9.8	8.7	-0.3	-0.2
Henan	15.7	24.8	16.4	27.7	-0.7	-2.9
Hubei	14.8	19.3	14.8	20.0	0.0	-0.7
Hunan	19.9	27.2	20.6	29.7	-0.7	-2.5
Inner Mongolia	26.7	30.0	29.0	34.0	-2.3	-4.0
Jiangsu	10.9	12.9	11.0	13.2	-0.1	-0.3
Jiangxi	25.9	60.2	28.2	83.7	-2.3	-23.5
Jilin	15.6	16.0	16.7	17.4	-1.1	-1.4
Liaoning	9.4	9.8	9.3	10.0	0.1	-0.2
Ningxia	22.8	22.1	24.5	23.7	-1.7	-1.6
Qinghai	37.5	40.0	42.4	46.5	-4.9	-6.5
Shaanxi	23.2	35.2	25.1	41.4	-1.9	-6.2
Shangdong	12.7	15.7	12.9	16.4	-0.2	-0.7
Shanghai	4.1	4.4	3.6	3.6	0.5	0.8
Shanxi	15.2	18.0	16.0	19.5	-0.8	-1.5
Sichuan	19.4	20.3	19.2	20.4	0.2	-0.1
Tianjin	4.0	4.0	3.9	3.9	0.1	0.1
Tibet	37.8	36.7	39.1	37.5	-1.3	-0.8
Xinjiang	28.2	25.0	29.4	25.7	-1.2	-0.7
Yunnan	52.2	66.7	64.4	97.4	-12.2	-30.7
Zhejiang	10.1	11.8	9.9	11.9	0.2	-0.1
National	**20.5**	**28.4**	**21.4**	**31.4**	**-0.9**	**-3.0**

* Refers to the period between November 1, 1999 and October 30, 2000.

***Table 9**: Adjusted life tables, by province: Selected indicators, 1990-2000*

Province	Males			Females		
	$_5q_0$	$_{45}q_{15}$	e_0	$_5q_0$	$_{45}q_{15}$	e_0
Anhui	0.03044	0.16409	69.53	0.04719	0.13914	70.75
Beijing	0.02437	0.12722	73.03	0.02851	0.08650	75.38
Fujian	0.02315	0.16422	70.76	0.02998	0.11062	74.92
Gansu	0.03676	0.17240	67.88	0.04597	0.12290	69.85
Guangdong	0.01970	0.14923	72.40	0.02692	0.10189	76.69
Guangxi	0.02739	0.18793	70.04	0.04213	0.12899	72.81
Guizhou	0.05083	0.21650	65.87	0.06374	0.15166	68.24
Hainan	0.02135	0.14973	72.29	0.03194	0.10775	76.43
Hebei	0.02481	0.17079	69.95	0.02977	0.11073	73.46
Heilongjiang	0.02932	0.20781	67.40	0.02828	0.12886	70.83
Henai	0.02937	0.20138	67.90	0.04543	0.15474	69.79
Hubei	0.03178	0.21155	66.70	0.03891	0.15909	69.42
Hunan	0.03563	0.19593	67.73	0.04418	0.14681	70.15
Inner Mongolia	0.03851	0.21050	66.44	0.03490	0.11425	71.10
Jiangsu	0.02635	0.15132	71.47	0.03132	0.10201	75.55
Jiangxi	0.03489	0.19652	67.69	0.06537	0.14689	68.62
Jilin	0.03725	0.23044	66.14	0.03546	0.13392	70.24
Liaoning	0.02872	0.16414	70.77	0.03003	0.10003	74.11
Ningxia	0.02771	0.16375	69.74	0.02722	0.10484	72.30
Qinghai	0.03172	0.15039	69.33	0.03667	0.11612	71.09
Shaanxi	0.03460	0.21354	66.62	0.03917	0.13100	70.51
Shandong	0.02518	0.16749	70.56	0.03072	0.10849	74.42
Shanghai	0.03252	0.12480	73.40	0.03950	0.09413	75.95
Shanxi	0.02768	0.17703	69.08	0.03053	0.11861	72.25
Sichuan*	0.03053	0.17635	69.70	0.03288	0.12084	73.34
Tianjin	0.02446	0.14165	72.02	0.02787	0.09564	74.44
Tibet	0.04781	0.27620	63.34	0.06025	0.25569	63.77
Xinjiang	0.03621	0.19191	69.27	0.03173	0.12671	71.77
Yunnan	0.05081	0.20863	66.10	0.06092	0.14480	69.02
Zhejiang	0.03629	0.18717	68.71	0.04038	0.11990	72.71

* Includes Chongqing province.

***Table 10**: Adjusted life tables, by province: Selected indicators, 1999-2000*

Province	Males			Females		
	$_5q_0$	$_{45}q_{15}$	e_0	$_5q_0$	$_{45}q_{15}$	e_0
Anhui	0.02885	0.15349	71.19	0.05011	0.11678	72.09
Beijing	0.00521	0.11363	75.08	0.00579	0.06978	77.91
Fujian	0.01847	0.15036	72.73	0.02738	0.08531	76.92
Gansu	0.04280	0.17039	68.54	0.05770	0.12163	70.38
Guangdong	0.01350	0.14258	73.38	0.02092	0.07999	77.65
Guangxi	0.02548	0.18467	71.07	0.04391	0.10065	75.02
Guizhou	0.06623	0.21477	65.75	0.08507	0.13264	68.92
Hainan	0.01716	0.13773	74.37	0.03148	0.08690	77.54
Hebei	0.01839	0.15612	70.59	0.02583	0.09540	73.99
Heilongjiang	0.01362	0.19966	70.09	0.01271	0.12490	73.99
Henai	0.02407	0.17732	69.40	0.04444	0.12700	71.01
Hubei	0.02283	0.17792	69.14	0.02992	0.12983	71.92
Hunan	0.03050	0.16741	70.02	0.04085	0.11924	72.66
Inner Mongolia	0.03367	0.20171	67.66	0.03370	0.10880	72.69
Jiangsu	0.01482	0.13328	73.50	0.01749	0.08186	77.53
Jiangxi	0.03554	0.17001	69.24	0.08629	0.11106	69.38
Jilin	0.02449	0.20402	68.73	0.02422	0.12124	72.95
Liaoning	0.01368	0.14722	72.64	0.01440	0.08645	76.28
Ningxia	0.02903	0.14639	71.14	0.02832	0.09455	74.29
Qinghai	0.03545	0.14856	73.60	0.04038	0.11067	74.95
Shaanxi	0.03070	0.18719	68.21	0.04179	0.11995	71.76
Shandong	0.01654	0.15010	72.01	0.02055	0.08615	76.23
Shanghai	0.00615	0.08498	76.90	0.00613	0.05676	79.99
Shanxi	0.01924	0.15719	70.53	0.02296	0.10161	73.79
Sichuan*	0.02682	0.17312	70.62	0.02709	0.11348	74.67
Tianjin	0.00585	0.11370	74.18	0.00562	0.07306	77.12
Tibet	0.05586	0.26005	65.45	0.06607	0.26664	64.96
Xinjiang	0.04031	0.16916	71.79	0.03390	0.11860	76.48
Yunnan	0.06454	0.19420	66.51	0.07859	0.12537	69.72
Zhejiang	0.01831	0.16800	70.85	0.01975	0.09402	75.30

* Includes Chongqing province.

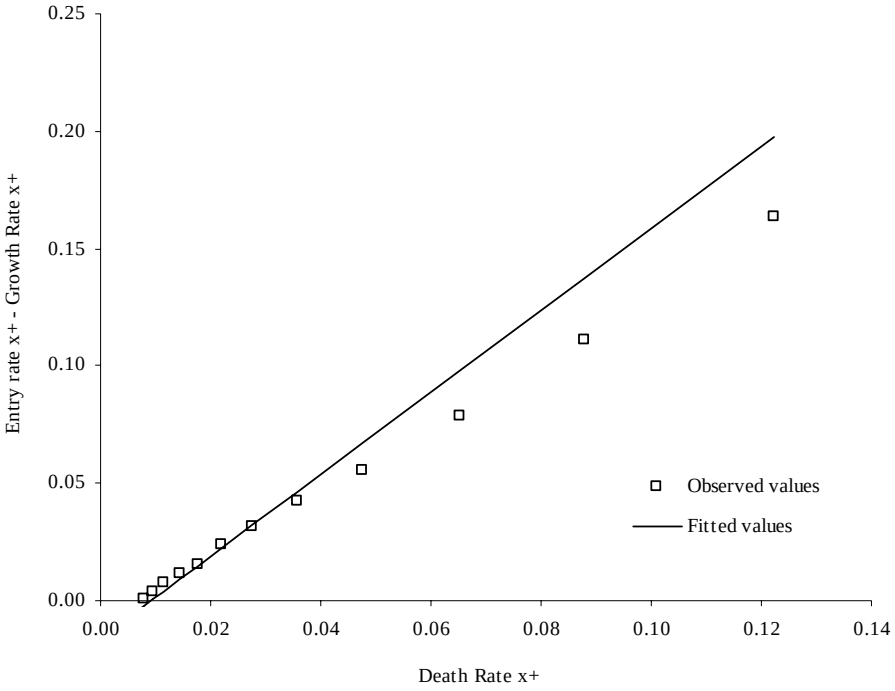
***Table 11**: Trends in life expectancy at birth, by sex and province, 1973-90*

	1973-75 [a]		1981 [b]		1990 [c]	
Province	Males	Females	Males	Females	Males	Females
Anhui	64.50	66.88	67.3	70.7	67.75	71.36
Beijing	68.34	70.77	70.5	73.5	71.07	74.93
Fujian	65.23	69.37	66.1	70.5	66.49	70.93
Gansu	—	—	64.8	66.3	66.35	68.25
Guangdong	—	—	68.1	73.4	69.71	75.43
Guangxi	—	—	67.4	70.8	67.17	70.34
Guizhou	59.03	59.48	59.6	59.7	63.04	65.63
Hainan	—	—	—	—	66.93	73.28
Hebei	67.11	70.17	69.0	71.9	68.47	72.53
Heilongjiang	69.25	71.53	67.4	69.3	65.50	68.73
Henan	65.06	68.82	67.7	71.4	67.96	72.55
Hubei	—	—	63.8	67.2	65.51	69.23
Hunan	61.39	63.63	63.9	66.5	65.41	68.70
Inner Mongolia	65.25	67.31	65.8	67.7	64.47	67.22
Jiangsu	65.10	69.34	67.0	71.3	69.26	73.57
Jiangxi	62.06	64.34	64.1	66.6	64.87	67.49
Jilin	65.00	66.73	68.2	69.7	66.65	69.49
Liaoning	68.64	70.78	69.6	71.9	68.72	71.94
Ningxia	61.86	62.66	64.0	65.8	65.95	68.05
Qinghai	60.55	62.04	59.7	61.5	59.29	61.96
Shaanxi	63.96	65.18	64.1	65.7	66.23	68.79
Shangdong	—	—	68.5	71.6	68.64	72.67
Shanghai	69.24	74.84	70.3	75.1	72.77	77.02
Shanxi	65.33	68.00	66.5	68.8	67.33	70.93
Sichuan	59.16	61.08	62.3	64.3	65.06	67.70
Tianjin	69.23	71.96	69.8	72.0	71.03	73.73
Tibet	59.47	63.22	—	—	57.64	61.57
Xinjiang	61.77	63.29	57.2	58.1	61.95	63.26
Yunnan	59.80	61.35	58.8	60.3	62.08	64.98
Zhejiang	66.44	70.52	67.6	71.2	69.66	74.24
National	63.62	66.31	65.8	68.7	66.84	70.47

Sources: [a] Banister (1987), Table 4.9, p. 95. [b] Hao, Arriaga and Banister (1988), Table 2, p.6. [c] Zhang and Li (1997), Table 1, p.1331.

***Figure 1**: Results of the application of GGB method to data from the 1990 and 2000 censuses of China by province: Beijing*

(a) Males



(b) Females

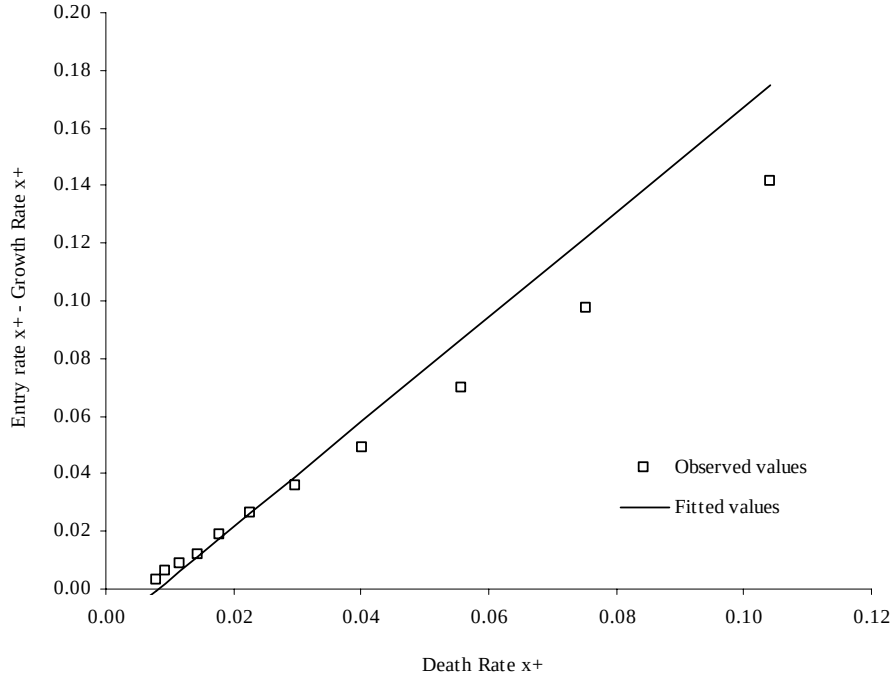


***Figure 2**: Correlation between GGB estimate and absolute number of migrants*

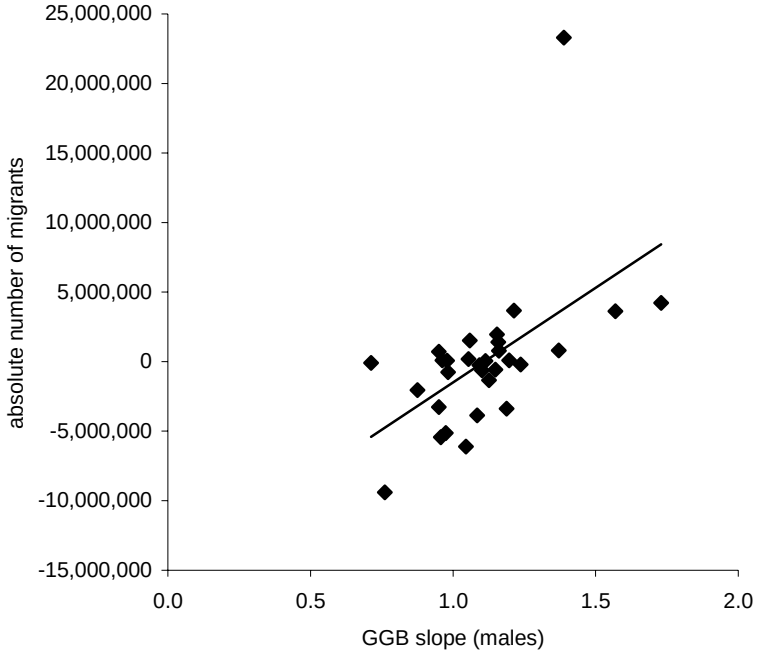


***Figure 3a**: Correlation between GGB estimate and proportion of net emigrants in the total population (corr = –.576)*

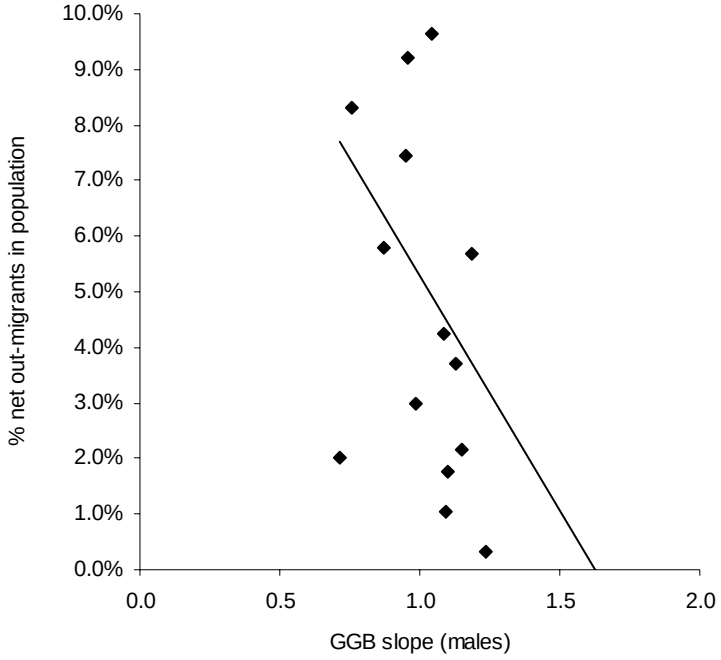


***Figure 3b**: Correlation between GGB estimate and proportion of net immigrants in the total population (corr = .706)*

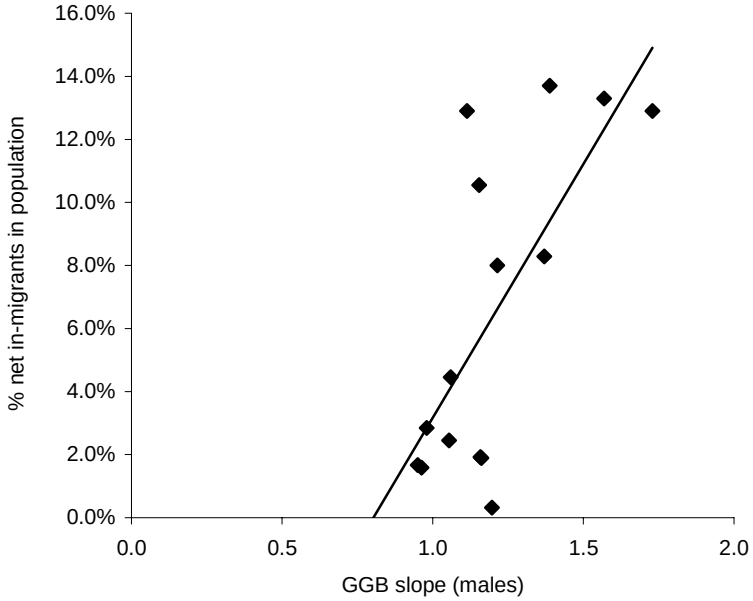


Figure 4 *: Comparison of GGB unadjusted method, Bhat's adjustment, and Hill-Queiroz's adjustment with national age pattern of migration, by province*

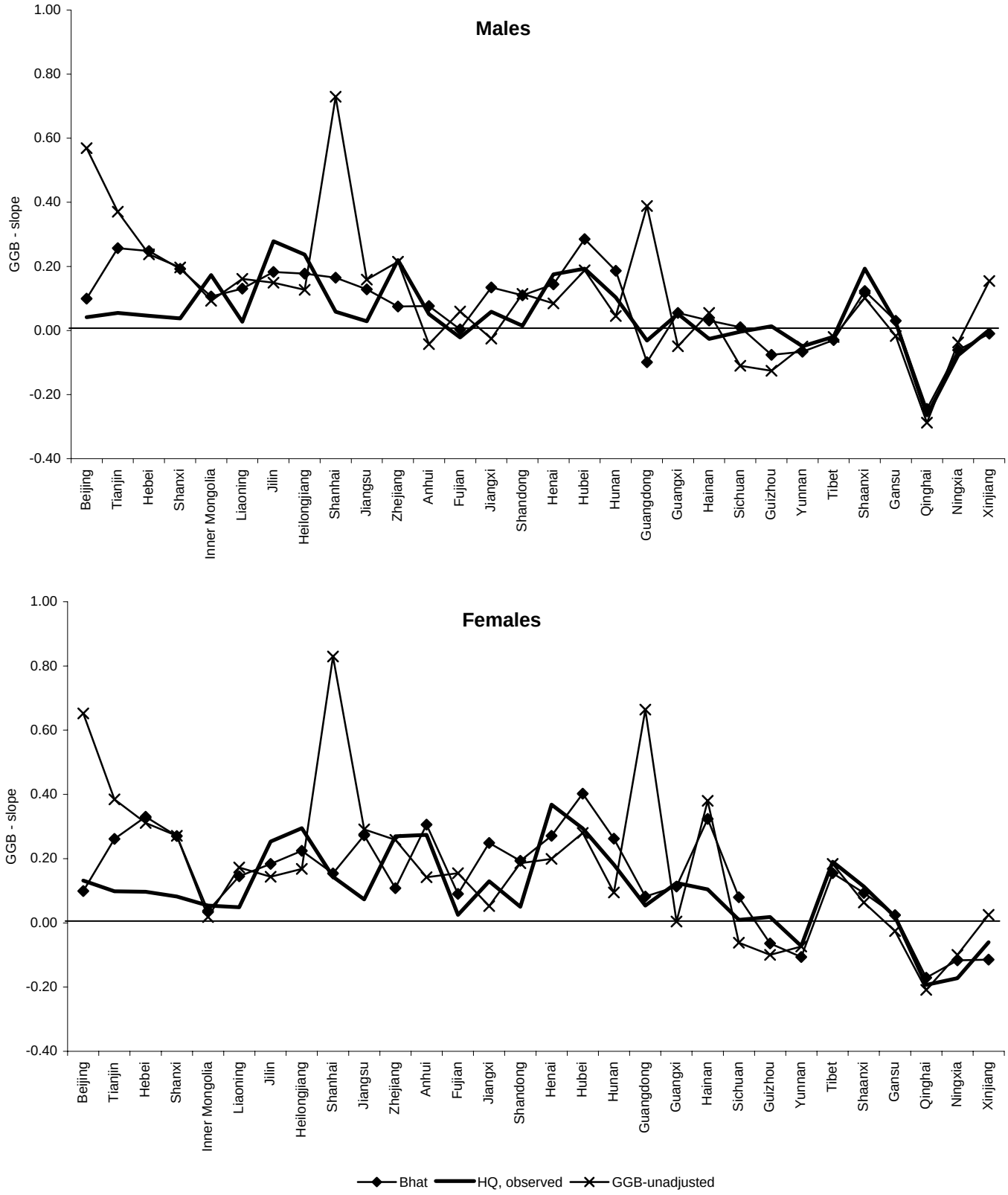
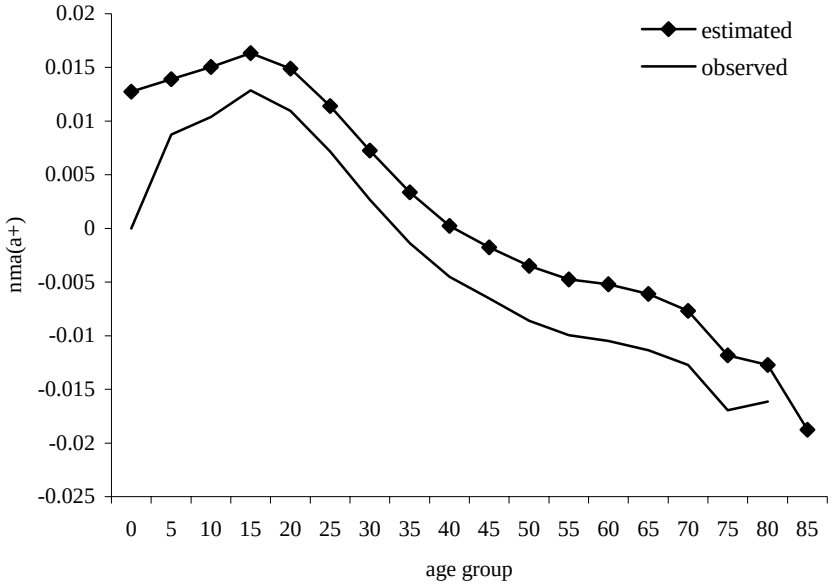


***Figure 5**: Comparison of nma(a+) between Bhat's method (observed) and Hill-Queiroz's method with national age pattern of migration (estimated): Beijing municipality*



Appendix

Table A1: *Unadjusted mortality data for China: Summary mortality indicators, by province, 1990-2000*

Province	Males			Females		
	$_5q_0$	$_{45}q_{15}$	e_0	$_5q_0$	$_{45}q_{15}$	e_0
Anhui	0.02901	0.15628	70.16	0.03738	0.10952	74.21
Beijing	0.02343	0.12226	73.57	0.02527	0.07652	77.04
Fujian	0.02365	0.16778	70.48	0.02926	0.10793	75.28
Gansu	0.03587	0.16818	68.20	0.04516	0.12066	70.08
Guangdong	0.02033	0.15395	71.98	0.02559	0.09677	77.48
Guangxi	0.02607	0.17882	70.79	0.03762	0.11488	74.66
Guizhou	0.05020	0.21374	66.06	0.06265	0.14894	68.53
Hainan	0.02191	0.15365	71.92	0.02901	0.09769	78.07
Hebei	0.02375	0.16344	70.54	0.02721	0.10108	74.66
Heilongjiang	0.02382	0.16877	70.14	0.02196	0.09983	73.80
Henai	0.02509	0.17183	70.04	0.03357	0.11357	74.27
Hubei	0.02677	0.17800	68.91	0.03031	0.12341	72.79
Hunan	0.03238	0.17788	69.08	0.03762	0.12452	72.49
Inner Mongolia	0.03299	0.17999	68.49	0.03316	0.10846	71.70
Jiangsu	0.02564	0.14721	71.85	0.02924	0.09512	76.57
Jiangxi	0.03303	0.18591	68.44	0.05828	0.13031	70.42
Jilin	0.02936	0.18127	69.52	0.02847	0.10715	73.01
Liaoning	0.02798	0.15986	71.15	0.02868	0.09544	74.73
Ningxia	0.02771	0.16375	69.74	0.02722	0.10484	72.30
Qinghai	0.04269	0.20341	65.48	0.04511	0.14355	68.45
Shaanxi	0.02915	0.17965	68.90	0.03532	0.11789	71.84
Shandong	0.02482	0.16507	70.76	0.02928	0.10333	75.10
Shanghai	0.03076	0.11796	74.22	0.03470	0.08241	78.00
Shanxi	0.02670	0.17068	69.55	0.02827	0.10972	73.20
Sichuan*	0.03053	0.17635	69.70	0.03256	0.11966	73.48
Tianjin	0.02321	0.13438	72.75	0.02543	0.08713	75.67
Tibet	0.04870	0.28146	63.06	0.05106	0.21561	66.45
Xinjiang	0.03614	0.19153	69.30	0.03371	0.13477	70.91
Yunnan	0.05332	0.21923	65.36	0.06541	0.15597	67.90
Zhejiang	0.02993	0.15397	71.51	0.03205	0.09466	76.08

* Includes Chongqing province.

Table A2: *Unadjusted mortality data for China: Summary mortality indicators, by province, 1999-2000*

Province	Males			Females		
	$_5q_0$	$_{45}q_{15}$	e_0	$_5q_0$	$_{45}q_{15}$	e_0
Anhui	0.02749	0.14619	71.89	0.03971	0.09188	75.65
Beijing	0.00501	0.10919	75.54	0.00512	0.06172	79.22
Fujian	0.01887	0.15362	72.44	0.02672	0.08322	77.26
Gansu	0.04178	0.16622	68.91	0.05669	0.11943	70.65
Guangdong	0.01393	0.14710	72.98	0.01988	0.07597	78.31
Guangxi	0.02425	0.17571	71.82	0.03922	0.08961	76.83
Guizhou	0.06542	0.21202	65.97	0.08363	0.13025	69.25
Hainan	0.01761	0.14134	74.00	0.02859	0.07878	79.03
Hebei	0.01760	0.14939	71.12	0.02361	0.08708	75.11
Heilongjiang	0.01104	0.16212	72.92	0.00984	0.09677	77.28
Henai	0.02054	0.15124	71.51	0.03283	0.09315	75.39
Hubei	0.01920	0.14962	71.40	0.02327	0.10065	75.34
Hunan	0.02771	0.15194	71.39	0.03477	0.10110	75.07
Inner Mongolia	0.02882	0.17246	69.73	0.03202	0.10329	73.36
Jiangsu	0.01442	0.12965	73.84	0.01632	0.07633	78.38
Jiangxi	0.03364	0.16080	70.03	0.07709	0.09848	71.40
Jilin	0.01925	0.16038	72.06	0.01941	0.09699	75.92
Liaoning	0.01332	0.14337	72.97	0.01374	0.08248	76.83
Ningxia	0.02903	0.14639	71.14	0.02832	0.09455	74.29
Qinghai	0.04766	0.20100	68.15	0.04962	0.13683	71.38
Shaanxi	0.02585	0.15738	70.55	0.03769	0.10793	73.23
Shandong	0.01630	0.14793	72.19	0.01958	0.08205	76.83
Shanghai	0.00581	0.08031	77.51	0.00536	0.04968	81.39
Shanxi	0.01855	0.15153	70.98	0.02125	0.09399	74.72
Sichuan*	0.02682	0.17312	70.62	0.02683	0.11237	74.81
Tianjin	0.00555	0.10786	74.78	0.00512	0.06655	78.13
Tibet	0.05690	0.26501	65.10	0.05603	0.22485	68.40
Xinjiang	0.04024	0.16883	71.83	0.03602	0.12615	75.34
Yunnan	0.06769	0.20410	65.68	0.08428	0.13506	68.45
Zhejiang	0.01506	0.13816	73.29	0.01562	0.07420	77.99

* Includes Chongqing province.

Table A3: *Unadjusted mortality data for China: Age-specific central death rates (m_x), by province, 1990-2000*[1], *Males*

Province	0-4	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85+
Beijing	0.00479	0.00061	0.00064	0.00084	0.00098	0.00089	0.00112	0.00156	0.00245	0.00368	0.00515	0.00808	0.01419	0.02471	0.04222	0.06455	0.10287	0.15673
Tianjin	0.00474	0.00063	0.00054	0.00090	0.00120	0.00101	0.00111	0.00153	0.00234	0.00383	0.00599	0.00935	0.01606	0.02809	0.04607	0.06748	0.10723	0.15699
Hebei	0.00485	0.00063	0.00058	0.00096	0.00131	0.00132	0.00149	0.00191	0.00278	0.00460	0.00720	0.01167	0.01999	0.03307	0.05498	0.07931	0.12848	0.20140
Shanxi	0.00547	0.00065	0.00055	0.00097	0.00139	0.00137	0.00162	0.00214	0.00309	0.00485	0.00746	0.01184	0.02116	0.03421	0.05756	0.08714	0.14925	0.25745
Inner Mongolia	0.00680	0.00056	0.00048	0.00088	0.00129	0.00127	0.00160	0.00222	0.00341	0.00520	0.00772	0.01309	0.02288	0.03648	0.06248	0.09712	0.16738	0.27385
Liaoning	0.00574	0.00072	0.00055	0.00094	0.00126	0.00116	0.00142	0.00194	0.00304	0.00445	0.00698	0.01130	0.01807	0.03040	0.05042	0.07266	0.10882	0.16269
Jilin	0.00603	0.00067	0.00051	0.00087	0.00116	0.00117	0.00153	0.00211	0.00328	0.00520	0.00786	0.01381	0.02229	0.03564	0.05986	0.08376	0.12603	0.17391
Heilongjiang	0.00487	0.00056	0.00045	0.00079	0.00110	0.00107	0.00140	0.00196	0.00309	0.00488	0.00748	0.01262	0.02094	0.03569	0.06039	0.08754	0.13667	0.19135
Shanhai	0.00633	0.00070	0.00067	0.00119	0.00124	0.00086	0.00084	0.00133	0.00212	0.00348	0.00548	0.00732	0.01248	0.02046	0.03460	0.05503	0.08718	0.14860
Jiangsu	0.00525	0.00073	0.00053	0.00087	0.00105	0.00112	0.00143	0.00173	0.00273	0.00396	0.00650	0.01050	0.01730	0.02735	0.04629	0.07418	0.11283	0.17459
Zhejiang	0.00615	0.00076	0.00056	0.00096	0.00125	0.00120	0.00153	0.00194	0.00290	0.00460	0.00678	0.01010	0.01679	0.02652	0.04542	0.06957	0.10977	0.16989
Anhui	0.00595	0.00070	0.00047	0.00077	0.00114	0.00130	0.00194	0.00198	0.00297	0.00405	0.00670	0.01089	0.01813	0.03023	0.05418	0.09309	0.16007	0.20822
Fujian	0.00483	0.00058	0.00050	0.00081	0.00120	0.00125	0.00157	0.00210	0.00332	0.00480	0.00735	0.01174	0.01902	0.03229	0.05333	0.08351	0.13753	0.20908
Jiangxi	0.00680	0.00085	0.00051	0.00087	0.00135	0.00146	0.00189	0.00245	0.00346	0.00517	0.00777	0.01347	0.02212	0.03502	0.05933	0.09452	0.16204	0.26506
Shandong	0.00507	0.00070	0.00054	0.00091	0.00139	0.00134	0.00158	0.00197	0.00302	0.00459	0.00729	0.01148	0.01919	0.03122	0.05053	0.07844	0.12139	0.18870
Henai	0.00513	0.00070	0.00052	0.00089	0.00129	0.00138	0.00175	0.00205	0.00308	0.00469	0.00774	0.01211	0.02039	0.03328	0.05522	0.08865	0.13166	0.20199
Hubei	0.00548	0.00081	0.00063	0.00095	0.00127	0.00134	0.00171	0.00225	0.00318	0.00474	0.00791	0.01291	0.02273	0.03448	0.06128	0.09573	0.17868	0.27656
Hunan	0.00667	0.00089	0.00066	0.00097	0.00137	0.00150	0.00199	0.00237	0.00345	0.00502	0.00729	0.01224	0.02070	0.03379	0.05638	0.08534	0.14250	0.21100
Guangdong	0.00414	0.00058	0.00050	0.00079	0.00108	0.00111	0.00145	0.00195	0.00299	0.00446	0.00665	0.01079	0.01771	0.02964	0.04867	0.07238	0.11428	0.16788
Guangxi	0.00534	0.00065	0.00047	0.00086	0.00139	0.00150	0.00199	0.00252	0.00367	0.00501	0.00747	0.01196	0.01971	0.03214	0.04948	0.07133	0.10309	0.15010
Hainan	0.00447	0.00058	0.00046	0.00079	0.00119	0.00117	0.00150	0.00199	0.00292	0.00456	0.00626	0.01083	0.01817	0.03020	0.05004	0.07544	0.11164	0.14334
Sichuan[2]	0.00628	0.00104	0.00073	0.00102	0.00163	0.00175	0.00209	0.00239	0.00370	0.00466	0.00712	0.01148	0.01886	0.03172	0.05133	0.07842	0.12899	0.18140
Guizhou	0.01051	0.00102	0.00069	0.00127	0.00207	0.00221	0.00279	0.00320	0.00427	0.00541	0.00845	0.01391	0.02405	0.04127	0.06107	0.08979	0.14370	0.22358
Yunnan	0.01119	0.00107	0.00073	0.00134	0.00196	0.00199	0.00259	0.00317	0.00436	0.00589	0.00900	0.01445	0.02442	0.04074	0.06594	0.10060	0.16719	0.28199
Tibet	0.01018	0.00115	0.00100	0.00161	0.00220	0.00221	0.00292	0.00396	0.00538	0.00744	0.01204	0.02015	0.03232	0.05207	0.08629	0.12626	0.21134	0.27352
Shaanxi	0.00598	0.00073	0.00064	0.00103	0.00153	0.00159	0.00184	0.00235	0.00331	0.00467	0.00751	0.01276	0.02260	0.03376	0.05618	0.08980	0.16186	0.28346
Gansu	0.00741	0.00070	0.00058	0.00089	0.00129	0.00146	0.00188	0.00225	0.00305	0.00413	0.00706	0.01221	0.02381	0.03715	0.06279	0.10127	0.18259	0.31000
Qinghai	0.00887	0.00086	0.00066	0.00115	0.00157	0.00160	0.00228	0.00281	0.00393	0.00551	0.00836	0.01429	0.02750	0.04872	0.08187	0.13729	0.24137	0.36288
Ningxia	0.00568	0.00075	0.00048	0.00104	0.00137	0.00135	0.00173	0.00211	0.00315	0.00416	0.00662	0.01176	0.02170	0.03520	0.05568	0.08671	0.14589	0.20639
Xinjiang	0.00747	0.00079	0.00060	0.00100	0.00149	0.00153	0.00189	0.00273	0.00363	0.00504	0.00755	0.01421	0.02140	0.03687	0.05822	0.08872	0.10905	0.10379

Notes: [1]Calculated as average of age-specific central death rates for 1989-1990 and 1999-2000. [2] Calculated as average of age-specific death rates for Sichuan and Chongqing province.
Sources: *1990 census*: Population Census Office (1993), vol. 2, pp.2-5; vol. 1, pp.69-72. *2000 census*: Population Census Office (2002), vol. 1, pp.134-144; vol.6, pp.661-671.

Table A3 (cont.): *Unadjusted mortality data for China: Age-specific central death rates (m_x), by province, 1990-2000*[1], *Females*

Province	0-4	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85+
Beijing	0.00517	0.00041	0.00046	0.00069	0.00083	0.00064	0.00067	0.00093	0.00143	0.00218	0.00303	0.00500	0.00945	0.01690	0.03188	0.05033	0.08254	0.13994
Tianjin	0.00520	0.00044	0.00040	0.00072	0.00091	0.00068	0.00068	0.00097	0.00141	0.00234	0.00384	0.00604	0.01109	0.02006	0.03611	0.05634	0.09422	0.15364
Hebei	0.00558	0.00039	0.00035	0.00063	0.00085	0.00085	0.00092	0.00112	0.00163	0.00280	0.00451	0.00712	0.01251	0.02108	0.03782	0.05850	0.09880	0.16990
Shanxi	0.00580	0.00043	0.00036	0.00062	0.00088	0.00082	0.00096	0.00123	0.00188	0.00312	0.00501	0.00767	0.01378	0.02285	0.04079	0.06637	0.12175	0.24320
Inner Mongolia	0.00683	0.00036	0.00031	0.00054	0.00083	0.00075	0.00085	0.00118	0.00187	0.00295	0.00472	0.00826	0.01529	0.02610	0.05044	0.08459	0.15815	0.32146
Liaoning	0.00589	0.00047	0.00036	0.00068	0.00085	0.00073	0.00080	0.00107	0.00164	0.00259	0.00416	0.00676	0.01158	0.02099	0.03890	0.06016	0.09700	0.16560
Jilin	0.00584	0.00043	0.00032	0.00064	0.00080	0.00074	0.00088	0.00117	0.00176	0.00286	0.00477	0.00805	0.01415	0.02539	0.04625	0.07091	0.12161	0.21499
Heilongjiang	0.00448	0.00036	0.00028	0.00050	0.00071	0.00066	0.00078	0.00105	0.00164	0.00266	0.00440	0.00778	0.01365	0.02464	0.04582	0.07028	0.12504	0.22464
Shanhai	0.00716	0.00053	0.00052	0.00106	0.00119	0.00072	0.00062	0.00092	0.00145	0.00239	0.00364	0.00459	0.00775	0.01264	0.02322	0.03872	0.06565	0.12058
Jiangsu	0.00600	0.00053	0.00038	0.00069	0.00078	0.00084	0.00099	0.00113	0.00171	0.00256	0.00414	0.00637	0.01036	0.01633	0.02822	0.04754	0.07738	0.13428
Zhejiang	0.00660	0.00051	0.00038	0.00066	0.00084	0.00077	0.00092	0.00114	0.00166	0.00278	0.00421	0.00611	0.01025	0.01653	0.02941	0.04776	0.08116	0.14293
Anhui	0.00773	0.00050	0.00035	0.00062	0.00092	0.00100	0.00145	0.00135	0.00203	0.00283	0.00470	0.00723	0.01158	0.01837	0.03290	0.05697	0.09857	0.14974
Fujian	0.00601	0.00042	0.00034	0.00062	0.00089	0.00091	0.00106	0.00134	0.00205	0.00316	0.00462	0.00716	0.01147	0.01938	0.03272	0.05079	0.08658	0.14725
Jiangxi	0.01229	0.00063	0.00042	0.00072	0.00108	0.00117	0.00133	0.00162	0.00231	0.00360	0.00543	0.00914	0.01499	0.02318	0.04055	0.06554	0.11450	0.20577
Shandong	0.00601	0.00048	0.00039	0.00067	0.00094	0.00091	0.00106	0.00124	0.00182	0.00287	0.00457	0.00680	0.01151	0.01933	0.03336	0.05454	0.08969	0.15330
Henai	0.00692	0.00048	0.00036	0.00063	0.00091	0.00099	0.00119	0.00132	0.00200	0.00318	0.00512	0.00762	0.01296	0.02042	0.03497	0.05785	0.08901	0.14639
Hubei	0.00623	0.00055	0.00044	0.00075	0.00100	0.00105	0.00124	0.00152	0.00214	0.00327	0.00548	0.00853	0.01487	0.02227	0.04034	0.06342	0.12132	0.19888
Hunan	0.00778	0.00062	0.00049	0.00076	0.00106	0.00113	0.00143	0.00160	0.00231	0.00348	0.00512	0.00829	0.01400	0.02298	0.03933	0.06083	0.10880	0.17881
Guangdong	0.00524	0.00041	0.00038	0.00056	0.00075	0.00078	0.00097	0.00128	0.00190	0.00283	0.00417	0.00631	0.01056	0.01720	0.02909	0.04361	0.07029	0.11446
Guangxi	0.00778	0.00049	0.00038	0.00071	0.00106	0.00107	0.00131	0.00160	0.00224	0.00313	0.00469	0.00741	0.01267	0.02061	0.03340	0.05145	0.07890	0.12212
Hainan	0.00596	0.00043	0.00034	0.00061	0.00085	0.00090	0.00100	0.00135	0.00197	0.00283	0.00380	0.00642	0.01050	0.01652	0.02771	0.04252	0.06356	0.09702
Sichuan[2]	0.00671	0.00074	0.00052	0.00071	0.00119	0.00124	0.00142	0.00145	0.00230	0.00307	0.00496	0.00786	0.01316	0.02222	0.03666	0.05929	0.09795	0.15754
Guizhou	0.01327	0.00088	0.00056	0.00104	0.00159	0.00162	0.00195	0.00209	0.00282	0.00366	0.00575	0.00967	0.01712	0.02949	0.04607	0.07059	0.12165	0.21356
Yunnan	0.01389	0.00080	0.00058	0.00109	0.00157	0.00153	0.00186	0.00218	0.00295	0.00408	0.00635	0.01003	0.01680	0.02820	0.04763	0.07700	0.13582	0.25495
Tibet	0.01070	0.00114	0.00081	0.00144	0.00214	0.00219	0.00249	0.00344	0.00418	0.00568	0.00897	0.01343	0.02193	0.03296	0.05489	0.08319	0.15036	0.22693
Shaanxi	0.00729	0.00051	0.00042	0.00071	0.00109	0.00106	0.00113	0.00142	0.00199	0.00300	0.00495	0.00851	0.01540	0.02400	0.04254	0.07327	0.13531	0.26585
Gansu	0.00941	0.00054	0.00043	0.00065	0.00104	0.00114	0.00136	0.00149	0.00211	0.00301	0.00502	0.00860	0.01745	0.02767	0.04896	0.08421	0.16514	0.34413
Qinghai	0.00940	0.00069	0.00047	0.00082	0.00130	0.00127	0.00164	0.00193	0.00252	0.00333	0.00616	0.01016	0.01906	0.03395	0.06097	0.10410	0.19407	0.35185
Ningxia	0.00558	0.00048	0.00033	0.00068	0.00090	0.00092	0.00105	0.00124	0.00179	0.00254	0.00435	0.00771	0.01520	0.02619	0.04661	0.08286	0.15785	0.28653
Xinjiang	0.00695	0.00055	0.00045	0.00079	0.00111	0.00109	0.00126	0.00171	0.00227	0.00338	0.00542	0.01031	0.01759	0.03193	0.05180	0.09396	0.12717	0.16122

Notes: [1]Calculated as average of age-specific central death rates for 1989-1990 and 1999-2000. [2] Calculated as average of age-specific death rates for Sichuan and Chongqing province.
Sources: *1990 census*: Population Census Office (1993), vol. 2, pp.2-5; vol. 1, pp.69-72. *2000 census*: Population Census Office (2002), vol. 1, pp.134-144; vol.6, pp.661-671.

Table A4: *Unadjusted mortality data for China: Age-specific central death rates (m_x), by province, 1999-2000, Males*

Province	0-4	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85+
Beijing	0.00101	0.00035	0.00036	0.00038	0.00067	0.00087	0.00114	0.00146	0.00210	0.00294	0.00469	0.00782	0.01302	0.02298	0.03916	0.06615	0.11309	0.18074
Tianjin	0.00111	0.00037	0.00027	0.00035	0.00066	0.00087	0.00100	0.00133	0.00197	0.00287	0.00467	0.00809	0.01508	0.02766	0.04559	0.07273	0.12077	0.17881
Hebei	0.00358	0.00054	0.00047	0.00067	0.00105	0.00127	0.00142	0.00186	0.00271	0.00400	0.00651	0.01085	0.01941	0.03284	0.05672	0.08741	0.14917	0.22159
Shanxi	0.00377	0.00048	0.00041	0.00082	0.00123	0.00137	0.00156	0.00197	0.00276	0.00404	0.00646	0.01057	0.01868	0.03172	0.05779	0.08957	0.15252	0.21996
Inner Mongolia	0.00592	0.00037	0.00036	0.00075	0.00116	0.00131	0.00165	0.00219	0.00318	0.00470	0.00755	0.01264	0.02067	0.03334	0.05745	0.08881	0.15084	0.21525
Liaoning	0.00270	0.00041	0.00038	0.00060	0.00097	0.00113	0.00149	0.00200	0.00298	0.00400	0.00599	0.00993	0.01619	0.02813	0.04519	0.07137	0.11628	0.19416
Jilin	0.00392	0.00036	0.00036	0.00055	0.00087	0.00107	0.00144	0.00210	0.00311	0.00458	0.00672	0.01219	0.01969	0.03163	0.05090	0.07101	0.10688	0.14850
Heilongjiang	0.00223	0.00032	0.00034	0.00065	0.00092	0.00104	0.00140	0.00198	0.00310	0.00452	0.00730	0.01209	0.01893	0.03129	0.04828	0.06938	0.10658	0.13821
Shanhai	0.00117	0.00030	0.00025	0.00032	0.00045	0.00048	0.00060	0.00112	0.00182	0.00238	0.00343	0.00560	0.01046	0.01863	0.03266	0.05634	0.09687	0.18326
Jiangsu	0.00292	0.00045	0.00034	0.00046	0.00077	0.00090	0.00119	0.00153	0.00277	0.00370	0.00579	0.00918	0.01521	0.02493	0.04253	0.06815	0.11032	0.18280
Zhejiang	0.00305	0.00054	0.00041	0.00064	0.00098	0.00114	0.00148	0.00180	0.00297	0.00403	0.00593	0.00902	0.01527	0.02372	0.04169	0.06775	0.11752	0.20446
Anhui	0.00563	0.00062	0.00041	0.00065	0.00111	0.00131	0.00151	0.00180	0.00303	0.00395	0.00618	0.01014	0.01742	0.02880	0.04800	0.07088	0.11424	0.14968
Fujian	0.00384	0.00050	0.00049	0.00066	0.00104	0.00119	0.00152	0.00194	0.00328	0.00432	0.00683	0.01042	0.01757	0.02772	0.04351	0.06815	0.11018	0.17624
Jiangxi	0.00693	0.00089	0.00053	0.00077	0.00125	0.00142	0.00184	0.00228	0.00324	0.00433	0.00650	0.01104	0.01886	0.03162	0.05380	0.08040	0.12699	0.17851
Shandong	0.00331	0.00051	0.00038	0.00065	0.00124	0.00130	0.00143	0.00187	0.00300	0.00408	0.00633	0.01011	0.01670	0.02811	0.04715	0.07849	0.12865	0.20641
Henai	0.00418	0.00059	0.00041	0.00074	0.00119	0.00131	0.00148	0.00189	0.00295	0.00406	0.00655	0.01055	0.01842	0.03125	0.05304	0.07973	0.12531	0.17544
Hubei	0.00391	0.00068	0.00052	0.00064	0.00100	0.00124	0.00145	0.00194	0.00285	0.00396	0.00638	0.01094	0.01996	0.03145	0.05565	0.08181	0.12704	0.17872
Hunan	0.00568	0.00082	0.00054	0.00073	0.00119	0.00142	0.00175	0.00213	0.00330	0.00429	0.00600	0.01002	0.01693	0.02867	0.04783	0.07346	0.11634	0.16520
Guangdong	0.00282	0.00056	0.00045	0.00063	0.00090	0.00107	0.00140	0.00184	0.00304	0.00433	0.00640	0.01026	0.01677	0.02687	0.04444	0.06957	0.11134	0.18343
Guangxi	0.00496	0.00071	0.00047	0.00074	0.00143	0.00166	0.00208	0.00264	0.00402	0.00525	0.00720	0.01067	0.01655	0.02596	0.04130	0.06455	0.09804	0.15453
Hainan	0.00358	0.00064	0.00046	0.00064	0.00112	0.00123	0.00131	0.00173	0.00266	0.00392	0.00581	0.01026	0.01602	0.02414	0.03973	0.06217	0.09068	0.13699
Sichuan[1]	0.00550	0.00099	0.00071	0.00104	0.00170	0.00179	0.00205	0.00244	0.00390	0.00469	0.00680	0.01076	0.01783	0.02994	0.04766	0.07152	0.11465	0.16112
Guizhou	0.01389	0.00124	0.00085	0.00155	0.00261	0.00268	0.00301	0.00341	0.00462	0.00539	0.00802	0.01182	0.01910	0.03086	0.04839	0.08121	0.12878	0.18149
Yunnan	0.01440	0.00123	0.00086	0.00153	0.00227	0.00231	0.00259	0.00305	0.00427	0.00542	0.00802	0.01206	0.02009	0.03274	0.05180	0.08679	0.13842	0.20596
Tibet	0.01198	0.00146	0.00124	0.00157	0.00225	0.00243	0.00277	0.00349	0.00531	0.00736	0.01155	0.01761	0.02696	0.04014	0.05974	0.07679	0.11307	0.11380
Shaanxi	0.00529	0.00060	0.00054	0.00088	0.00147	0.00171	0.00187	0.00223	0.00301	0.00412	0.00626	0.01039	0.01771	0.03021	0.05589	0.08506	0.14084	0.18363
Gansu	0.00868	0.00060	0.00051	0.00089	0.00144	0.00167	0.00176	0.00213	0.00301	0.00408	0.00708	0.01174	0.01965	0.03373	0.05979	0.09049	0.14356	0.16667
Qinghai	0.00995	0.00088	0.00078	0.00137	0.00186	0.00183	0.00223	0.00261	0.00376	0.00566	0.00853	0.01310	0.02106	0.03521	0.05260	0.08034	0.12132	0.11279
Ningxia	0.00596	0.00093	0.00055	0.00128	0.00159	0.00153	0.00171	0.00201	0.00297	0.00372	0.00547	0.00938	0.01530	0.02665	0.04763	0.07735	0.13663	0.17842
Xinjiang	0.00834	0.00085	0.00063	0.00100	0.00150	0.00150	0.00154	0.00217	0.00322	0.00482	0.00695	0.01163	0.01571	0.02768	0.04200	0.05928	0.07793	0.10845

Notes: [1] Calculated as average of age-specific death rates for Sichuan and Chongqing province.
Source: Population Census Office (2002), vol. 1, pp.134-144; vol.6, pp.661-671.

Table A4 (cont.): *Unadjusted mortality data for China: Age-specific central death rates (m_x), by province, 1999-2000, Females*

Province	0-4	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85+
Beijing	0.00103	0.00019	0.00021	0.00020	0.00035	0.00049	0.00054	0.00073	0.00108	0.00170	0.00272	0.00461	0.00883	0.01542	0.02922	0.05070	0.08820	0.16311
Tianjin	0.00103	0.00023	0.00016	0.00020	0.00029	0.00041	0.00048	0.00075	0.00104	0.00164	0.00320	0.00542	0.01117	0.02003	0.03427	0.05667	0.09699	0.16090
Hebei	0.00482	0.00029	0.00020	0.00032	0.00051	0.00070	0.00077	0.00094	0.00147	0.00226	0.00390	0.00672	0.01285	0.02191	0.03947	0.06353	0.10806	0.17432
Shanxi	0.00433	0.00031	0.00024	0.00038	0.00055	0.00061	0.00077	0.00092	0.00155	0.00254	0.00448	0.00721	0.01345	0.02264	0.04157	0.06630	0.11480	0.18492
Inner Mongolia	0.00659	0.00026	0.00023	0.00039	0.00061	0.00065	0.00074	0.00103	0.00167	0.00275	0.00480	0.00827	0.01397	0.02358	0.04428	0.07099	0.11932	0.18890
Liaoning	0.00278	0.00025	0.00022	0.00038	0.00050	0.00058	0.00070	0.00093	0.00140	0.00220	0.00370	0.00625	0.01100	0.01960	0.03396	0.05621	0.09591	0.17388
Jilin	0.00395	0.00024	0.00020	0.00046	0.00055	0.00061	0.00076	0.00108	0.00161	0.00252	0.00447	0.00755	0.01346	0.02397	0.03861	0.05640	0.08924	0.13495
Heilongjiang	0.00198	0.00024	0.00021	0.00035	0.00049	0.00057	0.00071	0.00097	0.00161	0.00256	0.00459	0.00773	0.01287	0.02183	0.03636	0.05251	0.08637	0.12710
Shanhai	0.00108	0.00020	0.00016	0.00020	0.00025	0.00029	0.00039	0.00060	0.00104	0.00142	0.00225	0.00354	0.00642	0.01071	0.02096	0.03874	0.07257	0.15610
Jiangsu	0.00331	0.00032	0.00020	0.00031	0.00047	0.00061	0.00074	0.00087	0.00152	0.00213	0.00339	0.00535	0.00890	0.01455	0.02583	0.04522	0.08111	0.15711
Zhejiang	0.00317	0.00033	0.00026	0.00034	0.00054	0.00061	0.00077	0.00092	0.00149	0.00203	0.00320	0.00505	0.00862	0.01398	0.02641	0.04721	0.08913	0.18047
Anhui	0.00823	0.00039	0.00027	0.00046	0.00084	0.00093	0.00101	0.00110	0.00188	0.00245	0.00379	0.00607	0.01006	0.01678	0.03051	0.04909	0.08460	0.13372
Fujian	0.00547	0.00035	0.00029	0.00044	0.00067	0.00079	0.00093	0.00107	0.00159	0.00227	0.00349	0.00553	0.00950	0.01559	0.02683	0.04440	0.07880	0.14838
Jiangxi	0.01655	0.00061	0.00044	0.00055	0.00083	0.00101	0.00111	0.00120	0.00179	0.00255	0.00403	0.00681	0.01169	0.01927	0.03525	0.05615	0.09356	0.14874
Shandong	0.00399	0.00030	0.00024	0.00038	0.00062	0.00073	0.00086	0.00100	0.00158	0.00222	0.00352	0.00562	0.01018	0.01759	0.03070	0.05295	0.09224	0.16724
Henai	0.00676	0.00036	0.00025	0.00040	0.00065	0.00084	0.00091	0.00109	0.00177	0.00257	0.00409	0.00649	0.01160	0.01944	0.03544	0.05527	0.08996	0.13794
Hubei	0.00475	0.00042	0.00033	0.00046	0.00069	0.00093	0.00102	0.00121	0.00183	0.00268	0.00439	0.00713	0.01265	0.02060	0.03769	0.05832	0.09543	0.14474
Hunan	0.00717	0.00056	0.00039	0.00051	0.00083	0.00099	0.00117	0.00132	0.00205	0.00271	0.00408	0.00675	0.01130	0.01932	0.03267	0.05122	0.08766	0.14042
Guangdong	0.00405	0.00036	0.00032	0.00031	0.00041	0.00057	0.00078	0.00103	0.00155	0.00214	0.00328	0.00524	0.00902	0.01438	0.02608	0.04336	0.07686	0.14864
Guangxi	0.00813	0.00049	0.00036	0.00048	0.00080	0.00090	0.00103	0.00123	0.00183	0.00260	0.00358	0.00562	0.00931	0.01463	0.02540	0.04367	0.07030	0.12251
Hainan	0.00587	0.00047	0.00033	0.00042	0.00060	0.00087	0.00076	0.00110	0.00155	0.00220	0.00315	0.00523	0.00844	0.01279	0.02300	0.03939	0.06294	0.11366
Sichuan[1]	0.00550	0.00068	0.00048	0.00067	0.00114	0.00117	0.00126	0.00138	0.00229	0.00298	0.00460	0.00721	0.01224	0.02068	0.03389	0.05495	0.08957	0.14452
Guizhou	0.01807	0.00112	0.00066	0.00114	0.00168	0.00161	0.00176	0.00182	0.00266	0.00324	0.00489	0.00753	0.01250	0.02058	0.03472	0.05852	0.09923	0.15212
Yunnan	0.01822	0.00088	0.00066	0.00112	0.00156	0.00154	0.00163	0.00181	0.00255	0.00350	0.00543	0.00819	0.01350	0.02276	0.03747	0.06510	0.10847	0.17918
Tibet	0.01179	0.00163	0.00099	0.00139	0.00222	0.00258	0.00261	0.00342	0.00444	0.00619	0.00967	0.01335	0.02199	0.02843	0.04176	0.05414	0.08163	0.09846
Shaanxi	0.00780	0.00042	0.00032	0.00052	0.00092	0.00102	0.00103	0.00124	0.00176	0.00286	0.00468	0.00781	0.01280	0.02238	0.04184	0.06582	0.10846	0.16095
Gansu	0.01194	0.00049	0.00035	0.00053	0.00109	0.00123	0.00117	0.00127	0.00211	0.00308	0.00515	0.00853	0.01441	0.02556	0.04604	0.07204	0.12178	0.17549
Qinghai	0.01038	0.00076	0.00053	0.00082	0.00143	0.00130	0.00144	0.00163	0.00234	0.00319	0.00637	0.00920	0.01490	0.02636	0.04449	0.06423	0.09572	0.12778
Ningxia	0.00581	0.00058	0.00038	0.00074	0.00092	0.00096	0.00092	0.00107	0.00163	0.00237	0.00400	0.00647	0.01094	0.02129	0.04101	0.06908	0.11322	0.15995
Xinjiang	0.00744	0.00062	0.00049	0.00080	0.00105	0.00097	0.00099	0.00140	0.00228	0.00371	0.00534	0.00901	0.01409	0.02340	0.03410	0.05129	0.06186	0.09253

Notes: [1] Calculated as average of age-specific death rates for Sichuan and Chongqing province.
Source: Population Census Office (2002), vol. 1, pp.134-144; vol.6, pp.661-671.

***Table A5**: Observed national pattern of relative migration risk at ages a and over derived from the 2000 census[*], and Rogers-Castro age-specific migration rates, by sex*

Age group	$m_s(a+)$*		Rogers-Castro ASMR
	Males	Females	
0-4	1.000	1.000	0.01573
5-9	1.346	1.055	0.00952
10-14	1.410	1.111	0.00579
15-19	1.508	1.196	0.01084
20-24	1.433	1.119	0.03269
25-29	1.283	0.920	0.02820
30-34	1.106	0.678	0.01800
35-39	0.946	0.563	0.01099
40-44	0.821	0.499	0.00668
45-49	0.742	0.460	0.00405
50-54	0.660	0.416	0.00246
55-59	0.607	0.391	0.00149
60-64	0.585	0.382	0.00090
65-69	0.551	0.371	0.00055
70-74	0.497	0.309	0.00033
75-79	0.331	0.184	0.00020
80-84	0.362	0.175	0.00012

* Refers to inter- and intra-province migration.
Source: Population Census Office (2002), vol. 1, pp.134-144; vol.6, pp.661-671.

***Table A6**: Net migration rates per annum (m0+) during the intercensal period 1990-2000[*], by sex and province (%)*

Age group	Males	Females
Beijing	0.253	0.302
Tianjin	0.076	0.087
Hebei	-0.003	-0.003
Shanxi	0.003	0.003
Inner Mongolia	-0.009	-0.011
Liaoning	0.017	0.019
Jilin	-0.020	-0.023
Heilongjiang	-0.033	-0.038
Shanhai	0.246	0.285
Jiangsu	0.018	0.020
Zhejiang	0.073	0.085
Anhui	-0.081	-0.096
Fujian	0.041	0.048
Jiangxi	-0.113	-0.134
Shandong	0.001	0.001
Henai	-0.038	-0.044
Hubei	-0.051	-0.061
Hunan	-0.084	-0.101
Guangdong	0.274	0.315
Guangxi	-0.064	-0.079
Hainan	0.022	0.027
Sichuan[1]	-0.085	-0.101
Guizhou	-0.052	-0.062
Yunnan	0.015	0.018
Tibet	0.027	0.031
Shaanxi	-0.016	-0.019
Gansu	-0.027	-0.032
Qinghai	-0.018	-0.021
Ningxia	0.015	0.017
Xinjiang	0.100	0.118

* Refers to inter-province migration only.
Source: Population Census Office (2002), vol. 1, pp.134-144; vol.6, pp.661-671.