How Far Has Fertility in China Really Declined?

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According to births in the past year as reported in China's 2000 census, the total fertility rate (TFR) in China was 1.22 children per woman in 2000 (National Bureau of Statistics of China 2002). There is considerable debate about the accuracy of this figure, however, with alternative estimates as high as 1.8 children per woman (Scharping 2003a, 2003b). The outcome of this debate bears directly on the question of how effective China's one-child family policy has been in recent years.

To assess more accurately the recent trend in China's fertility (including but not limited to the year 2000), we apply the own-children method of fertility estimation to both the 1990 and 2000 censuses. The own-children method provides two estimated fertility trends—one from each census—for the 15 years prior to each census. The two trends overlap during the period 1986–90. Were the data completely accurate, the two trends would coincide during the period of overlap, but we find that they do not coincide. Analysis of the pattern of discrepancies provides the basis for improving the estimates of the TFR for 1990 and 2000. We also examine another set of estimates derived by applying the birth history reconstruction method of fertility estimation to the two censuses. Birth history reconstruction is an extension of the own-children method.

The fertility measures considered include age-specific fertility rates (ASFRs) and a TFR calculated from ASFRs (TFR_{asfr}, usually denoted simply as TFR), as well as period parity progression ratios (PPPRs) and a total fertility rate calculated from PPPRs (TFR_{pppr}). Using both of these measures of total fertility, we also assess how much of the decline in fertility during the 1990s is accounted for by later marriage and less marriage and how much by falling fertility within marriage. As will be seen, the results of this decomposition of fertility decline into components depend on our assessment of how far fertility has really declined. We also provide estimates of differential fertility by urban/rural residence, education, ethnicity, and migration status, as well as estimates of how fertility by these characteristics has changed over time.

Background

More than a decade has passed since survey data indicated that China's TFR fell below the replacement level of about 2.1 children per woman in the early 1990s. This finding, which at the time seemed extraordinary for a country at China's level of development, attracted a good deal of attention and analysis (see, e.g., Feeney and Yuan 1994; Zeng 1996; Yu and Yuan 1996). Analysis of later surveys and of China's 2000 census indicates that the TFR continued to fall, from 1.8 in 1991 to 1.2 in 2000 (Department of Population and Social Science Statistics 2002; Guo 2003; Zhang 2003). The government has been reluctant to accept this evidence, however. Because of underreporting of births in the surveys and censuses, the government currently considers that the TFR in 2000 was about 1.8 children per woman (Zai 2003; Zhang and Cui 2003; Scharping 2003a, 2003b).

Some Chinese demographers have argued, on the other hand, that fertility is much lower than 1.8, even after accounting for underreporting of births. Guo (2003) concludes that even if the raw statistics are adjusted to allow for 20 percent underreporting of births, the TFR still does not come up to 1.8. Zhang (2003, 2004) concludes that the true level of the TFR in 2000 was between 1.5 and 1.6.

Inasmuch as many Asian countries without a one-child family policy have also experienced dramatic fertility decline from as high as 6 children per woman in the 1970s to as low as 1.4 in the mid-1990s (UN 2001), Zai (2003) and Zhang (2004) view estimates of rapid fertility decline in China to well below replacement level as plausible, given the country's rapid pace of economic and social development on top of its strong one-child family policy. This view is additionally supported by recent evidence that rural women want few children, partly because of new financial constraints associated with rapid increases in school fees and living costs (Chu 2001). This recent evidence indicates that new socioeconomic forces unleashed by market reforms are also contributing to lower fertility.

Despite the evidence that much of China's rapid fertility decline is real, there is also abundant evidence that, ever since the one-child family policy was announced in 1979, Chinese population statistics have suffered from considerable underreporting of "out-of-quota" births. A related problem contributing to this underreporting is that China's household registration system (*hukou*), which is used to help identify households to be enumerated in the census, has weakened considerably during the country's transition from a planned economy to a market economy (Scharping 2003b). The underreporting problem has been exacerbated by a massive migration from rural to urban areas, mainly during the 1990s. Most of this migration is officially unapproved, in which case the migrants are still registered in their rural areas of origin rather than in their current urban residence. The existence of this large "floating population" makes it easier for these migrants to underreport births, and it also made census enumeration much more difficult in 2000 than in 1990 (Zhang 2003).

Another problem is that in recent years, out-of-quota births are widely underreported not only by individual couples who try to avoid punishment but also by local cadres whose performance evaluation is linked directly to achievement of target fertility for their local area, in accordance with the "one vote down" cadre responsibility system instituted in 1991 (Zeng 1996; Merli 1998; Merli and Raftery 2000; Merli and Smith 2002; Murphy 2003; Scharping 2003a, 2003b). Under this system, failure to perform adequately in any one of several areas (fertility targets being one of them) can result in a major reduction in wages or even dismissal from one's job.

Our study injects further evidence into the debate about the true trend in fertility in China.

Methodology

We derive fertility estimates from the one-per-thousand samples from China's 1990 and 2000 censuses using two methods: (1) the own-children (OWCH) method and (2) the birth history reconstruction (BHR) method.[1]

Own-children method

The own-children method is applicable to censuses and household surveys. Enumerated children are first matched to mothers within households, on the basis of answers to questions on age, sex, marital status, relation to head of household, and (if available) number of children still living or number of children ever born. A computer algorithm is used for matching. The matched (i.e., own) children, classified by their own age and mother's age, are then reverse-survived to estimate numbers of births by age of mother in previous years. Reverse-survival is similarly used to estimate numbers of women by age in previous years. After adjustments are made for unmatched (i.e., non-own) children, age-specific fertility rates (ASFRs) are calculated by dividing the number of reverse-survived births by the number of reverse-survived women. Total fertility rates (TFRs) are then calculated from the ASFRs. The nature of the adjustment for non-own children is that each category of own children, classified by child's age and mother's age, is multiplied by the ratio of the number of all children (own plus non-own) at the specified child's age to the number of own children at the specified child's age. The same non-own adjustment factor must be used regardless of mother's age, because mother's age is not known for the non-own children.

Estimates are normally computed for each of the 15 years before the census or household survey. Estimates are not usually computed further back than 15 years because births would then have to be based on children aged 15 or older at enumeration, a large proportion of whom do not reside in the same household as their mother and hence cannot be matched. All calculations are done initially by single years of age and time. Estimates for grouped ages or grouped calendar years are obtained by appropriately aggregating single-year numerators (births) and denominators (women) and then dividing the aggregated numerator by the aggregated denominator. Such aggregation is often useful for minimizing the distorting effects of age misreporting on the fertility estimates. In China, however, age misreporting is not a problem, because of the importance of year of birth in Chinese culture. Most Chinese know the animal year of birth of family members, and census enumerators carry a conversion chart to convert animal year into calendar year.

The own-children method may be viewed as fertility estimation from incomplete birth histories, where the missing births correspond to children under age 15 who are either dead or no longer living in the mother's household at the time of the census. The own-children method uses reverse-survival and non-own adjustment factors to add these missing births back in. For purposes of reverse-survival, we have used life tables by sex for 1973, 1981, 1987, and 2000.[2] We interpolated these official life tables over time, so that life tables for each calendar year between 1973 and 2000 are part of the input data for the own-children fertility estimation procedure. For further details about the own-children method, see Cho et al. (1986).

Birth history reconstruction method

The birth history reconstruction method is an extension of the basic own-children method. The BHR method starts with the birth histories corresponding to the own children matched to a woman within a household. The year of birth of each own child is derived from the child's age at the time of the census, yielding a birth history for the mother that, however, may not be complete. The difference between a woman's number of children ever born (an essential piece of information for application of the BHR method) and the number of own children matched to her equals the number of missing births corresponding to children who are either dead or no longer living in the mother's household at the time of the census. These missing births are imputed into the incomplete birth history using probabilistic procedures developed by Norman Luther (Cho et al. 1986; Luther and Cho 1988; Luther and Pejaranonda 1991; Retherford and Luther 1996). For any particular woman, the complete reconstructed birth history may not be accurate. But when the birth histories are aggregated in the process of calculating fertility estimates, individual-level errors tend to cancel out, so that the fertility estimates are accurate when derived from large samples—unless, of course, other sources of error (such as age misreporting and undercount) are also present.

Once the birth histories are reconstructed, fertility estimates are derived by the conventional birth history method. This method is straightforward. One simply counts births by age of mother as reported in the birth histories for each year prior to the census. One similarly counts woman-years of exposure to the risk of birth by woman's age. Births by age of mother are then divided by woman-years of exposure in each age group in each calendar year or group of calendar years to obtain estimates of ASFRs for the same year or period. TFRs are then calculated in the usual way from the ASFRs.

Later in this article, we compare TFRs derived by the OWCH method and the BHR method. The estimates derived by the two methods are not identical, because they are subject to different sources of error. For example, urban TFR estimates derived by the OWCH method are biased downward if a substantial proportion of non-own (unmatched) children of urban women are living with grandparents in rural areas, because the urban adjustment factors for non-own children are then too low. Urban TFR estimates derived by the BHR method do not suffer from this problem, but they can also be too low if the number of children ever born is underreported, a problem that does not affect TFR estimates derived by the OWCH method.[3]

Period parity progression ratios

From the reconstructed birth histories, one can compute not only ASFRs and a conventional TFR calculated from them (TFR_{asfr}), but also period parity progression ratios (PPPRs) and a TFR calculated from them (TFR_{pppr}).

A woman's parity is defined as the number of children she has ever borne. A parity progression ratio is the proportion of women of specified parity who go on to have at least one more child (i.e., who eventually progress to the next parity). Each PPPR is calculated by the period life table method from duration-in-parity-specific probabilities of progressing to the next parity for a particular calendar year, where duration is measured in years up to a maximum of ten, at which point the life table is terminated. It is assumed that the probability of progression after a birth interval of ten years is small enough to be ignored without introducing appreciable error in the estimate of the PPPR. An exception is progression from a woman's own birth to her first marriage, in which case the life table is truncated at 35 years, the assumption being that a negligible proportion of first marriages occur after age 35. We denote the PPPRs as p_M (woman's own birth to her first marriage), p_0 (first marriage to parity 1), p_1 (parity 1 to parity 2), ..., p_5 (parity 5 to parity 6), and $p_6{}^*$ (parity 6 or higher to the next higher parity). In the case of p_M the concept of parity progression is extended to include not only birth events but also first-marriage events.

Feeney's method (Feeney 1986; Feeney and Yu 1987) is used to chain together the progression ratios p_M, p_0, p_1, ..., p_5, and $p_6{}^*$ into a $\mathrm{TFR}_{\mathrm{pppr}}$. The version of the formula we use is

$$\begin{aligned}\mathrm{TFR}_{\mathrm{pppr}} = {} & p_M p_0 + p_M p_0 p_1 + p_M p_0 p_1 p_2 + p_M p_0 p_1 p_2 p_3 + p_M p_0 p_1 p_2 p_3 p_4 \\ & + p_M p_0 p_1 p_2 p_3 p_4 p_5 + p_M p_0 p_1 p_2 p_3 p_4 p_5 p_6{}^*/(1 - p_6{}^*).\end{aligned} \tag{1}$$

In general, $\mathrm{TFR}_{\mathrm{pppr}}$ will not have the same value as the conventional TFR (denoted here as $\mathrm{TFR}_{\mathrm{asfr}}$, for reasons of clarity), although the two values are usually fairly close. A property of $\mathrm{TFR}_{\mathrm{pppr}}$ is that it tends to be less sensitive than $\mathrm{TFR}_{\mathrm{asfr}}$ to period fluctuations in the timing of marriage and births. Thus the trend in $\mathrm{TFR}_{\mathrm{pppr}}$ is usually smoother than the trend in $\mathrm{TFR}_{\mathrm{asfr}}$.

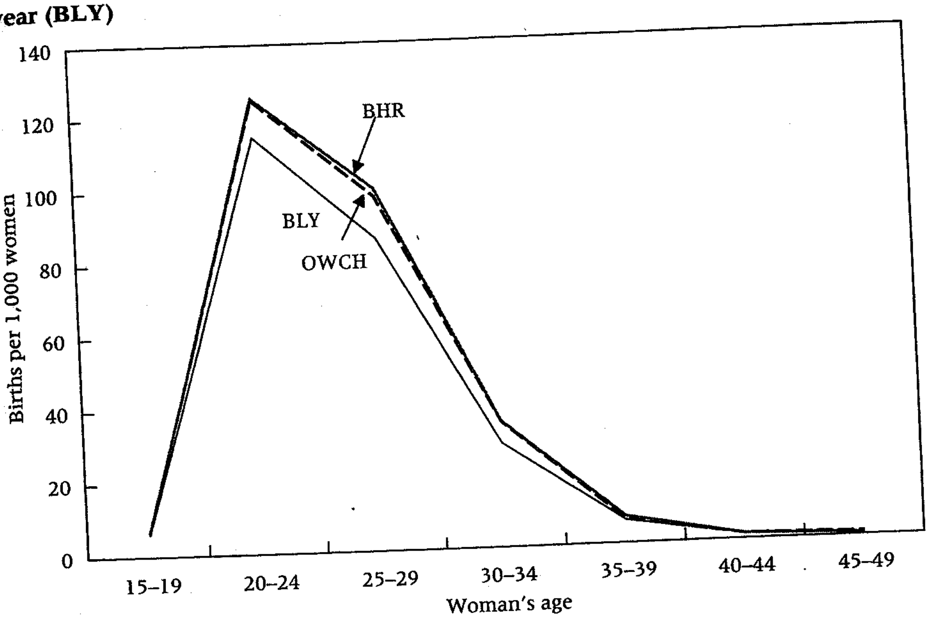
China's 1990 census did not contain a question on age at first marriage, so one cannot compute separate values of p_M and p_0. Instead, the product $p_M p_0$ in the above equation is replaced with p_B, denoting the woman's probability of progressing from her own birth to her first birth.

Findings

Trend in the TFR

The first step in our analysis was to compare estimates of age-specific fertility rates for the year 2000 derived alternatively by the own-children (OWCH) method, by the birth history reconstruction (BHR) method (both applied to the 2000 census data), and from responses to the 2000 census question on births in the last year (BLY). Graphs of the ASFR curves are presented in Figure 1, which shows that the OWCH and BHR estimates agree closely with each other and are higher than the BLY estimates. The principal reason why the BLY estimates are lower is that a substantial proportion of women, when asked directly about births in the last year, do not report births not permitted by the one-child family policy. (Lower BLY estimates can also result from reference period error, as, for example, in Indonesia, which has never had a one-child family policy (Cho et al. 1976).) Total fertility rates (TFRs) can be calculated from the ASFRs shown in the figure. The BLY estimate of the TFR is 1.22 children per woman, the OWCH estimate is 1.36, and the BHR estimate is 1.38. The OWCH estimate of the TFR

FIGURE 1 Age-specific fertility rates for the 12-month period before the 2000 census, derived by the own-children (OWCH) method, the birth history reconstruction (BHR) method, and from self-reported births during the last year (BLY)

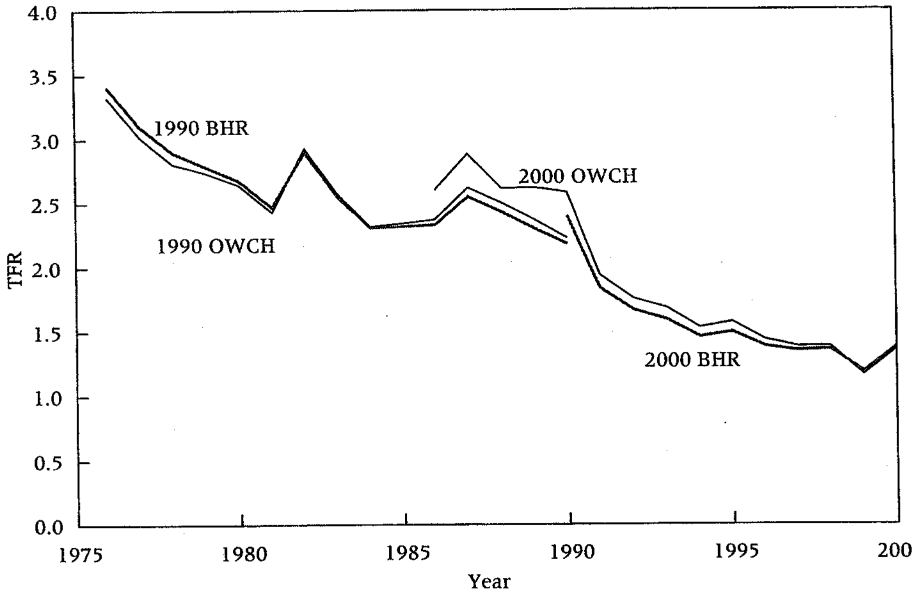


is 11 percent higher than the BLY estimate, and the BHR estimate of the TFR is 13 percent higher than the BLY estimate.

The OWCH and BHR estimates of the TFR for the year 2000 are based on children aged 0 (i.e., less than one year of age) at the time of the census. There is considerable evidence from earlier studies (e.g., Scharping 2003b) that these children are also underenumerated, though evidently less so than births as determined from the direct question on births in the last year. It thus seems reasonable to conclude from Figure 1 that the OWCH and BHR estimates of ASFRs and TFR for the year 2000 are downwardly biased, but not as much as the BLY estimates. In the remainder of this article, we focus on the OWCH and BHR estimates and ignore the BLY estimates.

Figure 2 shows the trend in the TFR (i.e., TFR_{asfr}), estimated alternatively by applying the OWCH method and the BHR method to the 1990 and 2000 censuses. In the case of the TFR trends estimated from the 2000 census, the BHR estimates go back only to 1990. The reason is that, in the 2000 census, the questions on number of children ever born and number of children still living, which are used in the BHR method to impute births corresponding to non-own children and children who died, were asked only of women aged 15–50. (In the 1990 census they were asked of women aged 15–64.) This means that, as we consider years before the 2000 census, information on children ever born and children still living is progressively

FIGURE 2 Trend in the total fertility rate for China, estimated alternatively by the own-children (OWCH) method and the birth history reconstruction (BHR) method applied to the 1990 and 2000 censuses, 1976–2000



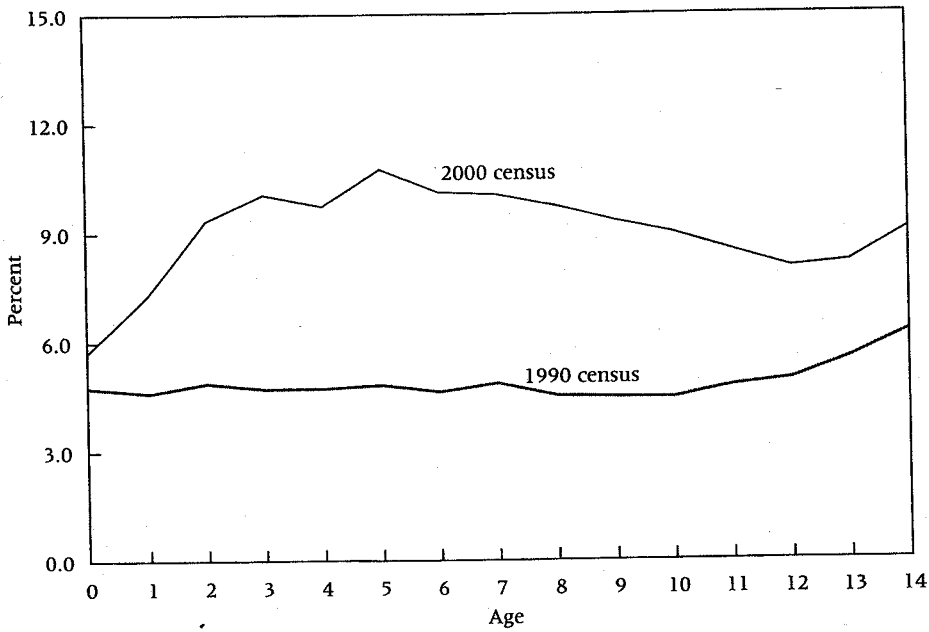
limited to younger women. For example, women aged 50 at the time of th(2000 census were aged 40 in 1990, implying that we do not know numbe of children ever born and number of children surviving for women age(41–49 in 1990. Because of this, the BHR method does not impute into th(reconstructed birth histories the missing children (those who are dead o living in another household) corresponding to births that occurred to wome] aged 41–49 in 1990. On the other hand, the births corresponding to ow] children matched to these women are retained in the birth histories, so tha the BHR estimates of ASFR(40–44) and ASFR(45–49) are lowered slightl' but not to zero. Because very few births occurred to Chinese women a ages 40 and older during the 1990s, the bias in the TFR estimate for 199(due to the omission of a small fraction of these births is very small. The bia becomes larger for years before 1990, however, so BHR estimates of TFR from the 2000 census for those earlier years are not shown.

Figure 2 shows that, in the case of TFR estimates derived from th 2000 census (but not those derived from the 1990 census), the BHR esti mates tend to be slightly lower than the OWCH estimates, and more so fo years further back from the census. This discrepancy may be due t underreporting of children ever born corresponding to some fraction of non own children. Indeed, the proportion of children who are non-own (i.e unmatched because they are living in a household other than that of their mother) is much higher in the 2000 census than in the 1990 census, as shown in Figure 3. The tendency not to report some of these non-own children when reporting children ever born may be greater when the woman has more than one child living elsewhere. Women who are especially likely to have more than one non-own child are those who moved to cities but who are not registered there and who left some or all of their children with grandparents or other relatives in the countryside.

If this reasoning is correct, the OWCH estimates of the TFR derived from the 2000 census are more accurate than the BHR estimates of the TFR derived from the 2000 census, because the OWCH estimates probably capture almost all of the non-own children by means of the non-own adjustment factor, whereas children ever born are more often underreported. For this reason we prefer the OWCH estimates over the BHR estimates. This preference pertains only to the estimates of the TFR for all China, however. It does not pertain to estimates of the TFR by woman's characteristics. In the latter case, the BHR estimates are usually preferable, for reasons that are discussed later.

The much higher proportion of children who are non-own in the 2000 census is a result of the large increase in the "floating population," which is defined in the 2000 census as persons who have been living away from

FIGURE 3 Non-own (unmatched) children as a percent of all children (matched plus unmatched) by age of child: 1990 and 2000 censuses



their place of household registration for more than six months. If we consider "living away" to mean residing in another city/county or another province, 7 percent of women aged 15–64 were floating in the year 2000. A comparable figure from the 1990 census is not available, because the census questions on migration were different in the two censuses.

Normally the percentage of children who are non-own increases with age, but this is not so in the 2000 census, as shown in Figure 3. The unusual pattern of a steep rise followed by a gradual decline in the 2000 census probably reflects the rapid growth of the floating population in towns and cities during the 1990s, which resulted in a parallel upsurge of young children left behind with relatives in the countryside and thus a tendency for the percent non-own to decline with age of child. This tendency, when superimposed on the usual tendency of the percent non-own to rise with age of child, could result in the rise-and-fall pattern shown for the 2000 census in Figure 3.

In Figure 2, the two TFR trends estimated by the own-children method overlap during the period 1986–90. As we mentioned earlier, if the data were perfect the two trends would coincide during this period.[4] Instead, there are systematic discrepancies whereby the TFR estimates derived from the 2000 census substantially exceed those derived from the 1990 census. The likely reason for this pattern of discrepancy is a tendency among respondents not to report children whose births were not permitted by the one-child family policy, especially young children who were born recently. We therefore expect the discrepancy to be greatest for 1990, the year immediately preceding the 1990 census, and this is what is observed in Figure 2.

The births underlying the 1990 TFR estimate derived by the own-children method from the 2000 census are reverse-survived from children who were aged 10 at the time of the 2000 census. If we assume that there was a negligible tendency to conceal children aged 10 in the 2000 census (since their births, even if illegal under the one-child family policy, occurred a long time ago), then the 1990 TFR estimate derived from the 2000 census can be considered reasonably accurate. On the other hand, the 1990 TFR estimate derived from the 1990 census, calculated by reverse-surviving children aged 0 at the time of the 1990 census, is almost certainly too low. The ratio of the former estimate to the latter estimate yields an adjustment factor of 1.1660.[5] In other words, application of this adjustment factor adjusts the 1990 census-derived OWCH estimate of the TFR for 1990 upward by 16.60 percent.

If one is willing to make the heroic assumption that the adjustment factor of 1.1660 is also applicable to the 2000 TFR estimate derived by the own-children method from the 2000 census, one can apply the adjustment factor to this TFR estimate as well. The true adjustment factor for the 2000 TFR is almost certainly different, but in the absence of other information an upward adjustment of 16.6 percent is almost certainly an improvement over no adjustment at all. The result of applying the adjustment factor of 1.1660 is to adjust upward the OWCH estimate of the TFR for the year 2000 from 1.36 to 1.59. This is our best estimate of the TFR in the year 2000. It is in close agreement with Zhang's (2003, 2004) conclusion, mentioned earlier, that the true TFR for 2000 was between 1.5 and 1.6.

To get a better sense of the reliability of the adjustment factor of 1.1660, we also calculated adjustment factors for 1989, 1988, and 1987, not only for the TFR but also for ASFRs for those years.[6] In each case the adjustment factor was calculated as the ratio of the 2000 census-based estimate of the TFR or ASFR for the specified year to the 1990 census-based estimate of the TFR or ASFR for that same year. As before, we used the estimates derived by the OWCH method for this purpose. Results are shown in Table 1. In the case of the TFR, the adjustment factors increase from 1.06 in 1987 to 1.11 in 1989. The smaller adjustments for earlier years are expected, because the TFRs in earlier years (as derived from the 1990 census) are based on older children, who are less likely than younger children to have been concealed from the census enumerator in cases where the child's birth violated the one-child family policy. In the case of ASFRs, there is considerable variability in the adjustment factors, which tend to be higher at ages 30–34 and 35–39 than at other ages, perhaps because the bulk of second births not permitted by the one-child family policy occur at these ages. The variability in the adjustment factors indicates that our adjustment factor of 1.1660 for the 1990 TFR should be viewed only as a rough estimate.

TABLE 1 Overlap-derived adjustment factors for 1990 census-based own-children estimates of the TFR and ASFRs for 1987, 1988, 1989, and 1990

ASFR/TFR	1987	1988	1989	1990
ASFR				
15–19	0.99	1.01	1.14	1.29
20–24	1.04	1.03	1.05	1.11
25–29	1.08	1.11	1.12	1.17
30–34	1.12	1.16	1.22	1.28
35–39	1.06	1.16	1.19	1.34
40–44	1.12	1.10	0.97	1.12
45–49	0.75	1.07	0.79	0.72
TFR	1.06	1.08	1.11	1.17

NOTE: The adjustment factor for the TFR in 1987, for example, is calculated as the ratio of the 2000 census-based estimate of the TFR for 1987 to the 1990 census-based estimate of the TFR for 1987 (with allowance made for the fact that the 1990 and 2000 censuses were not taken in the same month, as explained in endnotes 4 and 5). A similar procedure is used to calculate the adjustment factor for each ASFR in 1987.

Application of the adjustment factors for 1987, 1988, and 1989 to the 2000 census-derived estimates of the TFR for 1997, 1998, and 1999 yields adjusted TFR estimates of 1.47 for 1997, 1.50 for 1998, and 1.28 for 1999. These values are lower than the adjusted value of 1.59 for 2000. It is possible that the dip in 1999, which is also seen in the unadjusted estimate of the TFR for that year, stems from pressures on 2000 census enumerators not to miss infants, resulting in some shifting of children aged 1 to age 0. If so, our adjusted TFR estimate of 1.59 for 2000 may be too high. The average of the four adjusted TFR estimates for 1997 through 2000 is 1.46. The estimate of 1.46 for the period 1997–2000 may be more accurate than our estimate of 1.59 for 2000.

Some other features of the TFR trends in Figure 2 also deserve mention. An upward blip in the TFR in 1982 no doubt resulted, at least in part, from the new marriage law of 1980, which relaxed the later-marriage component of the "later-longer-fewer" policy dating back to 1971. Just before 1980, the policy specified a minimum age at marriage for women of 23 years in rural areas and 25 years in urban areas, whereas the new marriage law of 1980 specified a minimum of 20 years throughout the country (Choe et al. 1996; Riley 2004). The decline in age at marriage that occurred as a result of the 1980 law resulted in a parallel decline in the mean age at first birth that could partly account for the upward spike in the TFR in 1982 approximately two years after the 1980 law was promulgated.

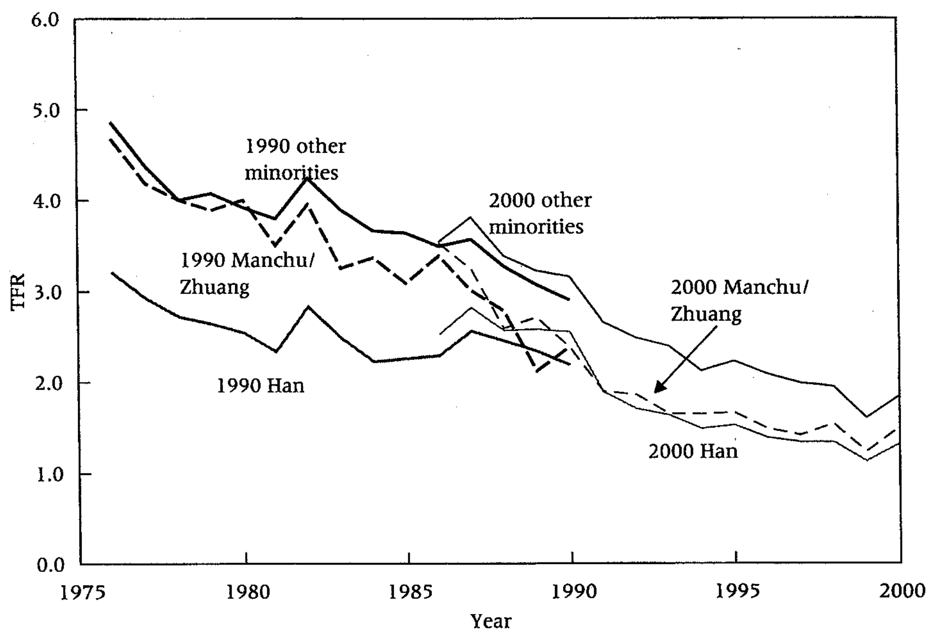
Moreover, 1980–81 was a relatively lenient period characterized by a lull in the issuance of new local regulations aimed at implementing the one-child family policy (Sharping 2003a), and this brief period of leniency may also have contributed to the upward blip in 1982. The drop in fertility in 1983 likely resulted from the considerable tightening up of the one-child policy that occurred in 1981 in urban areas and 1982 in rural areas (Greenhalgh 1986; Short and Zhai 1998). The second upward blip that occurred during 1985–87 was almost certainly a result of the relaxation of the one-child policy following the "open-a-small-hole" policy shift in 1984 (Luther et al. 1990). As a result of this shift, rural couples in some areas of the country whose first child was a girl were permitted to have a second child (Feeney and Yuan 1994; Greenhalgh 1986; Zeng 1989).

Enforcement of the one-child policy was tightened up again in 1988, after which the TFR headed sharply downward once more (Hardee-Cleaveland and Banister 1988). This was followed by further tightening during the 1990s (Scharping 2003a, 2003b). The downward blip in 1999 and upward blip in 2000 may be partly a result of births deferred to 2000, which was an unusually propitious year to have a birth since it was not only the year of the dragon (generally considered to be a lucky year) but also the first year of the new millennium. Another possible reason, already mentioned, is that the instruction to census enumerators not to miss infants may have resulted in some shifting of births from 1999 to 2000 (equivalent to reporting a child aged 1 as aged 0)—a pattern often observed in censuses in other Asian countries (Retherford et al. 1987).

Most ethnic minorities in China were exempt from the one-child family policy until the mid-1980s, after which the exemption was reduced. Two large minorities, the Manchu and Zhuang, were not exempt, however. For our purposes, a convenient classification of ethnicity is therefore Han (encompassing 92 percent of the population in 2000), Manchu/Zhuang (2 percent), and other minorities (6 percent). If nonreporting of births that violate the one-child family policy is the main reason for the pattern of discrepancies in the overlapping trend estimates of the TFR in Figure 2, then we would expect these discrepancies to be smaller for the "other minorities" category than for Manchu/Zhuang or Han. To test whether this expectation is borne out by the data, Figure 4 graphs OWCH estimates of the trend in the TFR for these three ethnic groups. The discrepancies are indeed somewhat smaller for "other minorities" than for Manchu/Zhuang or Han, but not by very much.

Another interesting feature of Figure 4 is that, prior to 1981, the fertility of Manchu/Zhuang was very close to the fertility of "other minorities." After 1981 the fertility of Manchu/Zhuang diverged from that of "other minorities," becoming almost indistinguishable from the fertility of the Han

FIGURE 4 Trend in the total fertility rate for China by ethnicity, estimated by the own-children method applied to the 1990 and 2000 censuses, 1976–2000



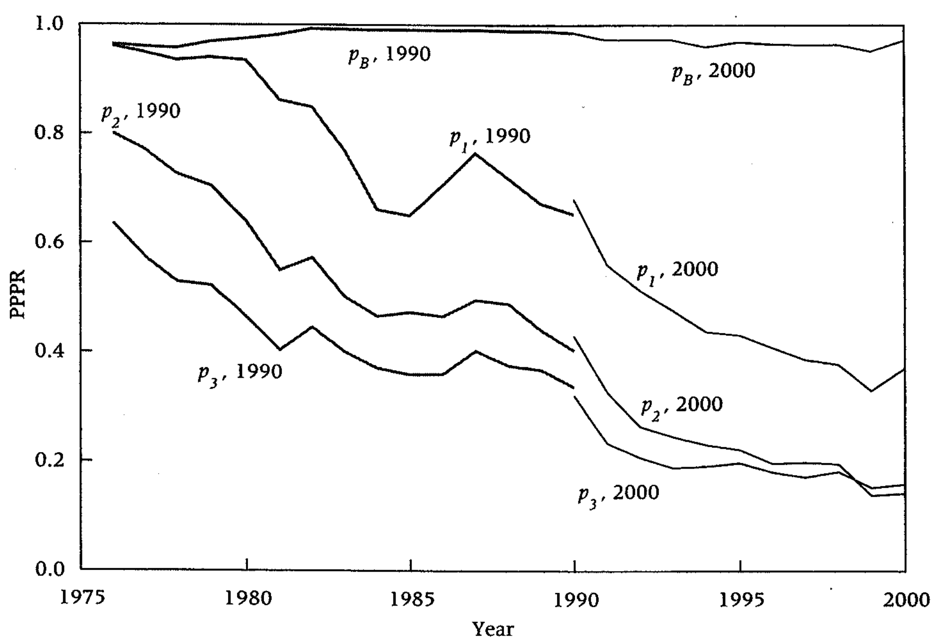
majority by 1987. This shift appears to reflect the effectiveness of the one-child family policy, to which the Manchu/Zhuang minorities were subject.

Trend in parity progression ratios and derived TFRs

We calculate trends in period parity progression ratios (PPPRs) and in total fertility rates derived from these ratios (TFR_{pppr}) by the BHR method. Figure 5 shows estimated trends in the first four PPPRs. As expected, p_B (denoting progression from the woman's own birth to her first birth) is close to one, with a slight increase in the 1980s followed by a slight decline in the 1990s. The rise in the 1980s probably resulted from the new marriage law of 1980, which, as mentioned earlier, relaxed the later-marriage component of the later-longer-fewer policy dating back to 1971. In view of past policy swings, no doubt many couples who might otherwise have waited to marry decided to marry sooner rather than later, just in case the policy were to swing back to later marriage. This may be the main reason why p_B rose to very close to one by 1982 and stayed there until 1990, after which age at marriage began to rise on its own, apparently without an added push from policy, and p_B began to decline.

The progression from first to second birth, p_1, follows a quite different trajectory. Starting at a value close to one, p_1 declined slowly between 1976

FIGURE 5 Trends in period parity progression ratios derived from the 1990 and 2000 censuses, 1976–2000



and 1980, then moved steeply downward beginning one or two years after implementation of the one-child family policy in 1979. It rose somewhat in the mid-1980s when enforcement of the one-child policy was relaxed, then resumed its decline in 1987 when the policy was tightened up (Feeney and Yuan 1994).

The ratios p_2 and p_3 followed a trajectory similar to p_1, except that they were already declining in 1976, no doubt largely as a consequence of the later-longer-fewer policy. The hint of a one-year upward blip seen for p_1 in 1982 is much more pronounced for p_2 and p_3, but in this case the upward blip cannot be a consequence of the 1980 marriage law. Instead, it is probably linked to the brief period of leniency in enforcement of the one-child policy during 1980 and 1981. The various PPPR trends derived from the 1990 and 2000 censuses overlap for the year 1990, as also shown in the figure. The overlapping estimates agree rather closely. The PPPR estimate for 1990 derived from the 2000 census exceeds the PPPR estimate for 1990 derived from the 1990 census, as expected, but not by very much.

A final comment on Figure 5 has to do with underreporting of children ever born, which means that a woman's reported parity is lower than it should be. For reasons discussed earlier, there is undoubtedly some underreporting of children ever born in the two censuses. This tends to bias downward the estimates of p_1 and higher-order PPPRs, and it is the mechanism by which underreporting of children ever born biases downward the estimates of TFR_{pppr}. But the close overlaps in the trends for the year 1990 suggest that this bias is small.

The PPPRs in Figure 5 (as well as p_4, p_5, and p_6^*, which are not shown) can be aggregated into estimates of TFR_{pppr}, as discussed in the earlier section on methodology. The trend in TFR_{pppr}, derived from the 1990 and 2000 censuses, is graphed in Figure 6, along with the trend in the conventional TFR (derived by the BHR method this time), which for clarity is denoted as TFR_{asfr} in the figure. As mentioned in the previous section, TFR_{pppr} is less affected than TFR_{asfr} by period fluctuations in fertility, with the result that the trend in TFR_{pppr} is smoother than the trend in TFR_{asfr}. The upward blip in 1982 is much more noticeable for TFR_{asfr} than for TFR_{pppr}, but, for reasons that are not clear, this is not the case for the upward blip in 1987.

Figure 6 also shows that the overlapping estimates for 1990 are in closer agreement for TFR_{pppr} than for TFR_{asfr}, consistent with the close agreement of overlapping estimates of PPPRs in Figure 5. Because the discrepancies in overlapping estimates of TFR_{pppr} are small, we do not calculate adjustment factors for TFR_{pppr} as we did in the case of TFR_{asfr}.

Because the 1990 census did not include a question on age at first marriage, it is not possible to disaggregate p_B into the product of p_M and p_0 when calculating PPPRs from that census. A question on age at first mar-

FIGURE 6 Trends in the TFR_{asfr} and TFR_{pppr} derived by the birth history reconstruction method applied to the 1990 and 2000 censuses, 1976–2000

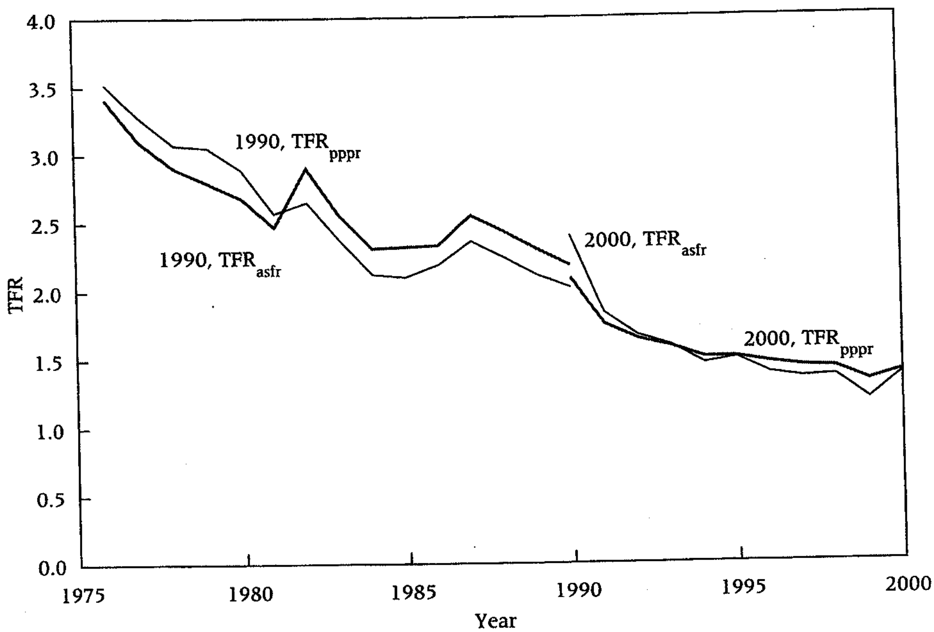
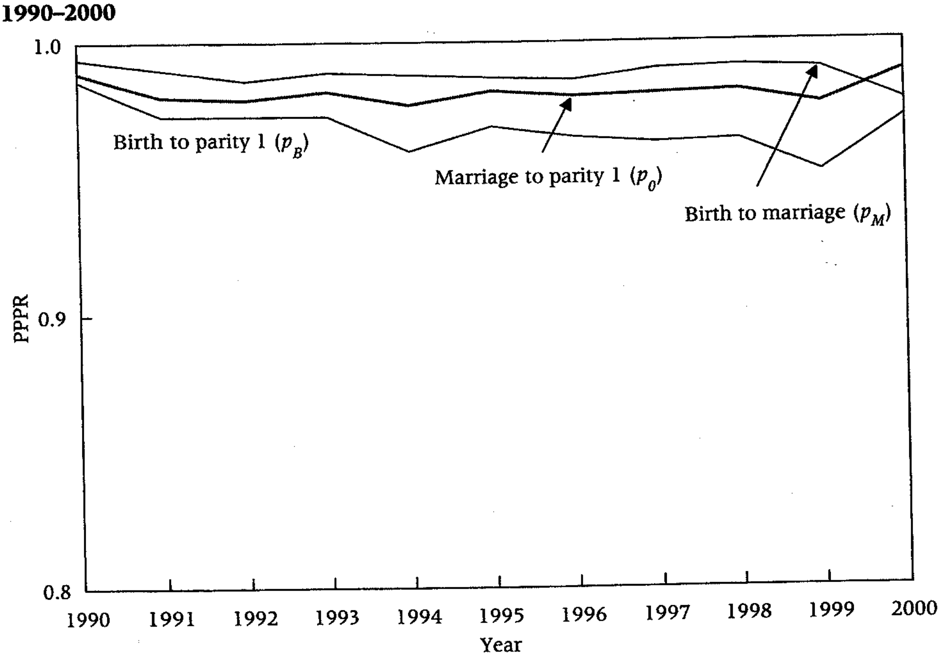


FIGURE 7 Trends in period parity progression ratios derived from the 2000 census: Birth to marriage, marriage to parity 1, and birth to parity 1, 1990–2000



NOTE: See endnote 7.

riage was included in the 2000 census, however, so that it is possible to calculate estimates of p_M and p_0 from the 2000 census that go back to 1990. The trends in these two PPPRs are graphed in Figure 7. Not surprisingly, since p_B is close to one throughout the 1990s as shown earlier in Figure 5, p_M and p_0 are even closer to one and do not show a clear trend.[7]

Decomposition of the change in the TFR

We decompose the change in the TFR into two components, one due to changes in age-specific proportions currently married and one due to changes in age-specific marital fertility rates, in order to assess the contribution of later marriage to China's fertility decline during the 1990s. The decomposition method used for this purpose has been described by Retherford and Ogawa (1978) and Retherford and Rele (1989), who adapted it from Kitagawa (1955). In this case the decomposition pertains to the TFR calculated from ASFRs.

The TFR is calculated as $5\Sigma F_x$, where F_x denotes the ASFR for the age group x to x+5 and the summation ranges from the age group 15–19 to the age group 45–49. We also specify that $F_x = P_x F_{mx}$, where P_x denotes the proportion currently married in the age group x to x+5, F_{mx} denotes the age-specific marital fertility rate (ASMFR) for the age group, and it is assumed that all fertility occurs within marriage (a reasonable assumption for China). It follows that

$$\Delta TFR = 5\sum \bar{F}_{mx}\Delta P_x + 5\sum \bar{P}_x \Delta F_{mx}, \tag{2}$$

where $\bar{F}_{mx}$ and $\bar{P}_x$ are averages, each obtained by summing beginning and end values and dividing the sum by 2 (the use of averages instead of starting values avoids the presence of residual terms in the decomposition), and where Δ denotes change between 1990 and 2000. The first of the two main components on the right side of (2) is interpreted as the portion of the change in the TFR due to nuptiality change, and the second of the two components is interpreted as the portion due to marital fertility change. Each of these two main components is a sum of age-specific components.

In accordance with our earlier reasoning about how the raw TFR estimates should be adjusted, the decomposition of the change in the TFR between 1990 and 2000 in Table 2 utilizes the OWCH estimate of the TFR and ASFRs for 1990 derived from the 2000 census, without adjustment, and the OWCH estimate of the TFR and ASFRs for 2000 derived from the 2000 census, adjusted upward by 16.60 percent. The table shows that declines in age-specific proportions married accounted for 43 percent of the change in the TFR between 1990 and 2000, and declines in age-specific marital fertility rates for 57 percent. Ninety-one percent of the marriage contribution is

TABLE 2 Decomposition of the change in the total fertility rate (TFR) between 1990 and 2000 into components attributable to changes in age-specific proportions currently married and changes in age-specific marital fertility rates

Age group	Starting TFR	Ending TFR	Percent contribution to change in TFR attributable to change in: Proportions married	Marital fertility	Total
15–19			10	1	11
20–24			29	8	37
25–29			3	27	30
30–34			0	10	11
35–39			0	8	8
40–44			0	3	3
45–49			0	0	0
Total	2.58	1.59	43	57	100

NOTE: TFR refers to TFR_{asfr}. Basic calculations for the decomposition were done for five-year age groups. Starting and ending ASFRs and TFRs were estimated by the own-children method applied to the 2000 census. The ending TFR and ASFRs were adjusted upward by 16.60 percent before calculating the decomposition. The official date of the 2000 census was 1 November 2000, so the starting year runs from 1 November 1989 to 31 October 1990, and the ending year runs from 1 November 1999 to 31 October 2000.

concentrated at ages 15–19 and 20–24, reflecting the increase in mean age at marriage. The marital fertility contribution is more spread out, with 94 percent of this contribution occurring at ages 20–39. During this same period, 1990–2000, the singulate mean age at marriage (SMAM) for women, calculated from age-specific proportions single (i.e., never-married) in the 1990 and 2000 censuses, rose from 22.1 to 23.3 years.

To test the sensitivity of the decomposition results to variation in the adjustment factor for the TFR in 2000, we repeated the calculation without any adjustment factor. When this is done (results not shown), the marriage contribution declines from 43 to 33 percent and the marital fertility contribution increases from 57 to 67 percent. These results indicate that changes in proportions married owing to rising age at marriage probably account for somewhere between 33 and 43 percent of the change in the TFR between 1990 and 2000 (but probably closer to 43 percent).

The change in TFR_{pppr} can also be decomposed into components, using the method proposed by Ogawa and Retherford (1993) and the formula for calculating TFR_{pppr} from PPPRs given earlier in equation (1).[8] It is possible to compute in this way a decomposition of the change in TFR_{pppr} between 1990 and 2000, based on estimated PPPRs in 1990 and 2000 as derived from the 2000 census. These estimated PPPRs are used without any adjustments for underreporting (because the overlapping estimates of trends in

TABLE 3 Decomposition of the change in the total fertility rate (TFR_{pppr}) between 1990 and 2000 into components attributable to change in each period parity progression ratio

	Percent contribution from change in								
	p_M	p_0	p_1	p_2	p_3	p_4	p_5	p_{6+}	Total
Decomposition	5	0	70	23	2	0	0	0	100

NOTE: TFR_{pppr} for 1990 and 2000 were both estimated from the 2000 census, without any adjustments. TFR_{pppr} fell from 2.09 in 1990 to 1.39 in 2000.

PPPRs, examined earlier, agree closely). The decomposition is shown in Table 3, which indicates that change in p_M accounts for 5 percent of the change in TFR_{pppr}, and change in p_0 accounts for 0 percent (not surprising since the proportion of married persons who have a first birth was close to one in both censuses). Seventy percent of the change in TFR_{pppr} stems from change in p_1, and another 23 percent from change in p_2. Changes at higher-parity PPPRs account for only 2 percent of the change in TFR_{pppr}. This result is very different from that obtained from the decomposition of the change in TFR_{asfr} in Table 2. The reason why the marriage component is so small in the case of the ΔTFR_{pppr} decomposition is that even though mean age at marriage is rising, almost everyone still gets married, so that p_M is still close to one. This is another illustration of the tendency of TFR_{pppr} to be less sensitive than TFR_{asfr} to changes in the timing of marriages and births.

Differential fertility

We also look at differential fertility and the trend in differential fertility by characteristics asked in the census, namely residence (city, town, rural), education (elementary or lower, middle school, high school, college), migration status (cross-province migrant, within-province migrant, nonmigrant), and ethnicity (Han, Manchu or Zhuang, other minority). A specified level of schooling, such as high school, means that the woman attended that level but did not necessarily complete it. Typically the number of years of schooling for completing each of the lower levels of education is 6 for elementary, 3 for middle, and 3 for high school, although there is some variation across different parts of the country.

Although categories of migration status are labeled identically for 1990 and 2000 in our analysis, they are not comparable because, as already mentioned, the migration questions were quite different in the two censuses. In the case of the 1990 census, we define a migrant simply as a woman who lived either in another county/city within the same province or in a different province five years ago, without reference to her official place of household registration. In the case of the 2000 census, we define a migrant as a person who has been living away from her official place of household registration for at least six months and whose official place of household registration is either in another county/city within the same province or in a different province. Migrants in our 2000 definition pertain to the "floating population," which does not include migrants who have succeeded in changing their official place of registration (not easy to do) to the same county/city where they resided at the time of the census.

Table 4 shows how women aged 15–64 were distributed over categories of these characteristics as well as over categories of age in the 1990 and 2000

TABLE 4 Percent distribution of women aged 15–64 by selected characteristics in the 1990 and 2000 censuses

Characteristics	1990 census	2000 census
Age		
15–19	16	12
20–24	17	10
25–29	14	13
30–34	11	15
35–39	11	13
40–44	8	10
45–49	6	10
50–54	6	7
55–59	5	6
60–64	5	5
Residence		
City	14	26
Town	9	14
Rural	77	60
Education		
Elementary or lower	62	45
Middle school	27	37
High school	10	14
College	1	4
Migration status		
Nonmigrant	96	93
Within-province migrant	3	3
Cross-province migrant	1	4
Ethnicity		
Han	93	92
Manchu or Zhuang	2	2
Other minority	5	6

NOTE: Migration categories are not comparable between the two censuses. See text for explanation.

census samples used in our analysis. The proportion in cities almost doubled between the two censuses, the proportion in towns increased by more than half, and the proportion in rural areas fell from 77 to 60 percent. By education, the proportion with elementary or less education fell from 62 to 45 percent, and the proportion at higher levels increased substantially. By migration status, the proportions for 1990 and 2000 are not comparable, but they do indicate that in 2000 the floating population accounted for 7 percent of the country's population of women aged 15–64. By ethnicity, the proportion who are Han fell slightly from 93 to 92 percent, and the proportion who are "other minority" increased slightly from 5 to 6 percent.[9]

Table 5 shows BHR estimates of the total fertility rate—both TFR_{asfr} and TFR_{pppr}—by these characteristics for five-year periods from 1976–80 to 1996–2000. For reasons of incomplete information discussed earlier, the BHR estimates for 1986–90 are derived from the 1990 census rather than the 2000 census. In no case have adjustments been made for omitted births. BHR estimates are used throughout instead of OWCH estimates, because in the OWCH method the same non-own factors must necessarily be used for all categories of a characteristic, whereas in reality these non-own factors (if we could measure them) are no doubt quite different in some cases.

We note first that fertility differentials by residence and education tend to be large. Urban fertility is much lower than rural fertility, and the fertility of the more-educated is much lower than that of the less-educated. Moreover, fertility declines sharply over time in all residence and education categories, indicating that changes in population composition by residence and education (rising proportions urban and educated) account for only part of the overall fertility decline. By 1996–2000 the total fertility rate, regardless of how measured, was close to 1.0 among women in cities and among women with a high school or college education. The fertility differentials by ethnicity and trends in them were discussed earlier.

TFR (whether TFR_{asfr} or TFR_{pppr}) differentials by migration status are not consistent over time. In 1976–80 the TFR is highest for nonmigrants and lowest for cross-province migrants, perhaps because the latter had more of an elite character (higher socioeconomic status) at that time. By 1996–2000, on the other hand, the TFR was highest for cross-province migrants. The higher fertility of cross-province migrants may occur because, by 1996–2000, most cross-province migration was from poorer, higher-fertility provinces to richer, lower-fertility provinces.

Because migration status is defined differently in the 1990 and 2000 censuses, one cannot say much about trends, although it is clear that fertility declined substantially within all migration status categories during the 1990s, given that the estimates of TFR_{asfr} and TFR_{pppr} for 1991–95 and 1996–2000 are derived only from the 2000 census. The sharp fertility declines within all migration-status categories indicate that changes in population

TABLE 5 Estimates of the total fertility rate for 1976–80, 1981–85, 1986–90, 1991–95, and 1996–2000 derived by the birth history reconstruction method applied to the 1990 and 2000 censuses

	Method	1976–80	1981–85	1986–90	1991–95	1996–2000
All China	TFR_{asfr}	2.96	2.50	2.36	1.61	1.33
	TFR_{pppr}	3.15	2.33	2.17	1.60	1.40
Residence						
City	TFR_{asfr}	1.67	1.41	1.33	1.14	1.04
	TFR_{pppr}	2.10	1.25	1.17	1.19	1.11
Town	TFR_{asfr}	2.30	1.83	1.66	1.44	1.24
	TFR_{pppr}	2.71	1.70	1.54	1.47	1.28
Rural	TFR_{asfr}	3.30	2.83	2.64	1.87	1.49
	TFR_{pppr}	3.44	2.66	2.46	1.84	1.57
Education						
Elementary or lower	TFR_{asfr}	3.35	2.90	2.70	1.99	1.67
	TFR_{pppr}	3.37	2.62	2.49	1.88	1.67
Middle school	TFR_{asfr}	2.23	2.13	2.18	1.53	1.32
	TFR_{pppr}	2.61	1.84	1.96	1.55	1.36
High school	TFR_{asfr}	1.80	1.85	1.66	1.08	1.02
	TFR_{pppr}	2.15	1.55	1.52	1.18	1.07
College	TFR_{asfr}	1.37	1.09	1.14	0.96	0.86
	TFR_{pppr}	1.61	1.05	1.02	1.00	0.93
Migration status						
Nonmigrant	TFR_{asfr}	2.98	2.54	2.37	1.62	1.33
	TFR_{pppr}	3.17	2.35	2.18	1.60	1.40
Within-province migrant	TFR_{asfr}	2.46	1.66	2.15	1.61	1.36
	TFR_{pppr}	2.68	1.88	1.84	1.59	1.38
Cross-province migrant	TFR_{asfr}	2.13	1.57	2.38	1.72	1.57
	TFR_{pppr}	2.25	1.62	1.96	1.74	1.54
Minority status						
Han	TFR_{asfr}	2.86	2.41	2.30	1.56	1.28
	TFR_{pppr}	3.09	2.26	2.11	1.56	1.37
Manchu and Zhuang	TFR_{asfr}	3.95	3.40	2.63	1.67	1.38
	TFR_{pppr}	3.96	3.02	2.42	1.70	1.46
Other minority	TFR_{asfr}	4.48	3.98	3.33	2.29	1.92
	TFR_{pppr}	4.32	3.71	3.11	2.15	1.91

NOTE: The estimates for 1976–80, 1981–85, and 1986–90 are derived from the 1990 census, and the estimates for 1991–95 and 1996–2000 are derived from the 2000 census. The estimates have not been adjusted and are biased downward because of the tendency not to report births that violate the one-child family policy. All estimates shown in the table are derived by the BHR method.

composition by migration status do not explain much of the overall fertility decline, especially since migrants are a small proportion of the population, as seen in Table 4.

Because of the difficulty of adjusting for omissions of births by characteristics in the two censuses, we do not attempt to decompose the decline in the TFR within each category of each characteristic considered in Table 5 into components attributable to changes in proportions married and changes in marital fertility. Instead, we simply provide estimates, shown in Table 6, of how the singulate mean age at marriage (SMAM) changed within each category of each characteristic between the 1990 and 2000 censuses. Overall, SMAM increased by 1.2 years. By residence, SMAM is higher for urban than for rural women, but over time it increased somewhat more for rural women. By education, SMAM is higher for those with more education, but over time it increased more for middle school and high school than for elementary school (and in the case of college there was no change). By migration status, SMAM is higher for nonmigrants than for migrants in the 1990 census, but the reverse is true in the 2000 census. The reasons for this reversal are unclear but probably have to do with the huge growth of the urban floating population between the two censuses as well as different definitions of migration status between the two censuses. By ethnicity, SMAM is higher for Han and Manchu/Zhuang than for "other minority," and over time SMAM increased more for Han and Manchu/Zhuang than for "other minority."

TABLE 6 Singulate mean age at marriage for women by selected characteristics, derived from the 1990 and 2000 censuses

Characteristics	1990 census	2000 census
All women	22.1	23.3
Residence		
City	23.8	24.5
Town	22.9	23.5
Rural	21.7	22.7
Education		
Elementary or lower	21.4	21.8
Middle school	22.2	23.1
High school	23.7	24.6
College	25.6	25.6
Migration status		
Nonmigrant	22.1	23.2
Within-province migrant	22.0	23.9
Cross-province migrant	21.3	24.5
Ethnicity		
Han	22.1	23.4
Manchu or Zhuang	22.0	23.4
Other minority	21.4	22.3

NOTE: Migration categories are not comparable between the two censuses. See text for explanation.

Conclusion

Our analysis indicates that the own-children estimate of TFR_{asfr} for 2000 needs to be adjusted upward by about 17 percent. The raw estimate of 1.36 children per woman is accordingly adjusted upward to 1.59, which is our best (albeit rough) estimate for 2000. Adjustment factors for TFR_{asfr} estimates for 1997, 1998, and 1999 are somewhat lower. The average adjusted TFR_{asfr} for the four years between 1997 and 2000 is 1.46, which is our best estimate for that period. The estimate of 1.46 for the period 1997–2000 may be more accurate than our estimate of 1.59 for 2000.

The decomposition analysis suggests that about two-fifths of the decline in TFR_{asfr} between 1990 and 2000 is accounted for by later age at marriage and three-fifths by declining fertility within marriage. On the other hand, change in the PPPR for progression from woman's own birth to her first marriage accounts for only about 5 percent of the decline in TFR_{pppr} over this same period. The reason for the much lower marriage contribution to decline in TFR_{pppr} is that even though age at marriage rises, almost everyone still gets married, so that the progression ratio for woman's birth to woman's first marriage is still close to one.

The analysis also shows large fertility differentials by urban/rural residence, education, ethnicity, and migration status. Over time, fertility has declined sharply within all categories of these characteristics, indicating that the one-child policy has had large across-the-board effects. A further implication is that compositional changes in the population by these characteristics account for little of the fertility decline. Major fluctuations in fertility since 1979 are clearly linked to fluctuations in enforcement of the one-child family policy.

Our calculations are not precise, owing to uncertainties in our adjustments for underreporting of births and children. Nevertheless, the analysis clearly indicates that the total fertility rate in China continued to decline substantially during the 1990s—not to 1.2 children per woman in the year 2000, as indicated by the 2000 census question on births during the last year, but probably to somewhere in the range of 1.5–1.6 children per woman.

Notes

We thank Chen Shengli for providing information on family planning policy changes over the past three decades, and Gayle Yamashita and Victoria Ho for computer programming assistance.

1 The one-per-thousand data file from the 1990 census is the same as that used by Feeney et al. (1992) and Feeney and Yuan (1994). The one-per-thousand data file from the 2000 census was provided by the National Bureau of Statistics of China. Respondents included in both of these data files responded to the long form of the census questionnaire.

2 The life tables for 1973, 1981, and 1987 are those previously used by Feeney et al. (1992). The life table for 2000 is an official life

table provided by the National Bureau of Statistics. Recently Banister and Hill (2004) have attempted to calculate improved estimates of mortality and life tables using the General Growth Balance method. Their estimated life tables differ little from ours at least as far back as 1987, as the following estimates of life expectancy at birth indicate:

Source and date	**Male**	**Female**
Our estimates 2000	69.6	73.3
Banister/Hill 1999–2000	69.7	72.8
Our estimates 1987	65.7	68.4
Banister/Hill 1982–90	65.9	68.8
Our estimates 1981	66.2	68.7
Banister/Hill	—	—
Our estimates 1973	61.6	62.9
Banister/Hill 1964–82	59.0	61.4

Differences between the two sets of estimates are not great enough to have an appreciable impact on our TFR estimates. The reason is twofold. First, mortality is low enough that reverse-survival factors are close to one. This means that large relative errors in age-specific mortality rates translate into small relative errors in reverse-survival factors. Second, errors in the reverse-survival factors for women (in the denominators of age-specific fertility rates) and children (in the numerators) are in the same direction and therefore cancel out to some extent. See Cho et al. (1986) for evidence on this point. Moreover, any errors in the OWCH estimates of the TFR stemming from errors in reverse-survival factors are small compared to errors stemming from underreporting of young children.

3 Undercount of women, to the extent that it occurred in the 1990 and 2000 censuses, is unlikely to bias significantly the fertility estimates, because if a woman is missed, in the vast majority of cases her children are missed too. Both numerators and denominators of estimated fertility rates are then reduced, so that errors tend to cancel out. For similar reasons, double-counting of women also has little effect on the fertility estimates.

4 Actually the two trends would not exactly coincide, because the 1990 and 2000 censuses were taken in different months of the year. The official date of the 1990 census was 1 July 1990, and the official date of the 2000 census was 1 November 2000. Our estimates are for years before the census, which means years that run from 1 July 1989 to 30 June 1990 in the case of the 1990 census, and from 1 November 1999 to 31 October 2000 in the case of the 2000 census. Thus the period 1986–90 as viewed from the 2000 census is not precisely the same as the period 1986–90 as viewed from the 1990 census, because of the four-month offset. Figure 2 makes no adjustments for this offset. Our convention is to label the year before the 1990 census as 1990, and the year before the 2000 census as 2000.

5 When calculating the adjustment factor, it is necessary to make an allowance for the fact that the 1990 and 2000 censuses were taken in different months of the year (see previous endnote). According to our labeling convention, the year labeled 1990 runs from 1 July 1989 to 30 June 1990 for the TFR estimate derived from the 1990 census, and from 1 November 1989 to 31 October 1990 for the TFR estimate derived from the 2000 census. To make the two estimates of the TFR for 1990 comparable, we adjust the estimate of TFR(1990) from the 2000 census so that it also runs from 1 July 1989 to 30 June 1990. The adjusted estimate is calculated as the following weighted average: (2/3)(TFR(1990)) + (1/3)(TFR(1989)), where TFR(1990) and TFR(1989) are both derived from the 2000 census.

6 We could not go back further than 1987, because the calculation of the adjustment factors for 1986 requires 2000-census-derived fertility estimates for 1985 (see previous endnote). But the application of the own-children method to the 2000 census provides fertility estimates going back only to 1986.

7 When p_B is calculated directly, without reference to marriage, it is not precisely true that $p_B = p_M p_0$. The discrepancy occurs because of the subdivision of the interval between the woman's own birth and her first birth. Much the same thing occurs when the TFR is calculated from single-year ASFRs instead of five-year ASFRs. In general, the TFR is not quite the same in the two cases.

8 The procedure for decomposing the change in TFR_{pppr} (ΔTFR_{pppr}) into a set of parity-specific components due to change in each PPPR is the following: To obtain the

contribution of Δp_M to ΔTFR_{pppr}, one first computes a standardized value of TFR_{pppr} using the 2000 value of p_M and the 1990 values of the remaining PPPRs. Denoting this standardized value as $TFR_{pppr}(M)$, one then calculates the contribution of Δp_M to ΔTFR_{pppr} as $TFR_{pppr}(M) - TFR_{pppr}(1990)$. To obtain the additional contribution of Δp_0 to ΔTFR_{pppr}, one first computes a standardized value of TFR_{pppr} using the 2000 values of p_M and p_0 and the 1990 values of the remaining PPPRs. Denoting this standardized value as $TFR_{pppr}(M,0)$, one calculates the additional contribution of Δp_0 to ΔTFR_{pppr} as $TFR_{pppr}(M,0) - TFR_{pppr}(M)$. Following the same logic, the remaining contributions from Δp_1, Δp_2, Δp_3, Δp_4, Δp_5, and Δp_6* are calculated as $TFR_{pppr}(M,0,1) - TFR_{pppr}(M,0)$, $TFR_{pppr}(M,0,1,2) - TFR_{pppr}(M,0,1)$, $TFR_{pppr}(M,0,1,2,3) - TFR_{pppr}(M,0,1,2)$, $TFR_{pppr}(M,0,1,2,3,4) - TFR_{pppr}(M,01,2,3)$, $TFR_{pppr}(M,0,1,2,3,4,5) - TFR_{pppr}(M,0,1,2,3,4)$, and $TFR_{pppr}(2000) - TFR_{pppr}(M,0,1,2,3,4,5)$. There are no residual terms in the decomposition.

9 Some of the variable categories in Table 4 are as small as 1 percent of the one-per-thousand sample. In the case of "college" in 1990, for example, this 1 percent translates into 5,330 women aged 15–64. This is enough to compute reasonably precise estimates of the total fertility rate. We have not attempted to compute confidence intervals.

References

Banister, Judith and Kenneth Hill. 2004. "Mortality in China 1964–2000," *Population Studies* 58: 55–75.

Cho, Lee-Jay, Sam Suharto, Geoffrey McNicoll, and S. G. Made Mamas. 1976. *Perkiraan Angka Kelahiran dan Kematian di Indonesia Berdasarkan Sensus Penduduk 1971* (Estimates of fertility and mortality in Indonesia based on the 1971 population census). Series Sensus Pendukuk 1971. SP 76-L 02. Jakarta: Biro Pusat Statistik.

Cho, Lee-Jay, Robert D. Retherford, and Minja K. Choe. 1986. *The Own-Children Method of Fertility Estimation*. Honolulu: East-West Center. [Chinese translation (Beijing: Science Press) includes Norman Y. Luther as a fourth author and additional material on the birth history reconstruction method.]

Choe, Minja K., Jianming Wu, Ruyao Zhang, and Fei Guo. 1996. "The pace of family building in China," in Alice Goldstein and Feng Wang (eds.), *China: The Many Facets of Demographic Change*. Boulder, CO: Westview Press.

Chu, Junhong. 2001. "Prenatal sex determination and sex-selective abortion in rural central China," *Population and Development Review* 27: 259–281.

Department of Population and Social Science Statistics. 2002. *China's 2001 Population*. Beijing: China Statistics Press (in Chinese).

Feeney, Griffith. 1986. *Period Parity Progression Measures of Fertility in Japan*. NUPRI Research Papers Series no. 35. Tokyo: Nihon University Population Research Institute.

Feeney, Griffith, Norman Y. Luther, Qing-pu Meng, and Ying Sun. 1992. "Recent fertility trends in China: Results from the 1990 census," paper presented at the International Seminar on China's 1990 Population Census, Beijing, 19–23 October.

Feeney, Griffith and Jingyuan Yu. 1987. "Period parity progression measures of fertility in China," *Population Studies* 41: 77–102.

Feeney, Griffith and Jianhua Yuan. 1994. "Below replacement fertility in China? A close look at recent evidence," *Population Studies* 48: 381–394.

Greenhalgh, Susan. 1986. "Shifts in China's population policy, 1984–86: Views from the central, provincial, and local levels," *Population and Development Review* 12: 491–515.

Guo, Zhigang. 2003. "Study for fertility of China in the 1990s," paper presented to the Workshop on Population Changes in China at the Beginning of the 21st Century, Canberra, Australia, 10–12 December.

Guo, Zhigang, Erli Zhang, Baochang Gu, and Feng Wang. 2003. "Variations in China's fertility policy as seen in policy-stipulated fertility levels," *Population Research* 27(5): 1–10 (in Chinese).

Hardee-Cleaveland, Karen, and Judith Banister. 1988. "Fertility policy and implementation in China, 1986–88," *Population and Development Review* 14: 245–286.

Kitagawa, Evelyn M. 1955. "Components of a difference between two rates," *Journal of the American Statistical Association* 50: 1168–1194.

Luther, Norman Y. and Lee-Jay Cho. 1988. "Reconstruction of birth histories from census and household survey data," *Population Studies* 42: 451–472.

Luther, Norman Y., Griffith Feeney, and Weimin Zhang. 1990. "One-child families or a baby boom? Evidence from China's 1987 One-per-Hundred Survey," *Population Studies* 44: 341–357.

Luther, N. Y. and Chintana Pejaranonda. 1991. "The parity structure of fertility decline in Thailand," *Genus* 47: 63–88.

Merli, M. Giovanna. 1998. "Underreporting of births and infant deaths in rural China: Evidence from field research in one county of northern China," *The China Quarterly* 155: 637–655.

Merli, M. Giovanna and Adrian E. Raftery. 2000. "Are births underreported in rural China? Manipulation of statistical records in response to China's population policies," *Demography* 37: 109–126.

Merli, M. Giovanna and Herbert L. Smith. 2002. "Has the Chinese family planning policy been successful in changing fertility preferences?," *Demography* 39: 557–572.

Murphy, Rachel. 2003. "Fertility and distorted sex ratios in a rural Chinese county: Culture, state, and policy," *Population and Development Review* 29: 595–626.

National Bureau of Statistics of China. 2002. *Tabulation on the 2000 Population Census of the People's Republic of China*. Beijing: China's Statistics Press.

Ogawa, Naohiro and Robert D. Retherford. 1993. "The resumption of fertility decline in Japan, 1973–92," *Population and Development Review* 19: 703–741.

Retherford, Robert D. and Norman Y. Luther. 1996. "Are fertility differentials by education converging in the United States?," *Genus* 52(3–4): 13–37.

Retherford, Robert D., G. Mujtaba Mirza, Mohammad Irfan, and Iqbal Alam. 1987. "Fertility trends in Pakistan—The decline that wasn't," *Asian and Pacific Population Forum* 1(2): 1–10.

Retherford, Robert D. and Naohiro Ogawa. 1978. "Decomposition of the change in the total fertility rate in the Republic of Korea, 1966–70," *Social Biology* 25: 115–127.

Retherford, Robert D. and J. R. Rele. 1989. "A decomposition of recent fertility changes in South Asia," *Population and Development Review* 15: 739–747.

Riley, Nancy E. 2004. "China's population: New trends and challenges," *Population Bulletin*, June.

Scharping, Thomas. 2003a. *Birth Control in China, 1949–2000*. London and New York: RoutledgeCurzon.

———. 2003b. "The 2000 census and the decay of Chinese birth statistics: A review of figures, procedures and policies," paper presented at the Workshop on Population Changes in China at the Beginning of the 21st Century, Canberra, Australia, 10–12 December.

Short, Susan E. and Zhai Fengying. 1998. "Looking locally at China's one-child policy," *Studies in Family Planning* 29: 373–387.

United Nations. 2001. *World Population Prospects: The 2000 Revision, Vol 1: Comprehensive Tables*. New York.

Yu, Jingyuan and Jianhua Yuan. 1996. "Analysis on fertility situation of women in China in the recent years," in Jiang Zhenghua (ed.), *The Collection of Research Papers of 1992 Fertility Sampling Survey in China*. Beijing: China Population Publishing House, pp. 21–34 (in Chinese).

Zai, Zhengwu. 2003. "Well-rounded building of a moderately developed society and all-rounded solution of the population problem," *Population Research* 27(1): 1–4 (in Chinese).

Zeng, Yi. 1989. "Is the Chinese family planning program 'tightening up'?," *Population and Development Review* 15: 333–337.

———. 1996. "Is fertility in China in 1991–92 far below replacement level?," *Population Studies* 50: 27–34.

Zhang, Guangyu. 2003. Estimates of China's fertility in the 1990s: Data sources, regional disparities and underreporting of births," paper presented to the Workshop on Population Changes in China at the Beginning of the 21st Century, Canberra, Australia, 10–12 December.

———. 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, Boston, 1–3 April.

Zhang Weimin and Cui Hongyan. 2003. "Estimation of the completeness of 2000 national population census data," Population *Research* 27(4): 25–35 (in Chinese).