Fertility, Child Underreporting, and Sex Ratios in China:

A Closer Look at the Current Consensus

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Abstract

I compare child counts in China's 2005 sample census to counts projected to that year based on the 1990 census and official fertility statistics. Implied age patterns of underreporting in 2005 suggest that official statistics overstate China's true fertility in the late 1990s, a conclusion shared by a "new consensus" of China demographers. Yet several assumptions of the new consensus are improbable, and child underreporting patterns are again key to understanding these issues. I then conduct a similar analysis of sex ratios of children and births from 1982 to 2005. Such ratios are now the world's highest, although due to excess underreporting of daughters, estimated ratios are lower than the reported ratios often quoted. I also find that China's sex ratio at birth (standardized by birth order) fell between 2000 and 2005 and that posited causal links between local "1.5-child" policies and sex selection are premature.

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Introduction

Interest in China's population is strong, given its rapid ascent in world affairs and status as a demographic billionaire (Tien, 1983). Yet uncertainty over China's fertility patterns, the main engine of its population growth, has hindered our ability to gauge the true pace of demographic change. Among three primary causes of that uncertainty, the first and foremost is China's family planning program. Since the early 1970s, parents who violate birth restrictions have been subjected to fines and penalties (Bongaarts and Greenhalgh, 1985; Banister, 1987; Lavely and Freedman, 1990; Tien, 1991; Zeng, 2007). Moreover, following a 1991 central decree (Xinhua, 1991), such penalties were increasingly enforced against officials who failed to limit fertility in their jurisdictions (Greenhalgh et al., 1994; Zeng, 1996; Smith et al., 1997; Merli, 1998; Tan, 1998; Merli and Raftery, 2000). China's fertility policies thus provide a powerful incentive for both parents and officials to underreport births as well as children (Feeney and Yuan, 1994; Merli, 1998; Tan, 1998; Scharping, 2007).

China's statistical authorities are well aware of these problems. Since 1990 the National Bureau of Statistics (the central authority for gathering and disseminating statistics in China) has adjusted the fertility levels reported in their censuses, sample censuses, and annual population surveys for presumed underreporting (Goodkind, 2004; Qiao, 2005; Zhang and Zhao, 2006). Such upward adjustments are incorporated in the birth and crude birth rate statistics published in their *China Statistical Yearbook.* Yet these adjustments themselves constitute a second cause of uncertainty (and dispute), in part because the National Bureau of Statistics (hereafter abbreviated as NBS) does not explain the reasoning behind them (ibid.).

A third and less-explored element contributing to uncertainty concerns the various interests among observers of China's statistics. Although there has long been a diversity of opinion, demographers have often been able to reach consensus, and that consensus has shifted over time. About a decade ago, a dominant concern was that NBS adjustments to fertility might not be sufficient (Feeney and Yuan, 1994; Zeng, 1996; Merli and Raftery, 2000; Attane, 2001). More recently, a new consensus of studies instead argues, either explicitly or implicitly, that the NBS *overinflates* fertility statistics (Guo et al., 2003; Guo, 2004; Scharping, 2005; Retherford et al. 2004 and 2005; Wang, 2005; Cai, 2005; Zhang and Zhao, 2006; Guo and Chen, 2007; Gu et al., 2007; Zeng, 2007). In my view, this new consensus has coalesced without enough review of the quality of the evidence presented. This paper begins by reviewing the assumptions and evidence presented by the new consensus. I find that key empirical arguments tend to be weak and inconsistent.

I then present an intercensal analysis comparing child counts in the recently released 2005 sample census with a projection of such counts based on the 1990 census and fertility statistics from the *China Statistical Yearbook*. Aberrant age patterns of child underreporting provide what may be the first convincing evidence that the NBS did indeed overinflate fertility in the late 1990s. Yet my analysis points to a different explanation than has heretofore been offered. Notable overinflation evidently did not occur until 1996, immediately after the NBS had determined high birth underreporting in the 1995 sample census. I show that child underreporting was also particularly pronounced in the 2000 census (long form) and 2005 sample census. My working hypothesis is that the NBS may have been influenced by such excess underreporting in quinquennial census years when deciding where to peg fertility in non-census years. To better unravel the forces leading to child underreporting by age in the 2000 census, I present an exploratory model illustrating the roles of fertility decline, cohort deviations from "policy fertility" (Gu et al. 2007), as well as age/period components.

I then address distortions in sex ratios of births and children, another topic that has drawn widespread attention (Hull, 1990; Johannson and Nygren, 1991; Zeng, et al., 1993; Goodkind, 1996; Short and Zhai, 1998; Li, 2007; Cai and Lavely, 2007). Based on an intercensal analysis of reported sex ratios of children, as well as other sources of data, I conclude, as have others, that China's sex distortions for almost a decade have been among the world's highest (Banister, 2004; Li, 2007). However, actual sex ratios at birth (and child sex ratios) tend to be lower than those quoted by many demographers due to excess underreporting of daughters relative to sons. The age pattern of excess daughter underreporting is similar to that for both sexes combined, with each pattern peaking around ages 1 to 3. I also find a decline in the propensity to selectively abort females from 2000 to 2005 and raise questions as to whether prenatal sex discrimination can be attributed to local "1.5-child" policies (which allow a second child only if the first is a daughter).

Fertility and Child Underreporting Patterns

Official Fertility Statistics: Reported, Provincial, and as Adjusted by NBS

The NBS publishes annual crude birth rates (births divided by the total population, hereafter abbreviated as CBR) in its *China Statistical Yearbook*. The figures reflect upward adjustments made to reported data in its annual survey of population change (typically a 1-per-1000 survey), as well as decennial censuses and sample censuses. Discrepancies between these adjusted statistics and other CBR figures published by NBS can cause confusion. For instance, results from the long form of the 2000 census indicate a CBR of 10.0 (per thousand) in the year prior to the census date (November 1, 2000), while results from the short form indicate that it was 11.4, more than 10 percent higher (Population Census Office, 2002). These two different figures are both "official" results of the census. Yet just a few months after releasing the census results, the NBS published a third crude birth rate of 14.0 for the year 2000 in the *China Statistical Yearbook 2002* (National Bureau of Statistics, 2002).

The NBS has not published an official total fertility rate (TFR – expected births per woman's lifetime) in the *China Statistical Yearbook* since 1992 (Guo and Chen, 2007). It does publish annual age-specific fertility rates, although these are not adjusted for underreporting. The avoidance of the TFR may be due to the sensitivity of this measure (ibid.). Unlike the CBR, the TFR provides an intuitive yardstick for authorities to gauge compliance with China's fertility policies. What are often taken to be China's "official" TFR statistics are quoted from the State Family Planning Committee (now part of the Population and Family Planning Commission), an organization tasked with implementing and enforcing China's fertility policies.[1] According to that Committee, China's TFR around the 2000 census was 1.8 births per woman (Gu, 2002), although it is not clear what methods were used to determine that figure.

[1]The State Family Planning Committee (SFPC) has conducted many surveys on China's fertility in recent years. Given the SFPC's responsibilities to enforce birth regulations, respondents to SFPC surveys may be particularly cautious – birth reporting is consistently less complete than in NBS surveys (Attane, 2001; Guo et al., 2003; Zhang and Zhao, 2006). Underreporting of births and children is also unusually high in China's household registration system (ibid.), which is maintained by the Department of Public Security. I do not analyze data from either of these organizations herein. In my view, any insights gained about China's fertility from SFPC surveys or the household registration system are outweighed by the questionable inferences and comparisons often drawn from them.

Estimates of China's TFR vary widely (Lutz et al., 2005) and span a variety of methods. For many years, the U.S. Census Bureau has used its population projection software to translate NBS-adjusted crude birth rates into matching TFRs.[2] This method indicates a TFR of 1.70 in 2000, the same estimate provided by the United Nations, as well as Liang (2003) and Li (2007). Despite some uncertainty about the accuracy of NBS adjustments, the U.S. Census Bureau avoids adjusting official estimates from other statistical agencies unless there is a strong empirical basis for doing so.

The top line of Figure 1 presents the U.S. Census Bureau translated time series of TFRs from 1991 to 2006 derived from NBS-adjusted CBRs. The bottom line of Figure 1 shows TFRs derived from the raw age-specific fertility rates reported from censuses, sample censuses, and annual surveys of population change (taken in non-census years). The middle line of Figure 1 shows translated TFR estimates based on weighted averages of crude birth rates provided by each provincial statistical bureau to the NBS. These province-reported estimates are based on a variety of local data sources, including surveys, vital registration (often partial), and other information. NBS adjustments imply that fertility is substantially underreported in national raw census and survey data, less so in provincial reports. Figure 1 also shows fertility estimates based on backdated annual new school enrollments (Scharping, 2005, to be discussed shortly), which experts have cited as a critical check on the accuracy of NBS adjustments (Zhang and Zhao, 2006).

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[2]CBRs are converted to their TFR equivalents via a population projection program, which uses official age-specific fertility in key years as well as some adjustments to the census count of 1990 (the base year of the projection) by age and sex (see footnote #3). These factors affect the relationship between the TFR and the crude birth rate. The projections also incorporate estimates of sex ratios at birth as well as age- and sex-specific mortality and net migration.

Underreporting in the 1990 and 2000 Censuses

Before considering further the NBS adjustments to annual reported fertility, Table 1 shows estimates of child underreporting in recent censuses of China and other Asian areas based on U.S. Census Bureau intercensal projections. A standard method to derive such estimates compares the number of children reported in each census to child numbers projected from an earlier census or backprojected from a later census at older ages. Forward projections use annual assumptions of age-specific fertility, sex ratios at birth, as well as age- and sex- specific mortality and migration. Backprojections use reverse survival by sex to bring back into the population those who died or migrated away. For 1982, separate estimates are based on backprojections from the 1990 and 2000 censuses, respectively. For 1990, estimates are based on backprojections from 2000 and forward projections from 1982. Although the pairs of estimates for 1982 and 1990 vary somewhat, this analysis suggests that child underreporting in these censuses was no higher than 8 percent at ages 0-4 and no higher than 4.2 percent at ages 5-9.

For 2000, estimates are based on comparisons of actual child counts to projections from the 1990 census.[3] Given some uncertainty about fertility in the 1990s (through which births are "generated" in our projections), I consider three scenarios. The first projection uses official NBS-adjusted fertility from 1990 to 2000 (the top line of

[3]The base population in 1990 used in these projections includes a variety of adjustments, including increases at ages 0-9 determined through comparisons with the 2000 census (Zhang and Cui, 2003; Goodkind, 2004; Retherford, et al., 2005). Basic annual parameters of net migration and mortality used in projections from 1990 to 2000 appear in Goodkind (2004; appendix).

Figure 1). The second utilizes province-reported fertility levels (the middle line of Figure 1). The third is a hybrid which, as I will shortly demonstrate, seems to represent the new consensus. It uses NBS-adjusted estimates for 1990-1995 (which nearly match the estimates back projected from new school enrollments) and province-reported estimates for 1996-2000 (which produce a TFR just below 1.6 by the late 1990s). This hybrid scenario suggests that 17.5 percent of children at ages 0-4 went underreported in 2000, more than double that of 1990. At ages 5-9, 12.2 percent went unreported in 2000, about triple that of 1990. The size and growth in these percentages is particularly striking given that underreporting above age 20 was negligible in the 2000 census (see Figure 1 in Goodkind, 2004). These findings provide some evidence that a long-held supposition that China's 1991 decree, which held local officials responsible for family planning violations within their jurisdictions, increased incentives to not report children to statistical authorities (Greenhalgh et al., 1994; Zeng, 1996; Merli and Raftery, 2000).

A Closer Look at New Consensus Studies

The new consensus of studies challenges NBS-adjusted estimates, typically arguing that China's total fertility rate as of the 2000 census was between 1.5 and 1.6 births per woman, or perhaps even lower. All of the authors in this consensus participated in a conference in Canberra in December 2003 on the demography of China, and resulting citations of the new consensus are tightly cross-referenced. I review the strengths and limitations of these studies below.

First, Guo (2004) and Guo and Chen (2007) employ two methods of fertility estimation based on the 2000 census (long form). They begin with child-mother matching techniques to estimate age-specific fertility in the 1990s based on reported children. No upward adjustments are made for either child underreporting or infant mortality. The resulting estimates imply that fertility declined fairly steadily after 1990, reaching a TFR of 1.23 in 2000, just above the basic long form estimate. The authors then use quantum-tempo approaches to remove short-term timing effects to better approximate lifetime fertility. This approach is especially helpful in China's context, since those evaluating the effectiveness of family planning regulations should be more concerned with lifetime measures of fertility than period measures. Their quantum-tempo adjusted TFR estimate in 1999 is 1.58, a finding often cited to reinforce the simple period measures computed by others. Yet such citations compare apples to oranges – a quantum-tempo estimate is an entirely different measure, and this particular quantum-tempo estimate is not adjusted for child underreporting.

Retherford et al. (2004, 2005) apply own-children methods to the age distribution of children in the long form of the 2000 census. Own-children results at age zero raise their estimate of the 2000 TFR from 1.22 (as reported in the long form) to 1.35 (comparable to that implied by the short form). They then further inflate that estimate to 1.59 based on the assumption that the same proportion of infants went underreported as in the 1990 census. That second correction factor for underreporting in 1990 (1.16) was calculated by comparing the reported cohort of infants in 1990 to those at age 10 in 2000. The authors acknowledge the *ceteris paribus* assumption to be "heroic" and that "the true correction factor … is almost certainly different" than the one they used, yet cite an absence of other information with which to make better estimates. The same assumption of unchanged underreporting at ages 1-3 between 1990 and 2000 suggests a TFR of 1.42

for the period 1997-1999,[4] which the authors offer may be more accurate than their point estimate for 2000. However, the reported data on Figure 1 (bottom line) does not support the *ceteris paribus* assumption. The estimate of 1.42 falls *below* the raw data collected in annual surveys from 1997-1999. That estimate could only be correct if one assumed that survey respondents in China *overreport* their births – an extraordinarily unlikely possibility. Moreover, as demonstrated in Table 1, child underreporting appears to have more than doubled between the 1990 and 2000 censuses.

Cai (2005) offers fertility estimates based on the "variable-r" method, which draws upon stable population theory. A major advantage of this elegant method is that it does not rely on back projected numbers of reported children – it only requires growth rates across time, which are derived by the author from child counts at ages 0-9 in China's 1990 and 2000 censuses. A limitation noted by the author, however, is that the method assumes no change in underreporting over time, the same assumption made by Retherford et al. (2005). The central TFR estimate derived from variable-r (1.58, which refers to the full interval from 1990-2000) is marginally below the average TFR reported in censuses and surveys over that same interval (1.60).[5] Thus, estimates based on variable-r imply that there was no underreporting of births during this period. In fact, Cai's impressive analysis of annual age counts by cohort implies that child

[4] I derived this figure from simple algebra applied to the best estimate TFRs offered by Retherford, et al (2005) for 1997-2000 (1.46) and 2000 (1.59). I solved for x as follows: [(1.59 *.25) + (x * .75) = 1.46].

[5] Cai's calculation of the reported TFR during the intercensal interval (1.48) is identical to the average of NBS data for 1991-2000 shown in Zhang and Zhao (2006; Table 3). Yet a calculation based on these data is biased downwards because 1) it does not include age-specific fertility among women at ages 35 and above; 2) it does not include a TFR for 1990 (part of the intercensal period), when fertility was highest; and 3) the 2000 TFR is based on the long form, which is about 10 percent below that of the short form.

underreporting, if anything, increased during the 1990s, in line with our findings in Table 1.[6]

Zhang and Zhao (2006) argue that NBS estimates of fertility imply rates of child underreporting that are too high, especially in the second half of the 1990s. However, the only direct empirical evidence the authors present to indicate overinflation is that NBS fertility adjustments in 1993 and 1994 (about 13 percent; see their Table 5) were about double that implied by post-enumeration surveys (PES) in those years (Jia and Sai, 1995). However, scholars who have examined PES efforts in other countries (Whitford and Banda, 2001) have raised serious questions about the ability of a PES to detect underreporting. And a PES may be especially ineffective in uncovering hidden children in China, since penalties for revealing an out-of-quota birth could be just as severe as in the original survey.

Lastly, the aforementioned study by Scharping (2005) projects backwards new school enrollment statistics to estimate the corresponding number born in each calendar year. Scharping's back projections improve upon other enrollment-based studies by considering that a small portion of new enrollments may occur at ages seven and higher. Since these data are derived from an independent source (the Ministry of Education) the results could provide an ideal way to verify NBS estimates. Scharping's total fertility rate calculations for the early 1990s are comparable to NBS-adjusted figures, while those for the late 1990s fall to just below 1.6, similar to province-reported figures (see Figure 1). However, even these estimates are subject to question. For instance, a critical

[6]Figures 3-5 in Cai (2005) show a U-shaped tendency for cohorts born in 1987-2001 – compared to initial counts at age zero, counts at ages 1-5 are relatively incomplete and then become more complete when they reach school age. Cai infers that child under-enumeration did not worsen during the 1990s. Yet these figures do not show temporal patterns. When one rearranges the data with calendar year on the X axis, reporting completeness at early childhood ages (relative to age zero) notably declines over the interval.

component of these back projections is school enrollment rates. Since not all children enroll, these rates are determined by dividing enrollees by the presumed total number of children. Due to substantial child underreporting, the denominator of this calculation is *itself* uncertain.

Wang (2005), Zeng (2007), Zhao and Guo (2007), and Gu et al. (2007), although not deriving independent estimates themselves, recently nod in favor of the new consensus. The latter study is particularly notable for estimating China's "policy fertility" – the national fertility level allowed under the variety of fertility restrictions implemented at the local level – to be 1.47, an important benchmark concept we will return to later in the paper. The authors cite new consensus estimates "of around 1.5 by the late 1990s" and draw other comparisons to propose a convergence between policy-mandated and actual fertility, although close inspection suggests less of a convergence than claimed.[7]

To conclude, new consensus studies have established a plausible hypothesis that official NBS-adjusted fertility statistics (published in its *China Statistical Yearbook*) may be overinflated. However, plausible hypotheses require convincing evidence before they can be accepted. In my view, with the possible exception of Scharping (2005), empirical evidence presented by the new consensus has been weak, often based on the improbable assumption that child underreporting does not exist, or that the prevalence of child underreporting did not change between the 1990 and 2000 censuses. Given the improbability of these assumptions, one may better understand why the NBS has not

[7]The authors claim to show convergence in their Table 3 (Gu et al., 2007), which compares estimates of policy fertility in each province with fertility reported in the 2000 census (short form). Yet the census figures quoted contain no upward adjustments for underreporting. As shown in Table 1, even new consensus estimates of fertility imply double digit underreporting of children.

revised downwards its fertility estimates to the levels implied by the new consensus,[8] and why other large statistical agencies that provide demographic estimates for China (such as the U.S. Census Bureau) have not provided a different set of fertility estimates.

Why then, given questions about the quality of evidence, has the new consensus coalesced? One possible explanation by Scharping (2007; p. 34) notes "a new debate over the accuracy of Chinese population statistics … [which] is intimately interwoven with the overall assessment of Chinese birth control policies … and leads to the question of whether present policies should be continued." This observation suggests that change in China's population policies may hinge on which demographic estimates gain most credence among population experts.

A New Test of the New Consensus - Intercensal Analysis of 2005 Child Reporting

I now present an analysis comparing the number of children counted at ages 0-19 in China's 2005 1-percent sample census (November 1) versus counts projected to that time based on the 1990 census – NBS-adjusted fertility from 1990-2005 projects the cohort at ages 0-14 in 2005. This analysis differs from those presented before, because it compares age patterns between a census and a sample. For proper comparisons with the census-based projection, we scaled up 2005 sampled counts at each age by the inverse of the sample portion (1.325 percent). Note that this sample portion is *itself* an estimate provided by the NBS, determined by dividing the sampled count by their projection of the total count in 2005. Naturally, there is little difference between our total projected

[8] Note that figures appearing in *China Statistical Yearbook* may be modified over time, sometimes in tandem with census findings. For instance, following the 1990 census, the crude birth rates listed for the 1980s were raised. Conversely, following the 2000 census, crude birth rates listed for 1998 and 1999 (in the 2000 and 2001 *Yearbooks*) were reduced in the 2002 *Yearbook*.

count in 2005 and the scaled count,[9] although there are relative differences at particular age groups. The results are shown in Table 2. Columns at the right in Table 2 show relative underreporting in the 2005 sample census by single years and 5-year age groups.

We contrast these findings with the bottom panel of Table 1, which shows child underreporting patterns in Asia. The average and median of underreporting at ages 0-4 is about 8 percent, more than double that at ages 5-9 (about 3 percent). Chinese censuses from 1982 to 2000 show a similar concentration of underreporting at 0-4. Underreporting may be higher at ages 0-4 in part because of uncertainty as to which household a young child may belong. It likely declines at 5-9 because school-age children often need to be registered, and such registration encourages parents to report children in censuses and surveys.

However, implied child underreporting is estimated at over 12 percent in 2005 both at ages 0-4 and 5-9. This pattern likely indicates that the official fertility statistics from 1996-2000 used in the projections increased the projected population at 5-9 in 2005 too far above the children counted in 2005. This may be the first strong evidence that current NBS estimates likely over-inflate China's fertility in the late 1990s. To reduce the percent underreported at 5-9 to half of that at 0-4, we would need to reduce the crude birth rates currently listed in the *China Statistical Yearbook* by about 6 percent from 1996-2000. The resulting fertility rates in those years would look surprisingly similar to the middle line on Figure 1 – the fertility rates as determined by the provinces. This would in turn imply that no further inflation of fertility by the NBS was required for those years beyond that estimated by the provincial bureaus.

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[9]The NBS estimate of a 1.325 percent sample is based on their projection of the total population. Our projection parameters (fertility, mortality, net migration) may differ somewhat, so our projected population total may not match exactly the inflated/scaled population.

Why Would the NBS Over-inflate Fertility? – A New Working Hypothesis

Zhang and Zhao (2006) suggest that China's NBS began to mistakenly overinflate fertility beginning in 1993, shortly after the 1991 decree was enacted (Xinhua, 1991). Yet if one accepts Scharping's (2005) backdated fertility estimates based on new school enrollments, there was no excess inflation over the interval 1991-1995 (Figure 1); a slight underinflation in 1991-1992 was counterbalanced by a slight overinflation in 1993-1994, and the adjustment in 1995 was a near match. Given strong incentives to underreport children due to China's family planning penalties, NBS adjustments to fertility during those years appear to have been remarkably accurate.

Notable overinflation did not seem to occur until 1996. Figure 2 shows the percent differences between fertility measures shown on Figure 1. In essence, Figure 2 shows the percentage of fertility underreporting implied through comparisons of each pair of measures. Based on comparisons of NBS-adjusted fertility and reported fertility, birth underreporting apparently jumped in the 1995 sample census.[10] Our working hypothesis is this jump in 1995 may have led the NBS to over-estimate underreporting in subsequent years. In fact, underreporting also jumped in the 2000 census and 2005 sample census relative to adjacent years. Ironically, it appears that census years, from which data are most nationally representative, most carefully analyzed, and most relevant to infer patterns in adjacent years, are the most prone to child underreporting.

Why might child underreporting be excessive in recent census and sample census years? One possible explanation is that parents and local officials fear that results from

[10]The data series quoted by Zhang and Zhao (2006, Table 5) did not show such a sharp jump in underreporting in 1995 because the quoted source of data (CPIRC Research Group, 2003) had already partially adjusted upwards child counts from the 2005 raw data.

such broader undertakings will invite closer scrutiny, causing more above-quota births to be omitted. Related to this is China's household (*hukou*) registration system, which is maintained by the Department of Public Security to track the location of its citizens. That system also gives authorities the means to monitor compliance with family planning regulations. Since freshly updated registers have traditionally provided a means for verifying counts in the census, omission of children from the registers due to fear of penalties (Merli, 1998; Attane, 2001) may be mirrored in especially high undercounts in census years. Other possible explanations could be related to the design and implementation of fertility questions asked in census and bi-census years compared to the annual surveys.

We leave exploration of the above theories for further research. The second aspect of our working hypothesis concerns the drop in *birth* underreporting implied by the new consensus. Scharping's (2005) fertility estimates imply that NBS presumptions of 11 percent underreporting of births in annual surveys from 1991-1994 (Figure 2) were highly accurate, yet from 1996-1999, province-reported estimates (consistent with the new consensus) imply that only 6 percent of births went unreported. This implies a puzzling conundrum. How is it that births might have become more completely reported during the 1990s when implied *child* underreporting increased so dramatically between the 1990 and 2000 censuses? We explore an answer to this puzzle in the next section.

An Exploratory Model of Birth and Child Reporting Based on Fertility Change and Policy Fertility

To better understand opposing trends in birth and child underreporting, and to link them to fertility decline, fertility restrictions and other factors, I present an exploratory model in Table 3. The top panel shows estimates of child underreporting in the 2000 census implied by comparisons to projections from the 1990 census – based on the fertility pattern which approximates the new consensus view of fertility decline.

I then determine the amount of census underreporting that could be due to "policy fertility," the concept described earlier (Gu et al., 2007). Although some localities in China enforce a strict one-child limit, some allow two (or even three) children, while the majority of localities promote a "1.5-child" limit, which permits a second child only if the first child is a daughter (Short and Zhai, 1998). Based on the distribution of such localities as well as assumptions about additional loopholes, Gu et al. (2007) determined that the policy fertility in China was 1.47 as of the 2000 census. The top panel in Table 3 presumes that "policy fertility" remained constant at 1.47 from 1991-2000 (it may actually shift; Short and Zhai, 1998). The table assumes that all births above that level go unreported at age zero, as well as at subsequent ages as the cohort progresses. The percent of each birth cohort expected to go unreported is listed in the second column from the right.

As fertility falls in China, the proportion of births that run afoul of family planning policies should decline. All else being equal, since fewer parents would need to hide their children for fear of family planning penalties, underreporting should decline. This might be considered a "cohort component" of underreporting in the 2000 census, a maximum that could be due to policy fertility. Note on the top panel that constant policy fertility of 1.47 combined with fertility decline suggest that almost 20 percent of birth cohorts born in 1991-1995 might go unreported, compared to about 7 percent of cohorts born from 1996-2000. Assuming fertility truly fell during the late 1990s in line with new consensus presumptions, the NBS may have overlooked the need to reduce its adjustment factor downwards (a key issue raised by Zhang and Zhao, 2006).

In the far right column of the top panel, I subtract the cohort component from the estimate of underreporting by age in the 2000 census. This second residual component represents an amalgam of factors affecting underreporting by age unrelated to the initial excess above policy fertility. Across ages 0-9 (e.g., those born 1991-2000), the residual component is not much different than zero (1 percent) because child underreporting in the 2000 census is close to the cohort component related to policy fertility (14.5 vs. 13.5 percent). The closeness of the latter two measures is reasonable. If policy fertility is correctly specified, the cohort component is the maximum of census underreporting that could be due to policy fertility, and there are no other omissions (e.g., some babies considered "too young" to be counted), the cohort component should match census underreporting. The residual component does, however, signify a *relative* age pattern, which balances out cohort deviations from policy fertility and which seems interpretable based on our knowledge of child underreporting. For instance, excess underreporting at pre-school ages is common. Thereafter, children reaching school age are likely to be more completely reported. The negative numbers in this column (above age 6) may reflect Chinese parents willingness to report such school-age children who may have been omitted at earlier ages because of fertility penalties.

The bottom panel addresses the conundrum identified earlier. Gu et al. (2007) note an estimate that China's policy fertility was 1.64 in 1990, just prior to the 1991 decree. The bottom panel gauges what child underreporting *might* have looked like in the 2000 census had policy fertility remained unchanged at 1.64. I re-estimate the cohort component of underreporting based on the new policy fertility, and if that policy fertility is correct, the residual component of underreporting under age 10 should sum to zero. I assume the residual shows the same age pattern as in the upper panel. The sum of the bottom rightmost columns suggests that child underreporting would have been about 7 percent at ages 0-4 and 3 percent at ages 5-9, well under half that suggested in the upper panel. Whether or not all the underlying assumptions are accurate, Table 3 illustrates how child underreporting could have increased from 1990 to 2000 due to stricter policy fertility in 1991, whereas annual birth underreporting may have declined over the same interval as fertility fell.

Sex Ratios of Births and Children

Excess Daughter Underreporting Implied by Comparisons of Census and Other Data

Demographic literature on fertility and sex-ratio imbalances in China tends to be rather bifurcated. Yet in my experience, important parallels can be drawn by devoting equal time to both topics in one sitting.

Thus, as in the earlier discussion of fertility trends, I begin here by examining recent trends in China's sex ratio at birth. Figure 3 shows estimates of this statistic (expressed as male births per 100 female births) based on a variety of sources. The most familiar estimates for many observers are the black diamonds, which show births reported in the year prior to censuses and sample censuses. The upward trend of these point estimates is very clear. Figure 3 also shows estimates of sex ratios at birth backdated from child sex distributions reported in the more recent censuses and sample censuses. On each of these fishhook-shaped curves, the rightmost point is backdated from zero-year-old counts, the next point to the left is backdated from 1-year-old counts, and so forth. Our backdating procedures take into account sex differentials in child mortality as well as net migration (e.g., adoptions abroad).[11] In addition to these estimates based on NBS data, Figure 3 also shows a time series of sex ratios at birth based on hospital data (Zeng et al., 1993), as well as a series backdated from new school enrollments (Zhang, 2005).

Note that the point estimate for births in 2000 comes from the census short form, which indicated a sex ratio at birth of 116.9 males per 100 females. Many demographers in research articles and international conferences instead quote the long form statistic – 119.9 (Riley, 2004; Wang, 2005; Li, 2007). Some who do so may not be aware of the short form results. In other cases, long form results may be quoted because short form results cannot be calculated directly, or because they provide a more appropriate aggregate baseline for detailed analyses of micro-data. Yet the short form provides the better measure.[12] Note that discrepancies in sex ratios at birth between the long and short forms parallel discrepancies in fertility rates described earlier. Quotations of the long form results pull down perceptions of fertility and raise perceptions of sex imbalances.

[11]With such backdated adjustments, sex ratios estimated at the time of birth become more feminine, typically about 0.5-1.0 per 100 below those reported for children in each census or sample census.
[12]One problem with the long form sample is that it is not nationally representative – for instance, migrant workers were more difficult to locate in the 2000 census, and when they were located, they were more likely to receive the short form. Another issue concerns the format of questions asked. The short form question (H7) asked about sons and daughters born to each *household* in the year before the census. The long form question (R26) asked respondents to link each son and daughter born to a particular mother currently alive and present in the household. Births to mothers who died or migrated away are thus not included in the long form. In addition, given China's fertility restrictions, the long form focus on childbearing of particular mothers may have exacerbated both underreporting of births as well as excess underreporting of daughters.

The diamonds on Figure 3 show that sex ratios of reported births in the 1980s lie above estimates based on children at older ages in later censuses and census samples. The year 1989 is particularly striking; although the oft-quoted point estimate from the 1990 census was 111.3, demographic evidence since then, as shown in Figure 3, consistently suggests that the true ratio was 3 per 100 below that, or about 108.3. Johansson and Nygren (1991) and Zeng et al. (1993) came to the same conclusion a dozen years ago based on other methods and data available at the time. We assume that the normal ratio is 106, which implies that excess underreporting of daughters accounted for 57 percent of the reported female birth shortage in 1989 [1-(108.3-106.0)/111.3-106.0)].[13] We see no reason for further debate that excess underreporting of daughters was the primary explanation for reported sex-ratio distortions around 1990.

Of course, as sex-selection technologies became more prevalent later in the 1990s, selective abortion eventually did succeed underreporting to become the dominant cause of reported distortions (Banister, 2004; Goodkind and West, 2007). Yet the precise level and pace of the rise in sex ratios from the 1990s through 2005 is still open to some debate. There is a split between estimates based on NBS data and other administrative data around 1990. Backdated NBS estimates suggest a far sharper rise than either hospital data (available only through 1991) or backdates from new school enrollments. The latter suggest that in 1995 daughters continued to be relatively underreported at birth; compared to backdated school enrollments, reported sex ratios at birth were 3 per 100

[13]Differential underreporting of daughters remains the primary explanation for the reported elevation in the sex ratio at birth in 1989 even if the normal ratio is presumed to be as low as 105.4. The “normal” sex ratio at birth and reasons for cross-cultural variation are subject to some debate. The ratio typically varies from about 103 to 107 (Johannson and Nygren, 1991). Vital statistics show that the sex ratio at birth among Chinese parents in the United States from 1940-2002 was 107.4 (Mathews and Hamilton., 2005). Around 1980, sex ratios at birth in East Asia tended to vary from 106 to 107, as we will shortly show.

higher (115.6 versus 112.7). If one accepts the validity of backdating school enrollments to estimate fertility levels (Scharping, 2005), one would presumably accept the validity of backdating sex ratios from this same source (Zhang, 2005). In contrast, NBS data imply that daughters in 1995 were no longer underreported relatives to sons. Sex ratios backdated from 10-year olds counted in 2005 match the sex ratio of births reported in 1995.

Yet NBS data in successive censuses and sample censuses produce inconsistent estimates of the sex ratio at birth. Sex ratios are consistently distorted at ages 1 through 3 – in line with the age patterns of underreporting for both sexes combined. Some demographers noting the fishhook age pattern of child sex ratios reported in recent years have inferred that sex ratios at age zero (roughly similar to the sex ratio at birth, once infant mortality sex differentials are considered) may be biased downwards for some reason (Qiao, 2005; Cai and Lavely, 2007).[14] However, Figure 3 suggests instead that sex ratios at 1-3 may be biased upwards. Estimates of sex ratios at birth tend to become more feminine when backdated from later child ages where reporting tends to be more complete (there is a parallel phenomenon for children of both sexes at ages 5-9 in Table 1). Consider, for instance, the sex ratio at birth in 1993. The sex ratio of births reported in the 1993 annual survey was 114.1 (not shown). Thereafter, sex ratios for this cohort

[14]One finding that may have contributed to the misinterpretation involves a post enumeration "cleanup" following a 1997 survey by the National Committee for Family Planning (the report was unpublished and available only in China; see Qiao and Suchindran, 2003). Births uncovered by the post enumeration cleanup were even more masculine than those reported in the original survey. Some observers took this to imply that hidden births are more masculine than reported births, the result being that reported sex ratios at birth (age zero) are biased downwards, a presumption consistent with the fishhook shaped age pattern of excess underreporting. Yet Figure 3 suggests instead that the fishhook is caused by sex ratios at ages 1-3 being biased upwards (e.g., too masculine). The excess of males discovered among hidden births in the PES might reflect parents being especially unlikely to reveal a previously hidden daughter during the cleanup. Moreover, daughters lost to infanticide or out-adoption would likely not be recalled as births at all in the later clean-up.

estimated from back projections of 2-year olds in 1995, 7-year olds in 2000, and 12-year olds in 2005 are 119.7, 114.1, and 112.7, respectively (Figure 3). The cohort shows the same fishhook pattern observed within any given year. Thus, true sex ratios of recent child cohorts may be below what was reported at birth. And if one believes the school enrollment data and trend from the hospital data, the true sex ratio at birth in 1993 could even be lower than 112.7. Even in their early teens, daughters may continue to be relatively omitted compared to sons.

Trends in Sex Ratios at Birth; Misinterpretations Due to Shifting Birth Order Distributions

Even in son-preferring societies employing selective abortion, the sex ratio of first births tends to be relatively normal (Banister, 2004). This may reflect in part the desire among many parents to have at least one daughter, as well as the option to try again for a son. Thereafter, sex ratios in these societies tend to be highly skewed among second- and higher-order births, a pattern shown in Figure 4 for China in 2000 and 2005. This is because parents who proceed to higher birth orders typically do so in order to have a son (Das Gupta and Baht, 1997). Note, however, that due to the steep difference between sex ratios of first and subsequent births, the aggregate sex ratio of all births is very sensitive to the birth order distribution. Thus, two contradictory dynamics may occur as fertility falls in societies with son preference (and access to sex selection); a decline in the proportion of higher order births causes the aggregate sex ratio at birth to fall, yet since parents have fewer chances to have sons, sex preference may intensify for all births, especially higher birth orders, so the sex ratio at birth may rise (ibid.).

Some observers (e.g., Li, 2007) have already noted the apparent rise in the aggregate sex ratio at birth between the 2000 census (119.9) and the 2005 census sample (120.5). Yet when one disaggregates sex ratios by birth order, one finds a notable decline in the sex ratio for second and higher order births (ibid.). In fact, when one standardizes the 2005 sex ratios by birth order to the birth order distribution in the 2000 long form, the resulting sex ratio at birth is 118.6, notably *below* the 119.9 in the 2000 long form.[15] The reason for the reversal? The 2005 census sample reports a larger proportion of higher-order births (beyond the first) than the 2000 census long form (37 percent versus 32 percent, a finding consistent with its higher TFR – 1.35 versus 1.22). Standardization corrects for this differential and implies that selective abortion likely fell over the interval.[16]

Consistent with this finding is a decline in the excess of female infant mortality. Although females continue to have worse survival chances (Li, 2007), the ratio of male-to-female infant mortality rose from .70 to .80 between 2000 and 2005, suggesting some decline in daughter disadvantage.[17] In contrast to recent reports emphasizing that sex ratio distortions are high and rising in China, the latest findings suggest that daughter disadvantage, while continuing, may have already peaked. We might consider whether these findings help to resolve any questions about the trends in excess daughter underreporting discussed earlier (Figure 3). Prenatal and postnatal discriminatory

[15]Note, however, a slight increase in the sex ratio of first births, which may indicate slightly increased use of sex selection, perhaps because these parents want only one child.

[16]Another potential explanation is that excess underreporting of daughters diminished over the interval.

[17]The typical sex ratio of infant mortality through the world ranges from about 1.2-1.4 (Hill and Upchurch, 1995). The sex ratio of reported mortality among males and females at ages 1-4 in China remained unchanged at 0.99 between 2000 and 2005. Typical sex ratios at these ages range from 1.00 to 1.20 (ibid.).

practices in China appear to have risen (Goodkind, 1996a; Banister, 2004) and now fallen in additive fashion. To the extent that excess daughter underreporting is also an expression of son preference, might such underreporting have also increased in additive fashion during the 1990s when selective abortion was on the rise, and now be declining in tandem with the fall?[18]

Before turning to other areas of East Asia for comparative insights, we use birth-order differentials to dispel another widely held view. Rural areas in China report higher sex ratios at birth than urban areas (Hull, 1990; Gu and Roy, 1995; Banister, 2004; Li, 2007), a finding often presumed to reflect greater use of selective abortion in rural areas, in line with traditional son preference and lack of alternative social security systems there. In the 2000 census (long form), for instance, reported sex ratios at birth were 121.7 in rural areas and 116.4 in urban areas (see Table 4). Yet urban sex ratios are lower because the proportion of all births that are first births is higher there. Upon standardizing rural and urban sex ratios by birth order to the 2000 birth order distribution for China as a whole, Table 4 shows that these figures reverse position; to 118.8 in rural areas versus 122.2 in urban areas.[19] In fact, standardization of all sectors in 2000 and 2005 to the 2000 total birth order distribution suggests that sex ratios in urban areas in 2005 *continued* to lead those of rural areas, yet with a decreasing gap.

[18]I leave these questions to further research. Yet the “substitution hypothesis,” which posits that selective abortion may lead to a decline in postnatal discriminatory practices (Goodkind, 1996a; 1999) has been prematurely dismissed from scholarly inquiry. Although such dynamics in China are evidently additive, China may be a special case. Fertility penalties may encourage Chinese parents to use all strategies at their disposal. South Korea showed some evidence of substitution (ibid.). Moreover, the substitutive dynamic is best understood as a process among individuals. It is not clear whether survey data exist that might better test this hypothesis.

[19]Other benchmarks for standardization can be chosen, but under any standard, the standardized excess of urban ratios over rural ratios will always equal 3.4.

The higher standardized urban sex ratios do not necessarily indicate stronger son *preference* among urban parents. The differential may instead indicate easier urban access to sex selective technologies or the stronger implementation of family planning programs there.[20] At the very least, however, these results suggest that parental propensities to use selective abortion may be greater in urban China.

East Asian Trends in Sex Ratios at Birth and Related Policies

I now put these findings in broader perspective by considering trends in the sex ratio at birth elsewhere in East Asia – South Korea, Taiwan, Hong Kong, Singapore (Chinese only), and Japan. In all of these societies, statistics come from high-quality annual vital registration systems. Figure 5 shows trends in the sex ratio at birth from 1980 to 2005. Three-year averages are calculated to dampen statistical variation (Goodkind, 1996a) as well as zodiacal preferences to have children of a particular sex born (or avoided) in a particular lunar year (Goodkind, 1991; Lee and Paik, 2006). For simplicity of presentation, I show in Figure 5 only aggregated sex ratios at birth without standardization. During the 1980s, South Korea was notable for showing the sharpest increase in its sex ratio at birth, which reached a plateau of over 114 male births per 100 female births in the early 1990s. Taiwan[21] exhibited twin peaks over the full interval, whereas Hong Kong showed a fairly steady increase. Singapore Chinese did not evince a rise, although reported ratios have tended to hover around 108, slightly above average.

[20]The latter explanation, in turn, could imply a stronger desire to use selective abortion or a greater tendency to underreport female births in urban areas.

[21]In Taiwan, a notable dip after 1991 was attributed to warnings by public health authorities that women who determined fetal sex using chorionic villus sampling (cvs), a type of amniocentesis performed within the first 6 weeks of pregnancy, would be more likely to bear children with birth defects (Chang, 1996).

Only Japan showed a fairly gradual decline within the normal range throughout this period.[22]

By the late 1990s, the notable upward trajectory had reversed in most areas. Currently, only Hong Kong shows a ratio higher than anytime in the past. South Korea is again particularly notable, with the sex ratio at birth plummeting by 5 per 100 in the 4 years between 1994 and 1998 (Goodkind, 2002). Choe and Kim (2006), within a broader review of fertility trends and policies in South Korea, showed that South Korea's sex ratio at birth declined at each birth order (the overall decline was not simply a result of shifting birth order distributions). Their suggested explanations for this notable social change included government interventions, such as raising the status of daughters, outlawing selective abortion, and enacting fines to punish medical personnel who reveal the fetal sex. Chung and Das Gupta (2007) then gave this topic full length treatment, offering that the turnaround was due primarily to secular declines in son preference, as opposed to developmental forces that distributed the population into social categories that have lower sex ratios at birth. Whatever the reason, the latest reported sex ratio at birth for South Korea in 2006 was 107.4, just slightly above the high end of the typical range.

For several years now, China has been implementing a set of policies, inspired in part perhaps by those enacted in South Korea, to raise the status of daughters. In March of 2004, China's President Hu Jintao called for lowering the sex ratio to normal levels by 2010, a call reiterated by many officials, including the Vice Minister of the National Population and Family Planning Commission (*Mail and Guardian*, 2004). In the wake of

[22]However, Japan early displayed a long-term peak in its reported sex ratio at birth in the mid 1960s which nearly coincided with the 1966 Year of the Fire Horse (an inauspicious year to have girl babies; see Goodkind, 1991; Lee and Paik, 2006). We do not know if the peak was related to the Fire Horse or to levels of fertility. Nor do we know of any effective sex testing technologies available at the time.

this call, an experimental “Care for Girls” program (*China Daily*, 2004) was enacted in a pilot county in each of 24 provinces to enforce the anti-sex-selection edicts that have already been on the books for many years (Xinhua, 2005; Li, 2007).

Recent discussions of the Care for Girls program have noted early promise in pilot areas and the hope that it may reduce daughter disadvantage more broadly in the future. Yet among higher-order births, falling sex ratios in Figure 4 suggest that there has already been a decline in selective abortion. China may have just turned the corner as South Korea did in the mid 1990s, a possibility that makes sense given the historical relationship between fertility levels and sex ratios at birth in other parts of Asia.[23] It is too early to tell if the decline might also be due in part to the Care for Girls program itself. This will be an important topic in future research.

Are Sex Ratio Imbalances Caused by China’s Fertility Restrictions?

Over the years, many demographers have offered the opinion that China’s fertility restrictions may be a key cause of its elevated sex ratio at birth (Hull, 1990; Banister, 2004; Li, 2007). The South Korean case illustrates that other causes contribute, since sex ratios at birth rose there without any fertility restrictions (Banister, 2004; Riley, 2004). Yet now that China’s sex ratios have become more distorted than anywhere else in the world, demographers are reviving this theory and addressing proposed links to population policy. Several observers, for instance, have suggested that China’s aforementioned “1.5”-child policy may be a key cause of sex ratio distortions (Greenhalgh and Li, 1995;

[23]In other Asian areas showing distortions in the sex ratio at birth, the time interval between first achieving replacement fertility and the year of the subsequent local peak in sex ratios at birth was 8-18 years (8-11 years in Taiwan, Singapore and Japan, – see previous footnote – and 18 years in Hong Kong; Goodkind and West, 2007). Based on that experience elsewhere in Asia, since China’s fertility first fell below replacement in 1991, one would expect a turnaround in sex ratios to occur between 1999 and 2009.

Riley, 2004; Wang, 2005; Li, 2007; Zeng, 2007; Guo, forthcoming). Under this policy, the most common in China's localities (Gu et al., 2007), parents may only have a second child without penalty if the first child is a daughter. As the theory goes, the 1.5-child policy devalues daughters, since the loophole reinforces parental notions favoring sons.

Two recent studies examine sex ratios at birth by local fertility policy type (Zeng, 2007; Guo, 2007). After adjustments for underreporting of males and females in the policy areas, Zeng (2007; footnote 10, addendum obtained from the author) estimates the sex ratio at birth to be 119.7 in 1.5-child policy areas versus 108.3 in 2.0-child policy areas, a difference of 11.4/100.[24] It is tempting to attribute this striking difference to enhanced use of selective abortion in localities after official implementation of the 1.5-child policy option. The inference one might draw is that localities could reduce discrimination by switching from a 1.5- to a 2.0-child policy. Yet there are at least two important caveats to this inference.

The first caveat is explained by Zeng (2007). I reinforce it here in Figure 6, which shows expected fertility patterns among parents in both 1.5- and 2.0-policy areas. The analysis in Figure 6 assumes that all parents have as many children as allowed under their regulations and that there is universal access to sex selection. Calculations of the expected sex ratio at birth in the top portion of the graph assume further that all parents are determined to have a son. When the first child is a daughter, the bottom tree is identical under both the 1.5- and 2.0- child policies. All parents will proceed to have a second child and will use selective abortion (if necessary) to ensure that it will be a son. The major difference is due to the top tree. When the first born child is a son, the 1.5-child areas impose a stopping rule. The resulting sex ratio at birth will be higher in 1.5-

[24]These adjusted ratios fall below the unadjusted figures listed in Table 3 of Zeng (2007).

child areas compared to 2.0-child areas (206 vs. 172), *not* because of sex selection but because of the algebra resulting from the stopping rule.

Of course, not all parents are determined to have a son, and the sex ratio of those indifferent to child sex is likely only about 106. I confirmed Zeng's estimate that a sex ratio at birth of 119.7 will occur in 1.5-child areas when 19.1 percent of parents whose first child is a girl use sex selection to ensure that the second child will be a boy (statistics shown on bottom of Figure 6). I then apply that same percentage to the 2-child areas, which implies a sex ratio at birth of 116.0. Thus, by my calculations, of the 11.4/100 excess in the adjusted sex ratio at birth in 1.5-child areas, 3.7/100 [or 32 percent; (119.7-116.0)/(119.7-108.3)] may be attributed to the stopping rule policy rather than selective abortion or other factors.

The second caveat is that most or all of the remaining sex ratio excess in 1.5-child policy areas [(11.4-3.7)=7.4)] could be due to selection effects. Did local policies create son preference or did local son preference lead to the selection of a particular policy in the first place? Although one cannot rule out some influence of the former, the local selection of a 1.5- versus a 2.0-child policy (or even a 1.0-child policy) is clearly not a random draw – areas with the strongest underlying son preference would almost certainly be most likely to want exemptions to the 1-child rule for parents whose first born is a daughter.[25] Note, for instance, that the sex ratio at birth in 2.0-child policy areas (adjusted for differential underreporting) was 108.3 in 2000, barely above normal and the

[25]Zeng (2007, p. 230) notes that in a few experimental localities, sex ratios in 1.5-child policy areas vastly exceeded those of adjacent areas with 2.0-child policies. Yet there is no indication that the differential policies were randomly assigned or that son preferences were truly equal prior to policy implementation. As Cai and Lavely (2007) show, son preference patterns sometimes cut sharply across local boundaries. Moreover, parents in 1.5-child areas may have better access to sex testing, brought about perhaps by stronger local son preferences. Lastly, issues of causality and access aside, confidence intervals around sex ratios are very wide. Even in a locality with 5,000 annual births, a 95 percent confidence interval would span 6 per 100 above and below an expected sex ratio of 106.

same as the national sex ratio at birth in 1989 (108.3; see Figure 3). It is not plausible that such ratios in 2.0-child policy areas could have remained flat from 1989 to 2000 (in contrast to the sharp rise in 1.5-child policy areas) unless there were differences in preferences that predated implementation of the policies. Sex-specific stopping rules are not prerequisites for substantial use of sex selection. Again, South Korean sex ratios at birth exceeded 114 in the early 1990s (Figure 5) without any such policies and have declined sharply without any relaxation in family planning policy.

The above discussion should not be misconstrued as denying that sex selective abortion is discriminatory, that a 2-child policy approach might be preferable to a 1.5-child policy, or that fertility policies could influence decisions to use selective abortion. I also acknowledge that the stopping rule imposed by the 1.5-child policy does contribute to sex imbalance in China, an imbalance posited to have dire social implications (Hudson and den Boer, 2004; Poston and Morrison, 2005). However, based on evidence presented so far, it is not clear that local implementation of the 1.5-child policy itself causes an increase in son preference or use of selective abortion. Studies making such claims, including those using multivariate analysis (Guo, 2007), should be treated with caution unless the aforementioned biases can be effectively removed.

In fact, Figure 6 suggests that in 1.5-child policy areas daughters might be *more valued* as first births, which account for over two-thirds of all births in China. Even in societies with strong son preference, the ideal for most parents is to have both a son and a daughter.[26] A first-born daughter in a 1.5-child policy area thus provides the opportunity

[26]Pande and Malhotra (2006) found that 87 percent of Indian parents want at least one daughter. Goodkind (1996b) found that 93 percent of Vietnamese parents identified a son and a daughter as their ideal if they had two children. For general issues regarding the wantedness of daughters in China, see Greenhalgh and Li (1995) and Johnson (2004).

for Chinese parents to have a second child without penalty (Short et al., 2001). Parents with a first-born son do not have that option. In fact, sex ratios of first births are notably lower (more feminine) in rural areas, where the 1.5-child policy predominates, than in urban areas.[27] If these lower rural ratios are due in part to the 1.5-child policy, one wonders whether daughters might lose that advantage if localities switch to a 2-child policy.

Conclusions

China began to restrict fertility over three decades ago. Although certain modifications have been implemented over the years, such as the sex-based 1.5-child provision, the basic structure of quotas and penalties remains. It is within this context that my paper has examined a body of knowledge offered in recent literature on fertility levels and child sex ratio imbalances in China. Although the variety of Chinese data available present formidable interpretive challenges and opinions differ somewhat among experts, I identified a set of estimates and assumptions that appear to constitute a current consensus. My review of the latest evidence leads me to agree with certain aspects of the consensus, yet to disagree with several of its key assumptions.

In regard to the "new consensus" on China's fertility levels, my analysis of child underreporting in the 2005 sample census supports the likelihood that National Bureau of Statistics (NBS) estimates of fertility in the late 1990s, and perhaps beyond, are too high.

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[27]Sex ratios of first births reported in the 2000 census long form were 105.6 in rural areas, compared to 109.4 in urban areas. The higher ratio in urban areas might indicate selective abortion in favor of sons. The lower ratio in rural areas (below 106) might indicate marginal selective abortion in favor of daughters or, at the very least, indifference to the sex of the first birth. To better test the hypothesis that daughters might be favored as first births in 1.5-child policy areas, one should compare sex ratios of first births across areas with different policy restrictions.

Yet key assumptions propelling the new consensus remain implausible. Most new consensus studies have either neglected child underreporting or assumed that child underreporting did not change between the 1990 and 2000 censuses. Since Chinese policymakers have been discussing timetables for lifting fertility restrictions (Yardley, 2008), if we want to understand the effects of such policy changes on child reporting in the future, we need to understand such patterns in the past. Even when new consensus estimates of fertility are used in our intercensal models, implied child underreporting more than doubled between 1990 and 2000. In addition, despite heightened difficulties faced by the NBS in measuring births following the 1991 decree, NBS adjustments to reported fertility appear to have been quite accurate through 1995. Fertility estimates based on new school enrollments suggest that notable overinflation did not begin until 1996, the year after exceptional underreporting occurred in the 1995 sample census and was correctly adjusted for. Exceptional underreporting was later observed in both the 2000 census and 2005 sample census. My working hypothesis is that the NBS pegged expectations of underreporting in non-census years to such tendencies in census and bi-census years, which may have reinforced skepticism that fertility declined substantially in the late 1990s.

The shifting dynamics of underreporting are also important to understand. In regard to the fishhook-shaped pattern of reported sex ratios by age, there is no evidence that sex ratios at birth (roughly comparable to sex ratios of infants) are underreported. Instead, there is evidence that sex ratios of young children tend to be over-reported due to excess underreporting of females. The excess tends to peak at ages 1 to 3 – the same ages at which underreporting often peaks for both sexes combined. Empirical evidence supports those who concluded in the early 1990s that China's sex-ratio distortions in the late 1980s were due primarily to excess underreporting of daughters. It was not until the 1990s that selective abortion increased dramatically to account for most of China's reported sex ratio distortions. That China's reported sex distortions have become the world's most severe is important news. Yet it is old news, first documented over a dozen years ago after the 1995 sample census and reinforced again after the 2000 national census.

The most current and interesting finding is that selective abortion has recently *declined* somewhat in China. Reported sex ratios at birth, after standardization to the 2000 birth order distribution, fell from 119.9 in the 2000 census long form sample to 118.6 in the 2005 sample census, contrary to the oft-quoted rise to 120.5 in the unstandardized 2005 measure (actual ratios in the population may be several points per hundred below the reported sample-based ratios). Child mortality figures indicate a similar lessening of daughter disadvantage between 2000 and 2005.

These trends suggest that a decline in discrimination against young daughters may already be underway in China. It is too early to tell whether that decline might be due in part to the "Care for Girls" program or to know how effective that program may ultimately be.

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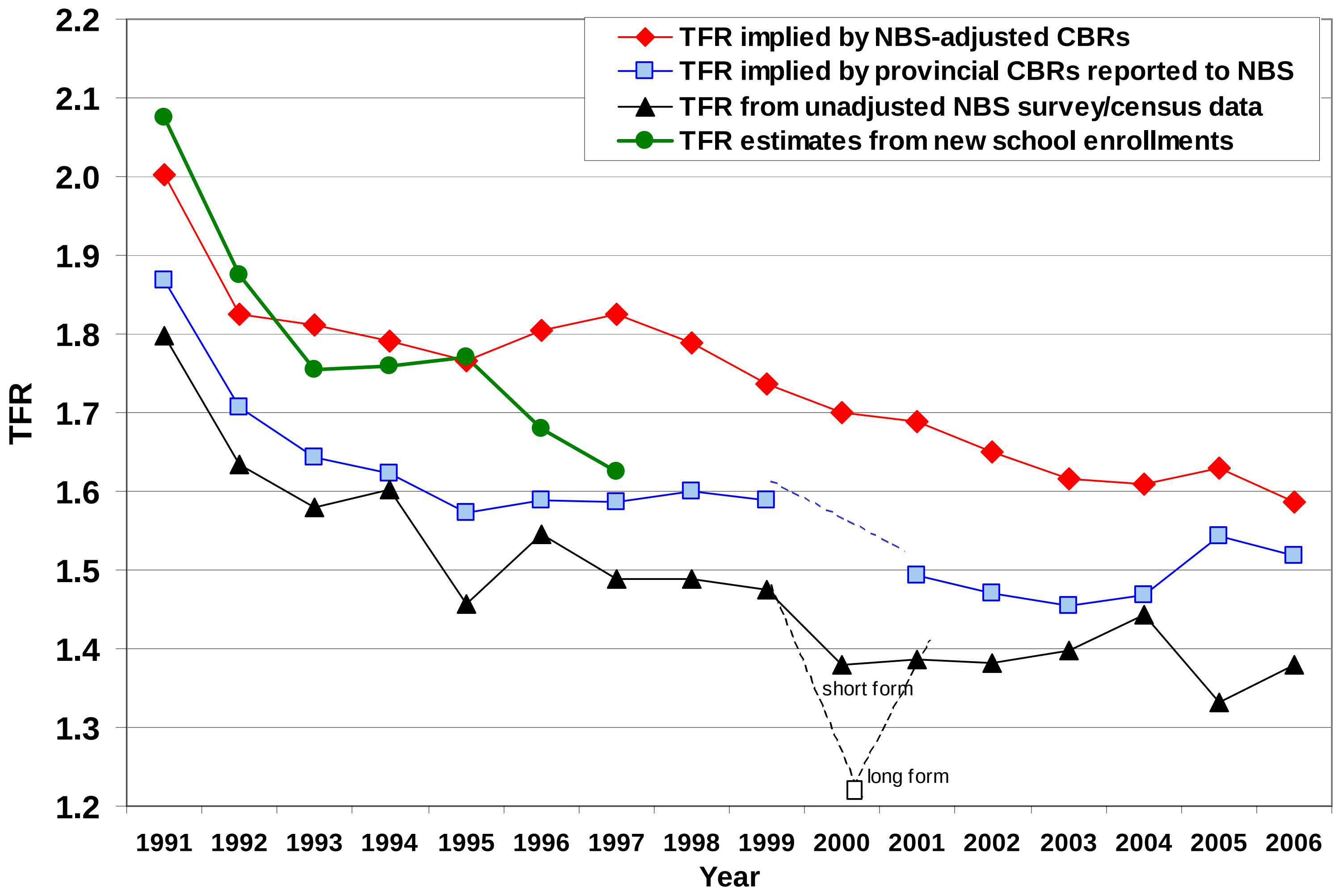
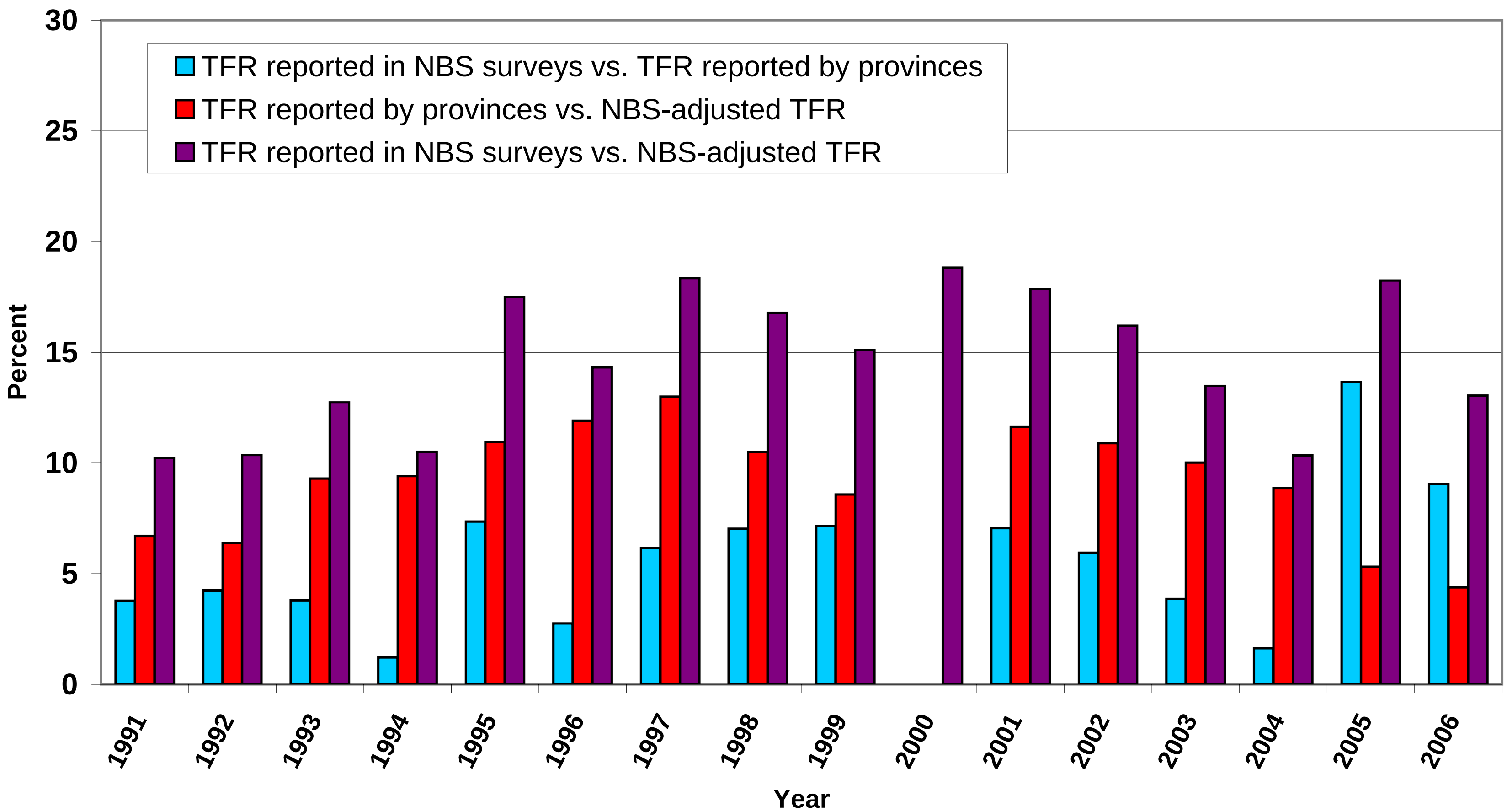
Figure 1. Measures of China's total fertility rate (TFR) -- unadjusted, province-reported, NBS-adjusted, & new school enrollment-based: 1991-2006



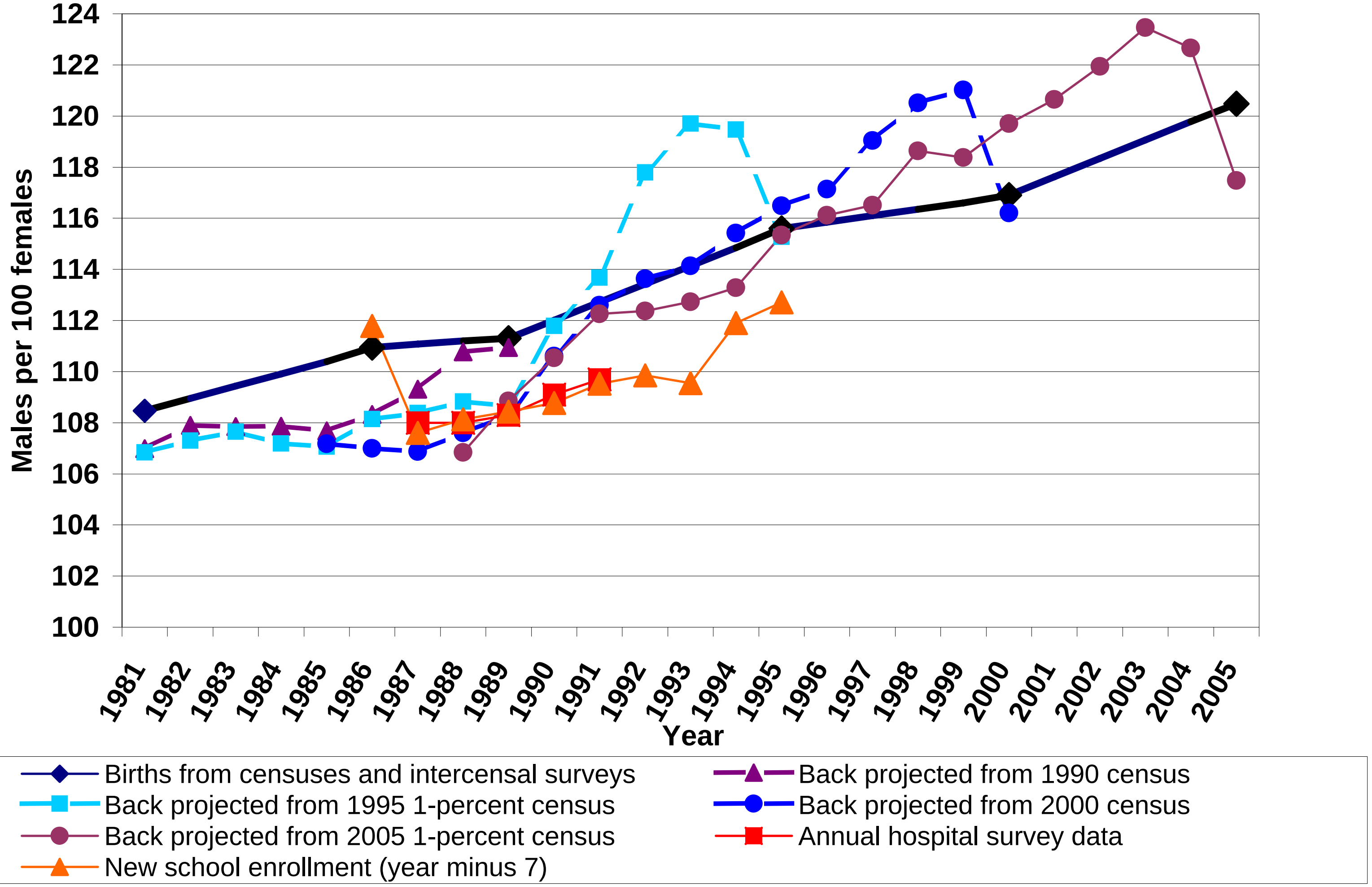
Source: NBS-adjusted TFRs calculated by U.S. Census Bureau using projection software to match China's official crude birth rates (National Bureau of Statistics, 2007a). Similarly, provincial TFRs match weighted average of provincial CBRs reported to NBS (ibid., 2007a; 1991-2007). Reported TFRs calculated from unadjusted ASFRs directly (ibid, 2007a; 1994-2007) or converted from unadjusted CBRs (ibid., 2007a; 1991-1993). New school enrollment-based estimates from Scharping (2005).

Figure 2. Percent difference in fertility measures for China: 1991-2006



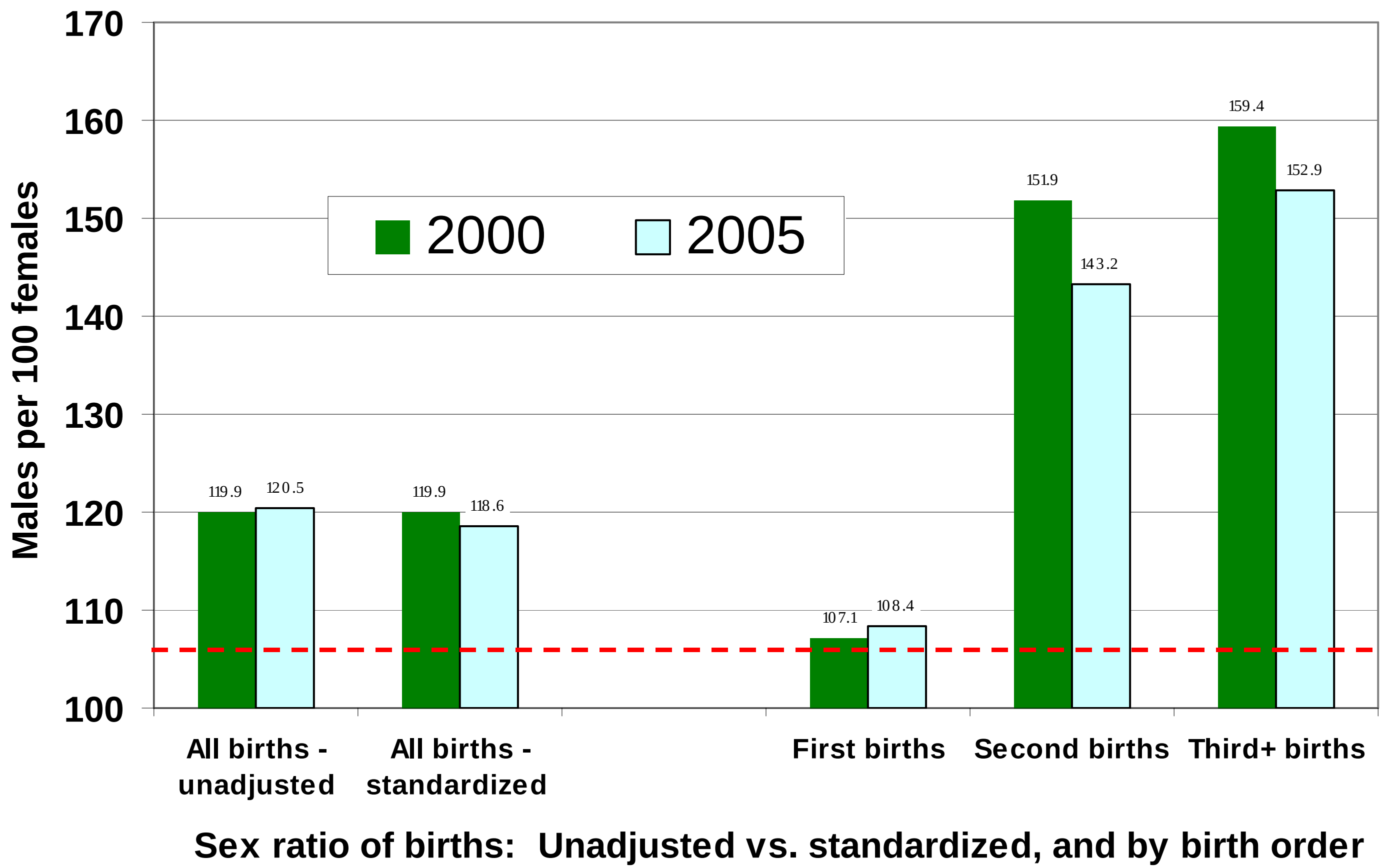
Source: Calculated from TFRs shown in Figure 1.

Figure 3. China sex ratios at birth implied by various sources: 1981-2005



Sources: Births from censuses and intercensal surveys refer to those born in the year preceding each census/survey - National Bureau of Statistics 1988, 1997, 2007b - Population Census Office 1985, 1993, 2002; Back projections from 1990, 1995, 2000, and 2005 child counts incorporate sex differences in mortality and international migration; Hospital surveys - see Zeng et al., 1993; New school enrollments 7 years hence (scaled for slight underenrollment of females) - Zhang, 2005.

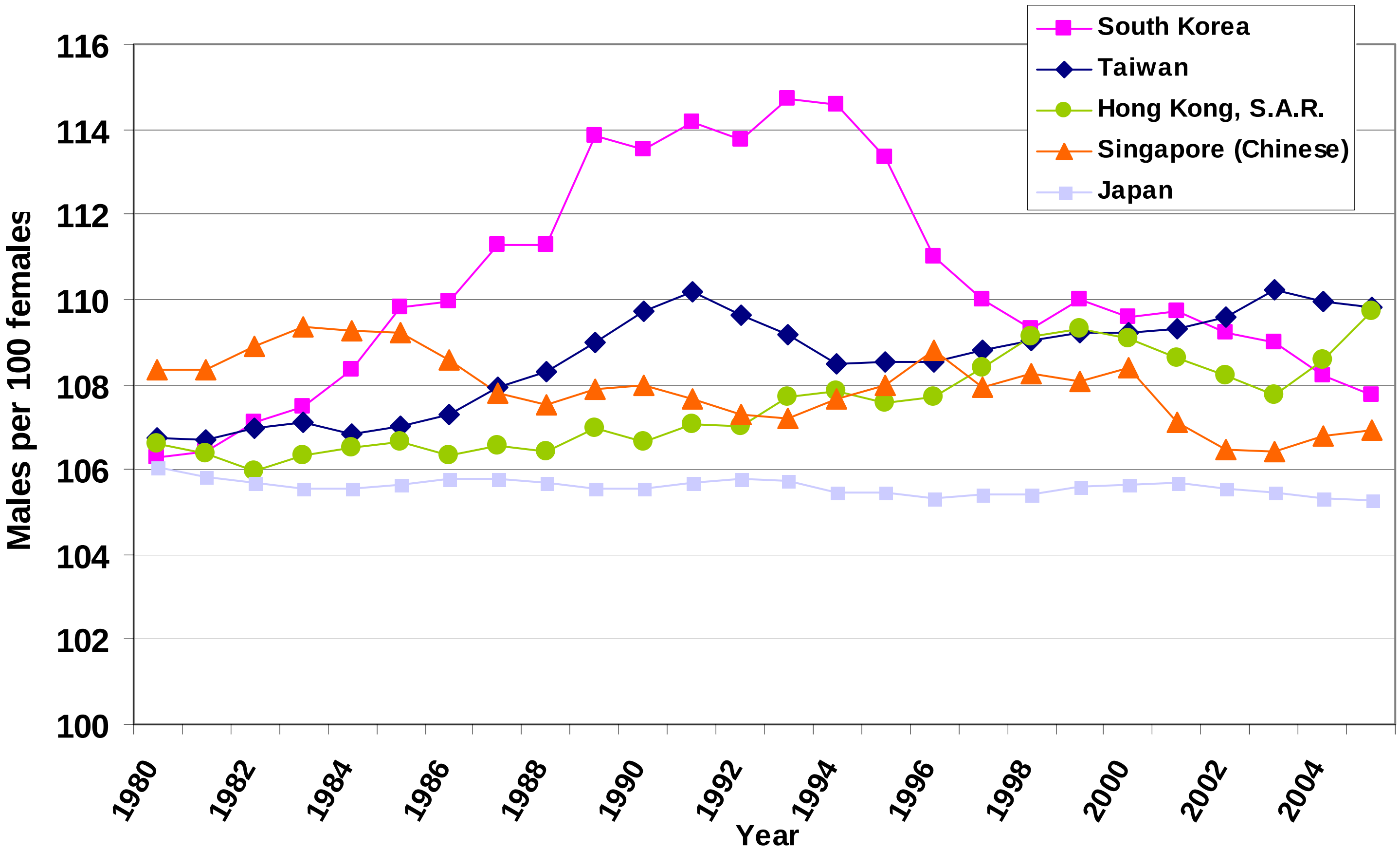
Figure 4. Sex ratios at birth reported in China's 2000 census (long form) and 2005 sample census; unadjusted, standardized, and by birth order



Note - 2000 census long form data used because the short form does not indicate birth order distributions. Moreover, long form results allow comparisons between two samples. Standardization applies the birth order distribution of all births in 2000 to the sex ratio at birth by birth order in 2005.

Source: 2000 Census long form (Population Census Office, 2002) and 2005 Sample Census (NBS, 2007b).

Figure 5. Sex ratios at birth reported in East Asia (3-year averages 1980-2005*)



*Vital statistics used for 3-year averages extend from 1979 through 2006. Confidence interval above and below 3-year average in 2005 exceeds 1.0 per 100 for Hong Kong, 1.5 per 100 for Singapore Chinese.

Sources: National Statistical Office, 2008; Department of Statistics, 2008; Li, 18 September 2002, 07 September 2004, 16 January 2008; Department of Statistics National Institute of Population and Social Security Research, 2004; Ministry of Health, Labour and Welfare, 21 January 2008.

Figure 6. Expected children by sex under different fertility policies and son preference assumptions

Expected fertility patterns in 1.5-child policy areas
where all parents want at least one son[1]

First Child — *Second Child*

Male 0.5146 — *Stopping rule imposed*

Female 0.4854 — *Sex selection to get a son* → **Male 0.4854**; X

Expected number of children	**1.5**
Expected sex ratio of all births (males per 100 females)	**206.0**

Expected sex ratio of births
under the following alternate scenarios:

No sex preference	**106.0**
19.1% of parents with first daughter want a son, 80.9% no sex preference[2]	**119.7**

Expected fertility patterns in 2.0-child policy areas
where all parents want at least one son[1]

First Child — *Second Child*

Male 0.5146 — *No sex selection in favor of either sex* → **Male 0.2648**; **Female 0.2498**

Female 0.4854 — *Sex selection to get a son* → **Male 0.4854**; X

Expected number of children	**2.0**
Expected sex ratio of all births (males per 100 females)	**172.0**

Expected sex ratio of births
under the following alternate scenarios:

No sex preference	**106.0**
19.1% of parents with first daughter want a son, 80.9% no sex preference[2]	**116.0**

[1]Assumes all parents have as many children as allowed under regulations and have full access to sex selection. Figures on upper diagram show the contribution of sons and daughters (by birth order) to expected number of children [e.g. 1.5 = .5146+.4854+.4854]. Sex ratios are expressed as males per 100 females. Sex ratio at birth in the absence of sex selection assumed to be 106 [=.5146/.4854*100]. See text for further details.

[2]These percentages were chosen to match the adjusted sex ratio at birth in 1.5-child policy areas in the 2000 census (Zeng, 2007; footnote 10).

Table 1. Implied coverage of children (undercounts/overcounts) in Asian censuses

Area	Census year	Coverage* (in percent) at age: 0-4	5-9	As measured against:
China	1982	-4.2	0.4	1990 Census backprojections
China	1982	-7.0	0.8	2000 Census backprojections
China	1990	-4.8	-2.1	1982 Census projections (NBS-adjusted fertility)
China	1990	-8.0	-4.2	2000 Census backprojections
China	2000	-26.2	-12.1	1990 Census projections (NBS-adjusted fertility)
China	2000	-17.2	-4.4	1990 Census projections (province-reported fertility)
China**	2000	-17.9	-11.8	New consensus hybrid of above two estimates
China***	2005	-12.8	-12.3	1990 Census projections (NBS-adjusted fertility)
China***	2005	-4.0	-2.5	1990 Census projections (province-reported fertility)
Cambodia	1998	-11.4	-3.9	1962 Census projections
Indonesia	2000	-13.4	-7.0	1980 Census projections
Japan	2000	-2.3	-1.2	1990 Census projections
Macau	2001	-3.9	1.1	1991 Census projections
Mongolia	2000	-15.9	-7.1	1990 Census projections
Philippines	1995	-7.9	-3.6	1980 Census projections
South Korea	2000	-3.6	-3.3	1990 Census projections
Sri Lanka	2001	-7.6	-5.3	1981 Census projections
Taiwan	2000	0.3	-0.3	1990 Census projections
Thailand	2000	-5.3	-2.1	1990 Census projections
Vietnam	1999	-10.1	-0.1	1989 Census projections
Asian average (excluding China)		*-7.4*	-3.0	
Asian median (excluding China)		-7.6	-3.3	

*Negative numbers indicate undercounts; positive numbers indicate overcounts.
**This model approximates the "consensus of the new consensus" of lower fertility in China (see text).
***2005 was a sample census. For further details and qualifications about this comparison, see Table 2.

Source: U.S. Census Bureau internal documentation of intercensal comparisons using RUPCEN software. Each projection begins with a "base" population, typically a census count (some with our adjustments), followed by annual estimates of age-specific fertility, sex ratios at birth, as well as age- and sex-specific mortality and migration. Estimates in the first five rows listed for China from Goodkind (2004, p. 289).

Table 2. China's 2005 inflated sample census count of those at ages 0-19 compared to counts projected to that time based on 1990 census and official fertility

	November 1, 2005					
Age	Projected*	Inflated sample census count**	Numerical Difference	Percent Difference	Age	Percent Difference
0	15,985,303	14,004,084	-1,981,219	-12.39	0-4	-12.8
1	15,579,789	13,723,299	-1,856,490	-11.92		
2	15,675,813	13,278,435	-2,397,378	-15.29		
3	16,055,567	13,772,823	-2,282,744	-14.22		
4	16,577,028	14,868,782	-1,708,246	-10.30		
5	17,141,774	15,379,754	-1,762,020	**-10.28**	5-9	**-12.3**
6	17,850,407	14,988,176	-2,862,231	**-16.03**		
7	18,741,895	16,689,240	-2,052,655	**-10.95**		
8	19,444,504	16,897,391	-2,547,113	**-13.10**		
9	19,693,193	17,483,300	-2,209,893	**-11.22**		
10	19,833,265	19,599,284	-233,981	-1.18	10-14	1.5
11	20,091,592	18,662,413	-1,429,179	-7.11		
12	20,213,696	20,756,207	542,511	2.68		
13	20,611,008	21,425,500	814,492	3.95		
14	21,574,706	23,460,327	1,885,621	8.74		
15	24,819,354	26,575,605	1,756,251	7.08	15-19	-10.9
16	25,566,174	24,200,949	-1,365,225	-5.34		
17	24,896,403	21,389,644	-3,506,759	-14.09		
18	25,691,918	21,444,618	-4,247,300	-16.53		
19	23,364,002	17,220,098	-6,143,904	-26.30		

*Projected counts based on 1990 census (July 1) aged forward to November 1, 2005 based on NBS-adjusted fertility, as well as mortality and net migration by age and sex (see text).

**The sample census was intended to be a 1-percent sample. The official sampling percentage was 1.35. The inflated sample census count above was determined by multiplying the sampled count at each age by the inverse of the sampling percentage (74.1).

Source: 2005 sample census count from National Bureau of Statistics, 2007b.

Table 3. Exploratory model decomposing reasons for child underreporting in China's 2000 census

Birth year	Age as of 2000 census	TFR	Policy fertility[1]	Implied percent in 2000 census not reported[2]	Implied child underreporting in 2000 census: Cohort based: Percent not reported based on TFR excess above policy fertility	Implied child underreporting in 2000 census: Age/period based: Residual percent not reported in 2000 census[3]
New consensus TFRs[4] and policy fertility of 1.47:						
2000	0	1.54	1.47	12.2	4.5	7.7
1999	1	1.59	1.47	29.5	7.5	21.9
1998	2	1.60	1.47	16.4	8.1	8.3
1997	3	1.59	1.47	15.7	7.5	8.1
1996	4	1.59	1.47	16.0	7.5	8.5
1995	5	1.77	1.47	13.1	16.7	-3.6
1994	6	1.79	1.47	18.2	17.9	0.4
1993	7	1.81	1.47	11.6	18.8	-7.2
1992	8	1.82	1.47	9.2	19.4	-10.2
1991	9	2.00	1.47	7.1	26.6	-19.4
1996-2000	*0-4*	*1.58*	1.47	*17.9*	*7.1*	10.8
1991-1995	*5-9*	*1.84*	1.47	*11.8*	*19.9*	-8.1
1991-2000	*0-9*	*1.71*	1.47	*14.5*	*13.5*	1.0
New consensus TFRs[4], policy fertility of 1.64, and same residual pattern (above)						
2000	0	1.54	1.64	*1.2*	-6.5	7.7
1999	1	1.59	1.64	*18.8*	-3.1	21.9
1998	2	1.60	1.64	*5.8*	-2.5	8.3
1997	3	1.59	1.64	*5.0*	-3.1	8.1
1996	4	1.59	1.64	*5.3*	-3.1	8.5
1995	5	1.77	1.64	*3.4*	7.1	-3.6
1994	6	1.79	1.64	*8.7*	8.4	0.4
1993	7	1.81	1.64	*2.2*	9.4	-7.2
1992	8	1.82	1.64	*-0.1*	10.1	-10.2
1991	9	2.00	1.64	*-1.4*	18.1	-19.4
1996-2000	*0-4*	*1.58*	1.64	*7.2*	*-3.7*	*10.8*
1991-1995	*5-9*	*1.84*	1.64	*2.5*	*10.6*	*-8.1*
1991-2000	*0-9*	*1.71*	1.64	*4.5*	*3.5*	*1.0*

Notes and Sources:

[1] Posited values and policy fertility concept from Gu et al (2007).

[2] Derived in top panel by comparing projected counts (based on TFR inputs) to census counts (not shown). Estimated in bottom panel by summing the two rightmost columns (see text).

[3] Derived in top panel as the difference between the prior two columns. Bottom panel assumed same values.

[4] NBS-adjusted 1991-1995, province-reported 1996-2000. 2000 TFR interpolates between 1999 and 2001. For sources see Figure 1.

Table 4. Sex ratio at birth in China by sector - as reported and standardized to birth order distribution in 2000

Year	Total	Rural	Urban	Sector difference
Reported				
2000	119.9	121.7	116.4	5.3
2005	120.5	122.9	117.1	5.7
Standardized*				
2000	119.9	118.8	122.2	-3.4
2005	118.6	117.9	118.7	-0.8

*For each year and sector, sex ratios by birth order are standardized to the total birth order distribution reported in the 2000 census long form.

Source: Population Census Office, 2002, volume 3; National Bureau of Statistics, 2007b.