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Child Underreporting, Fertility, and Sex Ratio Imbalance in China

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Abstract Child underreporting is often neglected in studies of fertility and sex ratio imbalance in China. To improve estimates of these measures, I use intercensal comparisons to identify a rise in underreporting, which followed the increased enforcement and penalization under the birth planning system in 1991. A new triangulation of evidence indicates that about 19% of children at ages 0–4 were unreported in the 2000 census, more than double that of the 1990 census. This evidence contradicts assumptions underlying the fertility estimates of most recent studies. Yet, the analysis also suggests that China's fertility in the late 1990s (and perhaps beyond) was below officially adjusted levels. I then conduct a similar intercensal analysis of sex ratios of births and children, which are the world's highest primarily because of prenatal sex selection. However, given excess underreporting of young daughters, especially pronounced just after 1990, estimated ratios are lower than reported ratios. Sex ratios in areas with a "1.5-child" policy are especially distorted because of excess daughter underreporting, as well as sex-linked stopping rules and other factors, although it is unclear whether such policies increase use of prenatal sex selection. China's sex ratio at birth, once it is standardized by birth order, fell between 2000 and 2005 and showed a continuing excess in *urban* China, not rural China.

Keywords China · Fertility · Children · Sex ratios · Underreporting · One-child policy

Introduction

There is great interest in China's population, 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

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to gauge the true pace of demographic change. Of the three primary causes of that uncertainty, the first and foremost is China's birth planning program. Since the early 1970s, parents who violate birth restrictions have been subjected to fines and penalties (Banister 1987; Bongaarts and Greenhalgh 1985; Lavely and Freedman 1990; Michelson 2010; 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 (Aird 2004; Goodkind 2004; Greenhalgh, Zhu, and Li 1994; Merli 1998; Merli and Raftery 2000; Scharping 2003; Smith et al. 1997; Tan 1998; Zeng 1996). China's fertility policies thus provide a powerful incentive for both parents and officials to underreport out-of-quota births as well as children (Attane 2001; Feeney and Yuan 1994; Merli 1998; Scharping 2007; Smith 1994).

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

A third and less-explored element contributing to uncertainty involves the 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 (Attane 2001; Feeney and Yuan 1994; Merli and Raftery 2000; Zeng 1996). More recently, a new consensus of studies instead argued, either explicitly or implicitly, that the NBS *over-adjusts* fertility (Cai 2008; Gu et al. 2007; Guo 2004; Guo and Chen 2007; Guo et al. 2003; Morgan, Guo, and Hayford 2009; Retherford et al. 2005; Scharping 2005; Wang 2005; Zeng 2007; Zhang and Zhao 2006). Others acknowledge that the new consensus view of fertility *could* be correct but question the validity of its assumptions (Goodkind 2008a, b).

I begin with a series of intercensal analyses to estimate child underreporting in China. A new triangulation of evidence suggests that about 19% of children at ages 0–4 went unreported in the 2000 census, more than double that unreported in the 1990 census. The same evidence suggests that the NBS *did* over-adjust China's fertility in the late 1990s, and perhaps beyond. Thus, key assumptions underlying the estimates of almost all new consensus studies—that child underreporting was nonexistent, negligible, or unchanging during the 1990s—are not only highly improbable but also unnecessary for establishing the case for lower fertility. I link the intercensal rise in child underreporting to the aforementioned 1991 decree, which increased incentives to hide out-of-quota children from statistical authorities.

I then show how China's birth planning system also contributes to reported distortions in sex ratios of births and children in China, a phenomenon that has drawn widespread attention (Attane and Guilmoto 2007; Cai and Lavely 2007; Coale and Banister 1994; Ebenstein 2010; Goodkind 1996a; Hull 1990; Johannson and Nygren 1991; Poston and Morrison 2005; Short and Zhai 1998; Zeng et al. 1993). China's sex distortions have reached the highest levels in the world during the past decade, primarily because of sex-selective abortion of female fetuses (Banister 2004; Zhu, Lu, and Hesketh 2009). However, intercensal analysis confirms that sex ratios at birth (and child sex ratios) rose later than many experts assume and tended to be lower than reported because of excess underreporting of daughters relative to sons. Unusually large excesses following the 1991 decree imply that enhanced penalties led to more underreporting of daughters than sons. Sex ratios in areas with a "1.5-child" policy are especially distorted because of excess daughter underreporting, as well as sex-linked stopping rules and other factors, although it is unclear whether such policies increase use of prenatal sex selection. China's sex ratio at birth, once it is standardized by birth order, *fell* between 2000 and 2005 and showed a continuing excess in *urban* China, not rural China.

Fertility and Child Underreporting Patterns

Official NBS Fertility Statistics: Reported and Adjusted

The NBS publishes annual crude birth rates (births divided by the total population, hereafter abbreviated as CBR and shown per 1,000 population) in its *China Statistical Yearbook*. The figures reflect upward adjustments made to data reported in its annual survey of population change (typically a 1-per-1,000 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 in the year prior to the census date (November 1, 2000), while results from the short form indicate a CBR of 11.4, more than 10% 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 an adjusted 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, or 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. 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 National Population and Family Planning Commission (NPFPC; formerly known as the State Family Planning Committee), an organization tasked with implementing and enforcing China's fertility policies.[1] According to the NPFPC, China's TFR around the 2000

[1] The NPFPC has conducted several retrospective surveys on China's fertility in recent years. Given its responsibilities to enforce birth regulations, respondents to NPFPC surveys may be particularly cautious: birth reporting is consistently less complete than in NBS annual 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 (Scharping 2007), 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 NPFPC surveys or the household registration system are often outweighed by the questionable inferences and comparisons drawn from them.

census was 1.8 births per woman (Guo and Chen 2007), although it is not clear what methods were used to determine that figure.

Estimates of China's TFR vary widely (Lutz et al. 2005) and are derived from a variety of methods. For many years, the U.S. Census Bureau has used its population projection software to estimate TFRs from NBS-adjusted crude birth rates.[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). That new consensus studies consistently emphasize China's fertility to be "well below replacement" (Cai 2008; Gu et al. 2007; Morgan et al. 2009; Retherford et al. 2005; Wang 2005; Zhang and Zhao 2006) seems intended to convince those who are "skeptical of . . . very low fertility" (Morgan et al. 2009:605). Yet, few seem truly skeptical. The top line of Fig. 1 presents the U.S. Census Bureau's estimated TFRs from 1991 to 2007 derived from NBS-adjusted CBRs. Even with the NBS' upward adjustments, China's TFR apparently fell below 1.6 in 2003.

The bottom line of Fig. 1 shows TFRs derived from the raw age-specific fertility rates reported from censuses, sample censuses, and annual surveys of population change (taken in noncensus years). The middle line of Fig. 1 shows 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 local data sources, including surveys, vital registration (often partial), and other information. Figure 1 also shows fertility estimates based on backdated new school enrollments (Scharping 2005). Because these data are derived from an independent source (the Ministry of Education), the results could provide an effective way to verify NBS estimates.

Child Underreporting in the 1990 and 2000 Censuses

Table 1 shows estimates of child underreporting in recent censuses of China and other Asian societies based on U.S. Census Bureau intercensal projections. A standard method to derive such estimates compares the number of children reported in each census with child numbers projected from an earlier census or back projected from older children enumerated in a later census. Forward projections use a cohort-component approach, which begins with a base population (by age and sex) and uses annual assumptions of age-specific fertility and sex ratios at birth, as well as age- and sex-specific mortality and net migration.[3] Back projections use reverse survival by sex to bring back into the population those who died or migrated out of the country.

[2] CBRs are converted to their TFR equivalents via a population projection program, which uses official age-specific fertility as well as some adjustments to the census count of 1990 (the base year of the projection) by age and sex (see also footnote 4). These factors affect the relationship between the TFR and the CBR. The projections also incorporate estimates of sex ratios at birth as well as age- and sex-specific mortality and net migration.

[3] For general background on the technical aspects of the estimates and projections, as well as methods, data evaluation, and other topics, see (U.S. Census Bureau, International Data Base, 2009) http://www.census.gov/ipc/www/idb/estandproj.php. For more information about the basic methods, data, and sources used for each country, see the U.S. Census Bureau's International Data Base (2009) at http://www.census.gov/ipc/www/idb/country.php.

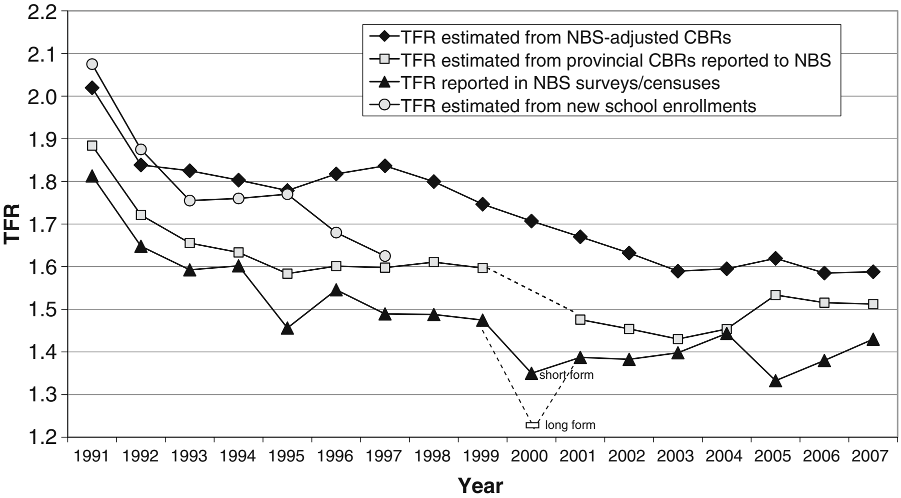

Fig. 1 Measures of China's total fertility rate (TFR): Unadjusted, province-reported, NBS-adjusted, and new school enrollment–based, 1991–2007. NBS-adjusted TFRs were calculated by the U.S. Census Bureau using projection software to match China's official crude birth rates (NBS 2008). Similarly, provincial TFRs were calculated to match weighted average of provincial CBRs reported to NBS (NBS 2008; 1991–2008). Reported TFRs were calculated from unadjusted ASFRs directly (NBS 2008; 1994–2008) or converted from unadjusted CBRs (NBS 2008; 1991–1993). New school enrollment–based estimates are from Scharping (2005)

For China, separate estimates of underreporting in 1982 are based on back projections from the 1990 and 2000 censuses, respectively.[4] For 1990, estimates are based on back projections 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 8.0% at ages 0–4 and no higher than 4.2% at ages 5–9.

For China in 2000, estimates are based on comparisons of actual child counts to projections from the 1990 census. Given uncertainty about fertility in the 1990s, I consider three scenarios. The first projection uses official NBS-adjusted fertility from 1990 to 2000 (the top line of Fig. 1). The second uses province-reported fertility levels (see Fig. 1). The third is a hybrid, which seems to best represent the new consensus. It uses NBS-adjusted estimates for 1990–1995 (which nearly match the estimates back projected from new school enrollments), Scharping's (2005) estimates for 1996–1997, and province-reported estimates for 1998–2000. The resulting TFR series (footnote b in Table 1) declines fairly smoothly and falls below 1.6 by the late 1990s. This hybrid scenario suggests that 19.1% of children at ages 0–4 were unreported in 2000, more than double that of 1990. At ages 5–9, 11.9% were unreported in 2000, almost triple that of 1990. Such levels exceed those of all other Asian societies shown in Table 1.

[4] 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 (Goodkind 2004; Retherford et al. 2005; Zhang and Cui 2003). Basic annual parameters of mortality and net migration used in projections from 1990 to 2000 appear in Goodkind (2004: appendix). Naturally, estimates of child underreporting (net coverage error) are accurate to the extent that underlying assumptions are accurate.

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

Area	Census Year	Coverage[a] (%) At Ages 0–4	Coverage[a] (%) At Ages 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[b]	2000	–19.1	–11.9	1990 census projections (new consensus fertility hybrid)
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	

[a] Negative numbers indicate implied undercounts; positive numbers indicate implied overcounts.
[b] This model approximates the "consensus of the new consensus" of lower fertility in China (see the text). The corresponding annual TFR series for 1990 to 2000 used in this projection is as follows: 2.19, 2.00, 1.82, 1.81, 1.79, 1.77, 1.68, 1.63, 1.60, 1.58, and 1.54.
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 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 (2004:289)

These estimates from forward projections and new consensus fertility are close to those based on back projections from the 2005 sample census. Figure 2 replicates a recent survival analysis by Cai (2008), who compared census counts at ages 0–9 in 1990 and 2000 to subsequent counts at ages 5–14 in the 1995 and 2005 1% sample censuses, respectively. Survival ratios greater than 1 are likely indications of underreporting in the census. Based on the overlap of the survival curves shown by Cai (reproduced by the bottom two lines), the author claimed "very similar underreporting rates" of children in 1990 and 2000 (Cai 2008:277). However, these survival curves overlap (and at levels near 1 for the cohort overall) only because of the author's large and *differential* upward adjustments to the official sample proportions in 1995 versus 2005. Closer inspection suggests that these differential adjustments were unwarranted.[5]

Without such adjustments, the top two lines of Fig. 2 imply that child underreporting in 2000 was about double that of 1990, with the overall levels close to those estimated in Table 1 (rows 4 and 7). This critical triangulation of evidence appears to confirm *both* the new consensus fertility series used in the projection as well as a sizeable rise in child underreporting (Goodkind 2004), the causes of which I explore in the next section.

Child Underreporting, the Birth Planning System, and the 1991 Decree

New consensus studies have produced fairly consistent estimates of China's fertility despite employing different methods. Nevertheless, the sharp intercensal rise in child underreporting demonstrated in the previous section contradicts the critical assumptions common to nearly all these studies. None of the estimates of China's fertility around 2000 by Guo (2004), Guo and Chen (2007), Gu et al. (2007; Table 3), East-West Center/NBS (2007),[6] and Morgan et al. (2009) contained any adjustments for child underreporting. Moreover, estimates in these studies were one-tenth or two-tenths of a birth lower than those of Retherford et al. (2005) and Cai (2008), who explicitly assumed no change in child underreporting between the 1990 and 2000 censuses.

Because recent literature has neglected the impact of China's birth planning system on child underreporting, I briefly review that system here. As mentioned earlier, China began to restrict fertility in the early 1970s, with the formal adoption of a one-child ideal beginning in 1979. The hypothesis underlying the policy was that China's development would be impaired if it did not drastically restrict population growth (Tien 1983). To achieve this end, an unprecedented bureaucratic control system was developed, led by the State Family Planning Committee, with

[5] Instead of using official sample proportions to compare sample census counts against census counts, Cai (2008) raised the sample proportion by 8% in 1995 and 16% in 2005 (calculations derived from figures in Cai 2008: footnote 3). These large and differential changes were proposed as proper adjustment for varying completeness of enumeration by age in the sample surveys. The adjustments emerged from an exercise in which the author chose to focus on those born between 1940 and 1954 and compared the count of this birth cohort (as projected from those aged 35–49 in the 1990 census) with the sampled counts of the cohort in 1995 and 2005, with each sampled count raised by the official sampling proportion. In a replication of this analysis, I found that the (inflated) sample count of the cohort aged 40–54 in 1995 was 8% higher than implied by the 1990 census–based projection, and the (inflated) sample count of the cohort aged 50–64 in 2005 was 16% higher that implied by the 1990 census–based projection. (These match the percentages of the differential adjustments Cai applied to ages 5–14.) Because the census counts are common to each projection exercise, the adjusted survival curves on the bottom of Fig. 2, by definition, do not indicate very similar child underreporting rates between the censuses; instead, their overlap simply reflects quirks in *adult age* reporting between the 1995 and 2005 *sample* censuses.

[6] This was a joint report published by the China Statistics Press, which issues most of the official materials of the NBS. Yet, the preface of the report acknowledged that its provincial fertility estimates (which contained no adjustments for child underreporting) were not official estimates. Moreover, the report was issued only in English, not Chinese. To avoid any mistaken impression that these were official estimates, East-West Center is listed as first author.

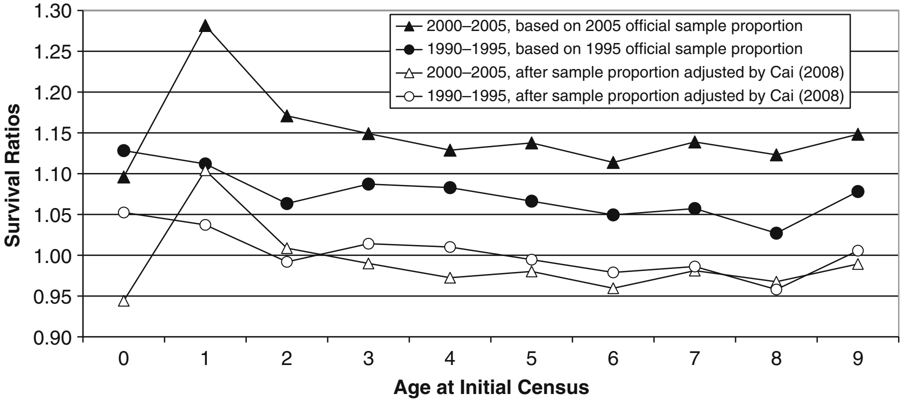

Fig. 2 Survival ratios of children at ages 0–9 counted in China censuses to ages 5–14 in each following sample census: 1990–1995 and 2000–2005. To permit a comparison of counts in censuses to census samples, the latter are inflated by official sampling proportions (1.027% in 1995 and 1.325% in 2005). The figure shows the resulting survival ratios, as well as those resulting from differential adjustments to the sampling proportions made by Cai (2008): 8% in 1995 and 16% in 2005. The 2000 and 2005 figures are both reckoned as of November 1. The 1990 and 1995 figures are reckoned as of July 1 and October 1, respectively. The October 1 sample figures are interpolated to July 1 to provide a five-year risk interval. *Sources:* NBS (1997, 2007); Population Census Office (1993, 2002)

parallel committees organized at administrative levels down to the local commune/village (Scharping 2003). The system featured numerous rules and regulations, mechanisms for control and surveillance (including monitoring of pregnancies), provision of family planning services, and fines and other punishments for children born outside the official plan (Banister 1987, Scharping 2003; Tien 1983).

After alternate phases of policy tightening and relaxation in the 1980s, the 1990 census results revealed that fertility was above replacement levels, a finding attributed to lax enforcement by birth planning cadres (Scharping 2003). In an effort to ensure compliance with existing policy, a central decree was issued (Xinhua 1991). What was unique about the decree was the seriousness with which regulations were to be enforced and the decision that local officials would be held personally responsible for allowing out-of-quota births. These same officials were responsible for funneling up to higher administrative levels the very statistics against which their performance would be evaluated (Merli 1998; Scharping 2003; Smith et al. 1997; Zeng 1996). If poor performance meant losing one's job, the likely choice for officials was either to enforce birth planning quotas or to underreport births in their jurisdictions.

Parents also had good reason to conceal an out-of-quota child, the fine for which rose to two or three times annual wages following the decree, double what the fine had been earlier (Scharping 2003). Statistical authorities were aware of this problem. To encourage full reporting when the 1990 census was conducted, parents were assured that they would not be punished if they revealed an out-of-quota child. However, those who did were indeed punished in some localities by birth planning authorities (Lavely 2001, Scharping 2003; Zeng 1996). Thus, parents were likely skeptical when they were given similar assurances prior to the 2000 census (Rosenthal 2000). A 2002 survey in six Chinese provinces provides a bracing reminder of the pervasive reach of China's birth planning program around the time of the 2000 census. Among households with two or more children (with one child younger than age 6), more than one-half reported a conflict with local birth planning authorities, by far the greatest reason for local conflict, and the incidence of such conflict was closely related to the level of fertility (Michelson 2010).

Some studies that downplay the role of the birth planning system offer alternative hypotheses to explain the rise of child underreporting in the 1990s. For instance, Zhang and Zhao (2006:294) hypothesized that the rise in underreporting was due to "increasing rural-urban migration and the weakening central administration." Although such changes occurred in post-1990 China, they have occurred in other countries as well; to my knowledge, however, none have experienced such sharp rises in underreporting. Moreover, these changes cannot explain why the rise in underreporting was confined to China's children. For instance, migration is most prevalent among young adults, yet intercensal analysis suggests no underreporting at these ages. In fact, counts at ages 20 and older in the 2000 census tended to be slightly higher than those projected from ages 10 and older in 1990 (Banister and Hill 2004; Goodkind 2004). In addition, reported fertility of cross-province migrants was 18% higher than for nonmigrants from 1996 to 2000 (Retherford et al. 2005). This evidence does not imply that underreporting of children was concentrated among migrants.

Three pieces of evidence suggest that the 1991 decree was the key cause of the large rise in child underreporting between 1990 and 2000. The first piece of evidence is based on an examination of China's "policy fertility," which is the national fertility level allowed given the variety of fertility restrictions called for at the local level (Gu et al. 2007). Although some localities in China call for a strict one-child limit, some allow two (or even three) children, while the majority of localities promote a "1.5-child" limit, permitting a second child only if the first child is a daughter (Short and Zhai 1998). Around 1989, China's policy fertility was 1.64 (Scharping 2003); when next measured at the 2000 census, it was 1.47 (Guo et al. 2003; Gu et al. 2007). Second, the 1991 decree not only lowered the nominal ceiling of policy fertility; it also strengthened enforcement and increased penalties against local officials who exceeded that ceiling, the same officials who were responsible for passing birth statistics up to higher administrative levels (Merli and Raftery 2000; Scharping 2003; Smith et al. 1997). Third, reported fertility in China fell sharply upon implementation of the decree (Fig. 1; bottom line) toward the very levels called for by policy (Scharping 2007). Although a portion of this decline may have been real, 1992 is widely regarded as the year in which the accuracy of birth reporting began to break down (Goodkind 2004; Zeng 1996; Zhang and Zhao 2006).

What Might Explain Apparent Overadjustment of Fertility in the Late 1990s?

To reiterate, there is no evidence that the NBS overadjusted fertility between 1990 and 1995. Scharping's (2005) estimates over the interval 1991–1995 are close to the adjusted estimates of the NBS (Fig. 1; top); and these NBS figures were used in the forward-projections model (Table 1; row 7), which produced child underreporting estimates at ages 5–9 that triangulate well with those from back projections (Fig. 2; top lines).[7]

[7] 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*.

Notable overadjustment did not seem to begin until 1996. Figure 3 shows the annual percentage of births that were unreported implied by comparisons with pairs of measures on Fig. 1. For instance, from 1991 to 1994, NBS adjustments imply that 10%–13% of births were unreported in annual surveys, about double that indicated by post-enumeration surveys.[8] In 1995, a sharp dip in reported fertility in the sample census implied that 17% of births were unreported. The triangulation of evidence noted earlier implies that these estimates are reasonable. Figure 3 suggests that the NBS assumed births in the late 1990s were unreported to a similar extent as occurred in 1995. However, the province-based TFRs used in the new consensus model for the late 1990s imply that only about 7% of births were unreported, less than one-half that assumed by the NBS. What is clear in hindsight is that the spike in 1995 was aberrant, as were spikes later observed in the 2000 census and 2005 sample census. These larger statistical undertakings, which are more nationally representative and often used to infer patterns in adjacent years, are most prone to child underreporting. In the late 1990s, a decline in fertility would have also reduced the share of births exceeding official quotas.[9]

Why might birth underreporting be excessive in census and sample census years? One hypothesis is that large-scale data collection efforts are simply less able to achieve complete reporting (Zeng 1996; Zhang and Zhao 2006). Another explanation may be that parents and local officials feared that results from broader undertakings would 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 birth planning regulations. Because freshly updated registers have traditionally provided a means for verifying counts in the census, omission of children from the registers because of fear of penalties (Lavely 2001; Merli 1998) 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 sample census years compared with those asked in annual surveys.

Sex Ratios of Births and Children

In this section, I show how China's birth planning system also contributed to a rise in excess underreporting of daughters relative to sons. The key analytical method relies on another series of intercensal comparisons. In addition, I use other basic demographic methods—standardization and decomposition—to better evaluate the reasons for reported sex ratio imbalances. Although prenatal selection accounts for

[8] Zhang and Zhao (2006) contended that NBS adjustments should have been based solely on births uncovered in post-enumeration surveys (PES), which implied only 6%–7% underreporting in 1993 and 1994 (Jia and Sai 1995). However, PES efforts in many countries may not fully capture hidden births (Whitford and Banda 2001), and birth planning policies in China provide special disincentives to report out-of-quota births (Scharping 2003).

[9] That falling fertility should have reduced the proportion of out-of-quota births not reported in the 1990s is not at odds with the observed rise in *child* underreporting between the 1990 and 2000 censuses after the 1991 decree. For an exploratory model of these two opposing forces, see Goodkind (2008a).

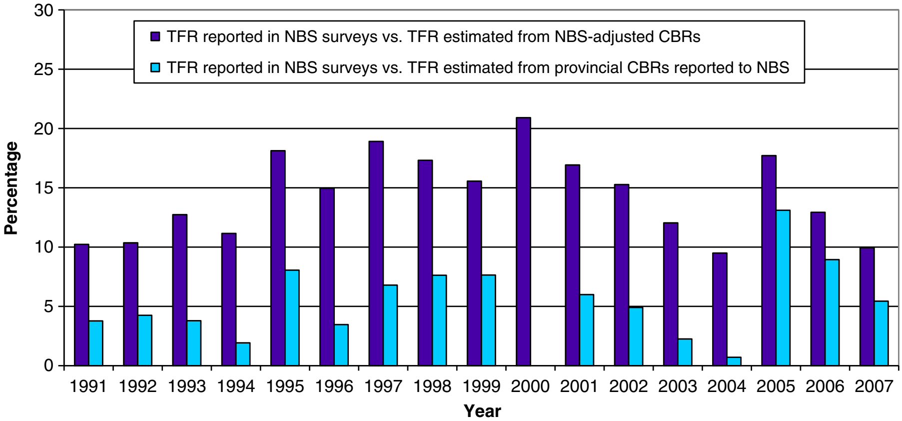

Fig. 3 Percentage difference in fertility measures for China: 1991–2007. Data were calculated from TFRs shown in Fig. 1

much of the rise in sex ratio distortions since 1990, excess underreporting of daughters also increased following the 1991 decree, and the differential stopping rule in 1.5-child policy areas further distorted child sex ratios.

The Rise in Reported Sex Ratios and Excess Underreporting of Daughters

Figure 4 shows annual estimates of China's sex ratio at birth (expressed as male births per 100 female births) based on a variety of sources. The diamonds in the figure show births reported in the year prior to censuses and sample censuses. These point estimates display a clear upward trend. The estimate for 2000 comes from the census short form, which indicated a sex ratio at birth of 116.9 males per 100 females. Many demographers instead quote the long form statistic—119.9 (Li 2007; Riley 2004; Wang 2005)—which is less reliable.[10] However, given that the long-form statistic comes from a sample, it may be more comparable with those derived from other sample data, such as annual surveys or sample censuses.[11]

Figure 4 also shows estimates of sex ratios at birth back projected from child sex distributions reported in the censuses and sample censuses. On each of these curves, the rightmost point is back projected from 0-year-old counts, the next point to the left is back projected from 1-year-old counts, and so forth. The back projecting procedures that I used take into account sex differences in child mortality as well as net migration (e.g., adoptions abroad). In addition to these estimates based on NBS

[10] One concern about the long form sample is that it is not nationally representative; for instance, migrant workers were difficult to locate in the 2000 census. When located, they were more likely to receive the short form. Another concern is 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's focus on childbearing of particular mothers may have exacerbated both underreporting of births as well as excess underreporting of daughters.

[11] For instance, the reported sex ratio at birth in the 2005 sample census (120.5) increased more in comparison with the 2000 census short-form sample (116.9) than the 2000 census long-form sample (119.9).

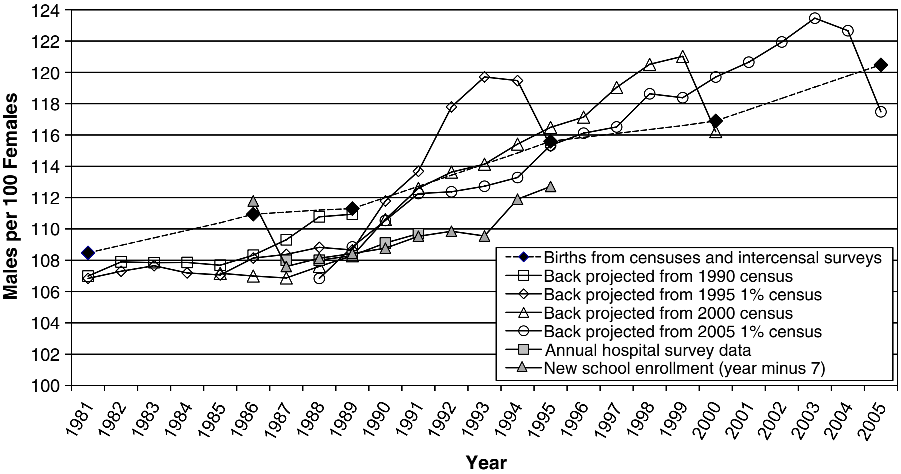

Fig. 4 Sex ratios at birth in China implied by various sources: 1981–2005. Births from censuses and intercensal surveys refer to those born in the year preceding each census/survey (NBS 1988, 1997, 2007; Population Census Office 1985, 1993, 2002). Back projections from 1990, 1995, 2000, and 2005 child counts consider sex differences in mortality and international migration. Hospital survey data are from Zeng et al. (1993). New school enrollments 7 years hence, scaled for slight female underenrollment, are from Zhang (2005)

data, Fig. 4 also shows annual series of sex ratios at birth based on hospital surveys (Zeng et al. 1993) as well as back projections from new school enrollments (Zhang 2005).

Intercensal comparisons on Fig. 4 grow from the same tradition exemplified by Coale and Banister (1994), who found strong consistency in sex ratios among cohorts reported across censuses taken in 1990 and before. In contrast, the diamonds in Fig. 4 show that sex ratios of births reported in the 1980s were 2 or 3 per 100 above estimates based on children counted at older ages *after* 1990. In 1989, for instance, although the oft-quoted point estimate from the 1990 census was 111.3, demographic evidence since then 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) reached a similar conclusion based on other methods and data available at the time. If the normal ratio is 106,[12] excess underreporting of daughters accounted for 57% of the reported female birth shortage in 1989 [1–(108.3–106.0)/111.3–106.0)]. Underreporting by sex also varied greatly among China's provinces,[13] so overt sex discrimination cannot fully account for regional variation in reported sex ratios, as one would infer from recent studies that either downplay excess daughter underreporting (Das Gupta, Chung, and Li 2009; Zhu et al. 2009) or do not consider it (Attane 2009; Ebenstein 2010).

[12] The "normal" sex ratio at birth and reasons for cross-cultural variation are subject to 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 to 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 I will shortly show.

[13] A comparison of sex ratios at birth in 1989 (from the 1990 census) to sex ratios of children reported at age 11 in the 2000 census suggests that the former were likely overstated by more than 5 per 100 in Zhejiang, Shandong, Henan, and Hebei (Goodkind and West 2005: Table 4).

Eventually, as sex selection technologies became more prevalent in the 1990s, selective abortion reportedly surpassed underreporting to become the dominant cause of distortions (Banister 2004; Goodkind and West 2007). Following the 1990 census, though, was also a notable increase in excess underreporting of daughters. Sex ratios from child counts in 1995, 2000, and 2005 became especially distorted at ages 1–3 compared with age 0 (Fig. 4; see also Banister 2004). These fishhook-shaped patterns render the reported sex ratios of young children from any particular census or survey too masculine: sex ratios are more feminine at later child ages where reporting tends to be more complete (the same dynamic one finds for children of both sexes; Table 1). Consider, for instance, the sex ratio at birth in 1993, which was 114.1 according to the 1993 annual survey (not shown). Thereafter, the sex ratio at birth for this cohort as estimated from back projections of 2-year-olds in 1995, 7-year-olds in 2000, and 12-year-olds in 2005 was 119.7, 114.1, and 112.7, respectively (see Fig. 4). As it aged, the 1993 birth cohort showed the same fishhook pattern of sex ratios observed within any given year, with the latest estimate (112.7) below what was reported at birth.[14] And if one believes the administrative data from school enrollments and the trend from hospital surveys, the true sex ratio at birth in 1993 may have been lower than 112.7.

Thus, the 1995 census sample, the largest statistical undertaking following the 1991 decree, revealed a dramatic increase in excess daughter underreporting. Reported sex ratios of young children in 1995 were 6 or 7 per 100 above those indicated by subsequent counts of these children at older ages, compared with an excess of just 2 or 3 per 100 in 1982 and 1990. I posit two possible explanations for this rise. First, given strong son preference in China, increased penalties after the 1991 decree could have rendered parents even less willing than before to report an out-of-quota daughter than an out-of-quota son. Second, given the rising prevalence of areas with a 1.5-child policy in the late 1980s (Scharping 2003), parents having a daughter after a son may not have reported her if they wished to avoid penalties. Later in this article, I return to the strategic shifts caused by this policy.

The distinctive fishhook pattern of sex ratios by child ages in the 2000 census and 2005 sample census continue to indicate excess daughter underreporting. For instance, sex ratios at birth for the cohort born from 1997 to 1999 are about 2–3 per 100 lower when estimated from ages 6–8 in the 2005 sample census than when estimated at ages 1–3 in the 2000 census, and counts of those at ages 11–13 in the 2010 census may show even lower sex ratios. However, the upward arc of the

[14] This implies that the fishhook pattern by age results from overreporting of sex ratios at ages 1–3, rather than underreporting at age 0 as many have hypothesized (Qiao 2005; Cai and Lavely 2007). One finding that may have contributed to the earlier hypothesis involves a post-enumeration "cleanup" following a 1997 survey by the National Committee for Family Planning. (The report was unpublished and available only in Chinese; 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 0) are biased downward. However, the excess of males discovered among hidden births in the PES might reflect parents' greater willingness to reveal an out-of-quota son than an out-of-quota daughter during the cleanup. Moreover, daughters lost to infanticide or out-adoption might not be recalled as births at all in the later cleanup.

fishhook causing this gap appears to have been less steep in 2000 (vs. 2005) than in 1995 (vs. 2000). If this were due to a decline in excess underreporting of daughters, why would that decline have occurred? One explanation may be that the strictest enforcement of the decree took place during the mid-1990s, closer to enactment of the 1991 decree. Another explanation could be declining fertility, which should have reduced the proportion of out-of-quota daughters. A third hypothesis is that rising use of prenatal sex selection reduced the proportion of daughters that parents might want to conceal (Goodkind and West 2005).

Trends in China's Sex Ratios at Birth: Other Interpretive Challenges Attributable to Shifting Birth-Order Distributions

Even in societies where son preference exists and sex selection is employed, the sex ratio of first births tends to be relatively normal (Banister 2004; Zheng 2007). Thereafter, sex ratios tend to be highly skewed among second- and higher-order births—as shown in Fig. 5 for China in 2000 and 2005—because parents who proceed to higher-order births often do so to have a son (Bhat and Zavier 2003). As a result, because of the steep gradient between sex ratios of first and subsequent births, the aggregate sex ratio of all births is very sensitive to the birth order distribution.

There was a reported rise in the overall sex ratio at birth between the 2000 census (119.9; long form) and the 2005 census sample (120.5). However, after sex ratios by birth order are disaggregated, the sex ratio declines notably for second- and higher-order births. In fact, when the 2005 sex ratios are standardized by birth order to the birth order distribution in the 2000 long form (Fig. 5), the resulting sex ratio at birth is 118.6, *below* the 119.9 in the 2000 long form. The reason for the reversal? The

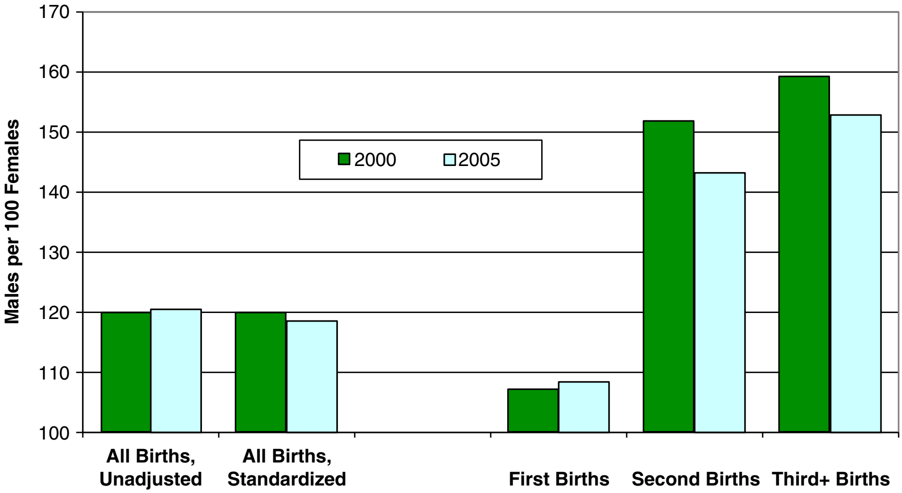

Fig. 5 Sex ratios at birth reported in China's 2000 census (long form) and 2005 sample census: Unadjusted, standardized, and by birth order. Data from the 2000 census long form are used because the short form does not indicate birth order distributions. Moreover, long-form results allow comparisons between two samples. Standardization applies the birth order distribution of all births in 2000 to the sex ratio at birth, by birth order in 2005. *Sources:* NBS (2007), Population Census Office (2002)

2005 census sample reports a larger proportion of higher-order births (beyond the first) than the 2000 census long form (37% vs. 32%, a finding consistent with its higher TFR: 1.35 vs. 1.22). Standardization corrects for this differential and implies that the propensity to sex select likely declined over the interval.[15]

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 0.70 to 0.80 between 2000 and 2005, suggesting some decline in daughter disadvantage.[16] In contrast to recent reports emphasizing high or rising sex distortions in China (Li 2007; Zhu et al. 2009) or claiming regional intimations of incipient decline (Das Gupta et al. 2009), these findings suggest that sex ratios may have already declined. Prenatal and postnatal discriminatory practices in China appear to have both risen (Goodkind 1996a:118) and fallen additively. To the extent that excess underreporting of daughters also reflects son preference, one might expect it to have increased in additive fashion during the 1990s and declined since.[17]

Before turning to other areas of East Asia for comparative insights, I use birth-order differentials to dispel another misconception. Rural areas in China report higher sex ratios at birth than urban areas (Banister 2004; Gu and Roy 1995; Hull 1990; Li 2007; Zhu et al. 2009), a finding widely assumed 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 2). Urban sex ratios tend to be lower, though, because the proportion of first births among all births is higher. Upon standardizing rural and urban sex ratios by birth order to the 2000 birth order distribution for China as a whole, Table 2 shows that these figures reverse position: to 118.8 in rural areas versus 122.2 in urban areas.[18] 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, albeit with a decreasing gap.

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[15] Another potential explanation is that excess underreporting of daughters diminished over the interval. Also note that the 2000 census short form does not contain information on birth order, and as mentioned earlier, demographic measures differ between the short- and long-form results. Figure 5 shows comparisons between the two samples: the 2005 sample census and the 2000 census long form.

[16] The typical sex ratio of infant mortality throughout the world ranges from about 1.2 to 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 (Hill and Upchurch 1995).

[17] The substitution hypothesis, as originally formulated, posits that prenatal sex selection may lead to a decline in postnatal discriminatory practices (Goodkind 1996a, 1999). Although South Korea showed possible evidence of such substitution, the dynamic in China has been additive, perhaps because of the role of the birth planning system in increasing discrimination of all kinds (Goodkind 1996a:118). A softer version of the hypothesis, however, has never been examined in China's context; that is, if prenatal selection had not been available, postnatal discrimination against daughters may have increased even more than it did. Ideally, the substitution hypothesis should be examined with individual-level data, although few researchers have attempted to do so (for a rare exception, see Shepherd [2008]).

[18] Other benchmarks for standardization can be chosen, but under any standard, the standardized excess of urban ratios above rural ratios will always equal 3.4. Standardization of sex ratios at birth in the 1990 census also reveal an excess in urban areas (not shown).

Table 2 Sex ratio at birth in China by sector, as reported and standardized to the 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[a]				
2000	119.9	118.8	122.2	–3.4
2005	118.6	117.9	118.7	–0.8

[a] 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.

Sources: NBS (2007); Population Census Office (2002: vol. 3)

Higher standardized urban sex ratios do not necessarily indicate stronger son *preference* among urban parents. The differential may reflect easier urban access to sex selection technologies, the stronger implementation of the birth planning system there, or other factors. At the very least, however, these results suggest that parental propensities to use sex selection may be greater in urban China. Current policies to combat sex discrimination focus instead on rural areas (Zheng 2007).

East Asian Trends in Sex Ratios at Birth and Related Policies

I 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 these societies, statistics come from high-quality annual vital registration systems. Figure 6 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, 1993; Lee and Paik 2006). For simplicity, Fig. 6 shows only aggregate sex ratios at birth without standardization. During the 1980s, South Korea displayed the sharpest increase in its sex ratio at birth, reaching a plateau of more than 114 male births per 100 female births in the early 1990s. Taiwan exhibited twin peaks over the full interval,[19] whereas Hong Kong showed a fairly steady increase. Only Japan showed a fairly gradual decline within the normal range throughout this period.[20]

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

[20] However, Japan earlier 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). Whether the peak was related to the Fire Horse or to levels of fertility is unclear, as is the availability of any effective sex-testing technologies at that time.

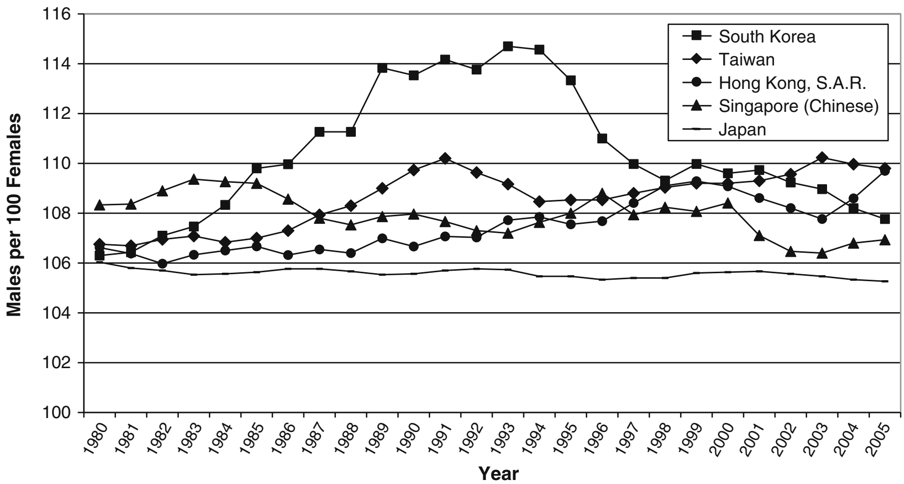

Fig. 6 Sex ratios at birth reported in East Asia: Three-year averages, 1980–2005. Vital statistics used for three-year averages extend from 1979 through 2006. The confidence interval above and below the three-year average in 2005 exceeds 1.0 per 100 for Hong Kong, and 1.5 per 100 for Singapore Chinese. Data are from the Department of Statistics (2007, 2008); P. Chun, pers. comm., September 7, 2004; Li, pers. comm., September 18, 2002 and January 16, 2008; Ministry of Health, Labour and Welfare, pers. comm., January 21, 2008; National Institute of Population and Social Security Research (2004); National Statistical Office (2008)

By the late 1990s, the upward trajectory had reversed in most areas. South Korea was again notable, with the sex ratio at birth plummeting by 5 per 100 in the four years between 1994 and 1998, and then falling to near normal by 2006. Chung and Das Gupta (2007) argued that this 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. The change in preference may have been due in part to 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).

For several years, China has been implementing a set of policies to raise the status of daughters, inspired perhaps by similar policies enacted in South Korea. 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 & Guardian 2004). In the wake of 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).

The Care for Girls program has shown promise in pilot areas and may contribute to reducing daughter disadvantage in the future (Zheng 2007). Yet, among higher-order births, declining sex ratios (see Fig. 5) suggest that there may have already been a decline in selective abortion. China may have already 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.[21]

Causes of Reported Sex Ratio Imbalances: A Closer Look at the 1.5-Child Policy

Demographers have often suggested that China's fertility restrictions may be a key cause of its elevated sex ratio at birth (Banister 2004; Ebenstein 2010; Greenhalgh and Li 1995; Hull 1990; Zhu et al. 2009), an imbalance posited to have dire social implications (Hudson and den Boer 2004; Poston and Morrison 2005). The South Korean case illustrates that other causes contribute, given that sex ratios at birth rose there without any fertility restrictions (Banister 2004). Yet, now that China's sex ratios have become more distorted than anywhere else in the world, demographers have kept this theory afloat. Several observers, for instance, have suggested that China's 1.5-child policy may be a key causal factor (Greenhalgh and Li 1995; Li 2007; Riley 2004; Wang 2005). Under this policy, the most common in China's localities (Gu et al. 2007) and widespread in rural areas, parents may have a second child without penalty if the first child is a daughter. The prevailing view is that this policy reinforces son preference and exacerbates sex distortions, although in marked contrast to studies in the early 1990s (Hull 1990; Johansson and Nygren 1991; Zeng et al. 1993), recent literature has made little effort to assess the specific mix of factors causing reported distortions.

Several recent studies have found a striking connection between sex ratios at birth and local fertility policy type (Attane 2009; Ebenstein 2010; Guo 2007; Zeng 2007; Zhu et al. 2009). For instance, the 2000 census reported a sex ratio at birth of 124.7 in 1.5-child areas, far higher than the 109.0 in 2-child areas (Zeng 2007). Aforementioned studies attributed this differential to enhanced use of selective abortion in localities that implement the 1.5-child policy option and inferred that sex selection would decline if they switched to a 2-child policy. There are at least four important caveats to such an inference, however. The first caveat is that daughters in 1.5-child areas are underreported to a greater extent than in 2-child areas, in part because penalties would be invoked automatically against parents having a daughter after a first-born son. After adjustments for differential underreporting of males and females in the policy areas, Zeng (2007: footnote 10, addendum obtained from the author) estimated the sex ratio at birth to be 119.7 in 1.5-child policy areas versus 108.3 in 2-child policy areas, a difference of 11.4/100.

The second caveat, noted also by Zeng (2007), concerns stopping rules. I reinforce this little-known point in Fig. 7, which shows a model of expected fertility patterns among parents in both 1.5-child and 2-child policy areas. The model in Fig. 7 assumes that all parents have as many children as allowed under their regulations, that there is universal access to sex selection, and that sex selection is employed only after the first birth. Calculations of the expected sex ratio at birth in the decision trees of the graph

[21] 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 8–11 years in Taiwan, Singapore, and Japan; and 18 years in Hong Kong (Goodkind and West 2007). The longer gap in Hong Kong might be due to increased migration of Chinese from the mainland. Based on these patterns elsewhere in Asia, because China's fertility first fell below replacement in 1991, one would expect a turnaround in sex ratios between 1999 and 2009.

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-child and 2-child policies. All parents will proceed to have a second child and will use selective abortion (if necessary) to ensure that the child will be a son. The major difference is the top tree. When the first-born child is a son, the 1.5-child areas impose a stopping rule, which allows no second-born daughters at all. *Ceteris paribus*, the sex ratio at birth will be higher in 1.5-child areas than in 2-child areas (206 vs. 172) *not* because of sex selection but because of compliance with differential stopping rules.

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 (2007) estimate that a sex ratio at birth of 119.7 will occur in 1.5-child areas when 19.1% of parents whose first child is a girl use sex selection to ensure that the second child will be a boy. *Ceteris paribus*, the same percentage (19.1) in 2-child areas implies a sex ratio at birth of 116.0 (Fig. 7; bottom). Thus, of the 11.4/100 excess in Zeng's adjusted sex ratio at birth in 1.5-child areas, 3.7/100 [or 32%; (119.7–116.0) / (119.7–108.3)] may be attributed to compliance with stopping rules.

A third caveat concerns the confluence of stopping rules and *daughter preference.* Many studies have shown that parents, even those in societies that strongly desire sons, want to have daughters as well.[22] Although parents are most likely to use sex selection to ensure having a son, China's 2000 census revealed that sex ratios of third births among parents with two sons were disproportionately feminine (76.5; Zheng 2007; see also findings from the 1990 census in Zeng et al. 1993), which could indicate selective abortion against male fetuses. To the extent that selection against males cancels out selection against females, the overall sex ratio at birth will be more normal (McLelland 1983). Since parents in 2-child areas can use sex selection to ensure having both a daughter as well as a son, they should have lower sex ratios than in 1.5-child areas, where stopping rules permit sex selection only to ensure having a son. Figure 7 does not incorporate daughter preference, although preliminary explorations suggest the importance of this offsetting factor in future biometric modeling.

The fourth caveat is that after factoring in the first three caveats, much of the remaining sex ratio excess in 1.5-child policy areas could be due to composition or selection effects. For example, ethnic minorities are more likely to live in areas with 2-child or 3-child policies (Scharping 2003). Since ethnic minorities have weaker son preference than Han Chinese, sex ratios tend to be much lower in these areas (Attane 2009). Similarly, to the extent that localities could choose between a 1.5-child and a 2-child policy (or even a 1-child policy), the choice was not a random draw: areas with the strongest son preference would more likely want exemptions to the 1-child rule for parents whose first born was a daughter and might also have better access to sex testing.[23]

[22] Pande and Malhotra (2006) found that 87% of Indian parents want at least one daughter. Goodkind (1996b) found that 93% 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).

[23] In a few experimental localities, reported sex ratios in 1.5-child policy areas vastly exceeded those of adjacent areas with 2.0-child policies (Zeng 2007:230). In addition to aforementioned caveats about the causes and interpretation of such reported differentials, statistical confidence intervals around sex ratios are very wide. Even in a locality with 5,000 annual births, a 95% confidence interval would span 6 per 100 above and below an expected sex ratio of 106.

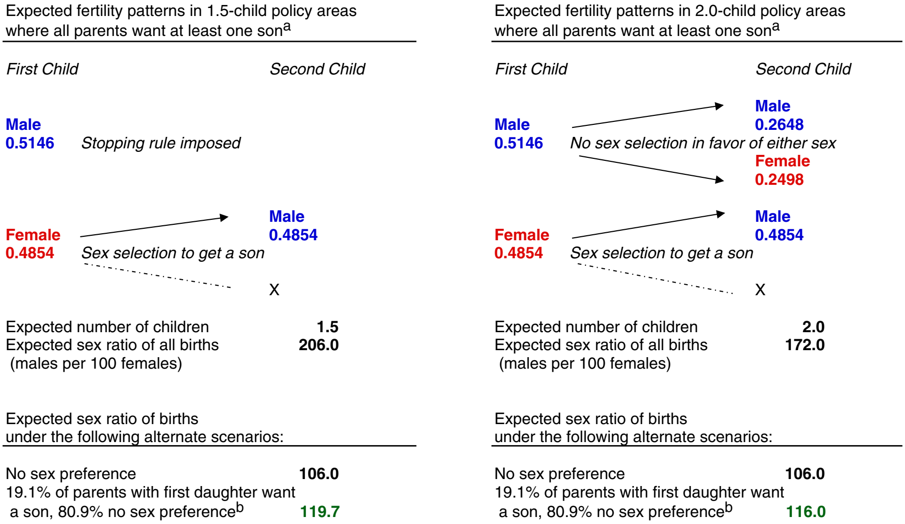

Fig. 7 Expected children by sex under different fertility policies and son preference assumptions
[a]Assumes all parents have as many children as allowed under regulations and have full access to sex selection. Figures on upper diagram show the contribution of sons and daughters (by birth order) to expected number of children (e.g., $1.5 = 0.5146 + 0.4854 + 0.4854$). Sex ratios are expressed as males per 100 females. Sex ratio at birth in the absence of sex selection is assumed to be $106 (= 0.5146/0.4854 \times 100)$. See the text for further details
[b]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)

The preceding discussion should not be misconstrued as denying that prenatal sex selection is discriminatory or that a 2-child policy approach is more equitable and might be preferable to a 1.5-child policy. My primary concern has been to explain why China has reported the highest sex ratios in the world. China's birth planning system has contributed to child sex imbalance in two ways: actual imbalances resulting from the 1.5-child stopping rule and nominal imbalances due to differential underreporting of daughters. In the absence of these policy-related factors, sex ratio distortions in China attributable to prenatal selection alone might have peaked at lower levels, closer to those evinced by South Korea in the early 1990s (see Fig. 6).[24] Yet, it remains unclear whether son preference or prenatal selection increased in response to the 1.5-child policy or other features of the birth planning system. Studies making such claims should be treated with caution unless the aforementioned confounding factors can be effectively isolated.

In fact, Fig. 7 suggests that in 1.5-child policy areas, daughters might be *more valued* as first births, which account for more than two-thirds of all births in China. Again, because the ideal for most parents is to have both a son and a daughter, a

[24] Fig. 4 implies that reported child sex ratios since the late 1980s were likely about 3 per 100 higher because of excess underreporting of daughters. Figure 7 implies that sex ratios may be further elevated by 3.7 per 100 in 1.5-child areas because of compliance with the stopping rule. Since just over one-half of China's localities impose the 1.5-child rule (Gu et al. 2007), the national elevation attributable to this policy is likely almost 2 per 100. If these two factors were removed, China's reported sex ratios might be reduced by as much as 5 per 100, implying a sex ratio plateau closer to that of South Korea in the early 1990s (Fig. 6).

first-born daughter in a 1.5-child policy area gives parents the opportunity to have a second child without penalty (Short et al. 2001; Smith et al. 1997), an option not available to those with first-born sons. Moreover, in a study of parental care of children, Short et al. (2001:935) concluded that "girls are better off in [1.5-child] communities, particularly when compared to girls in communities where couples can have two or more children." The authors' primary theory for their unexpected finding was that girls in 1.5-child areas are more wanted. Potential links between wantedness and child well-being have been an integral focus of family planning and sex preference literature for several decades.

Conclusions

China began to restrict fertility in the early 1970s. Since then, it increased penalties and strengthened enforcement through the 1991 central decree. It also opened local loopholes, such as the 1.5-child rule, allowing for a second birth after a first-born daughter. This article explores how such features of China's birth planning system have affected not only reproductive decisions but also the willingness to report children of both sexes combined as well as daughters relative to sons. These two underreporting phenomena have often gone unacknowledged in recent literature, and even when they are discussed, they have been treated as separate problems, though they are related.

In regard to China's fertility levels, a new triangulation of evidence based on intercensal analysis implies that NBS estimates of fertility in the late 1990s, and perhaps beyond, are too high, a finding in line with the new consensus among recent studies. This same evidence also implies that child underreporting more than doubled between the 1990 and 2000 censuses to levels much higher than elsewhere in Asia. This finding contradicts assumptions underlying the estimates of nearly all new consensus studies: that child underreporting in China was nonexistent or remained constant during the 1990s. A sharp intercensal rise in child underreporting makes sense. The 1991 central decree lowered birth quotas and raised penalties for officials who permitted out-of-quota children in their jurisdictions. These concerns dovetailed well with those of parents, who at the time of the 2000 census still faced huge fines and conflicts with local authorities for reporting out-of-quota births. Given this confluence of interests and other evidence presented herein, the "old consensus" concerns about the effects of the birth planning system on reporting completeness remain valid and should not be ignored.

I also examine the shifting dynamics of underreporting by sex. My intercensal analysis confirms that the primary cause of sex distortions in the 1980s was excess underreporting of daughters. During the 1990s, China's sharply rising sex imbalance was due largely to increasing use of selective abortion, although excess underreporting of daughters also became more severe through 1995 and still accounts for some of the reported imbalance. Intersecting fishhook-shaped patterns indicate that a portion of missing females at young ages tend to be found at later ages when counted in subsequent censuses or sample censuses. The distinctive shape and magnitude of these distortions became pronounced after the 1991 decree. Given enhanced penalties, parents were apparently even less willing than before to report out-of-quota daughters than out-of-quota sons. The 1.5-child loophole also appears to have shifted strategies for parents wanting one child of each sex. Although the loophole made first-born daughters more valuable (because they gave parents the option of having a second child), parents might then, as in other countries, use prenatal selection to ensure that the next child would be a son. However, for parents wanting a daughter after the birth of a son, a likely option if they wished to avoid penalties was to not report her, even if they used sex selection to get her.

That China's reported sex distortions have become the world's most severe is important and well-told news, first documented more than a dozen years ago. In addition to enhancing understanding of excess underreporting of daughters, this analysis produced four important new findings. The first is that the propensity to use sex selection may have already *declined* in China. After they were standardized by birth order, reported sex ratios at birth fell between the 2000 census (long-form sample) and the 2005 sample census. Future studies can better determine whether that observed decline might be due in part to China's Care for Girls program. Second, standardization by birth order reveals that sex ratios at birth, long thought to be higher in rural China, are instead higher in urban China. Rural areas show higher unstandardized ratios because they have larger proportions of higher-order births (where sex selection is most often employed), not because rural parents are more likely to practice sex selection at each birth order. Third, especially distorted sex ratios in 1.5-child areas seem to be due primarily to excess underreporting of daughters, compliance with sex-linked stopping rules (which affect parents' ability to have both sons *and* daughters), policy-selection effects, ethnic composition, and other factors. These explanations need to be taken into account before one can determine whether 1.5-child policies lead to more prenatal sex selection than in other areas. Lastly, if China's birth planning system had not contributed to sex ratio distortions via the 1.5-child stopping rule and excess daughter underreporting, distortions due solely to prenatal sex selection might have peaked at lower levels, closer to those evinced by South Korea in the early 1990s.

Acknowledgments This article draws from the author's work on China at the Census Bureau over the last decade. Several sections borrow from reports that were co-authored and developed in collaboration with Loraine West. Helpful comments on this and related reports over the years were provided by Peter Johnson, James Gibbs, Peter Way, and Frank Hobbs. Several demographic models used here carry over ideas developed by predecessors who covered China for the Census Bureau: John Aird and Judith Banister. Others who have facilitated this work include Andrea Miles, J. Gregory Robinson, John Long, Donna Dove, and Wan He. Editors and reviewers at *Demography* provided critical advice and support. This work is intended to inform interested parties of ongoing research and to encourage discussion of work in progress. Any views expressed are those of the author and not necessarily those of the U.S. Census Bureau.

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